T. A. T. Logan

A MANUAL

OF

MODERN SURGERY:

AN EXPOSITION OF THE

ACCEPTED DOCTRINES AND APPROVED OPERATIVE PROCEDURES OF THE PRESENT TIME.

FOR THE USE OF

STUDENTS AND PRACTITIONERS.

BY

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ILLUSTRATED WITH 473 ENGRAVINGS AND 8 PLATES IN COLOR AND MONOTONE.

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TO

THE MEMORY

OF

MY FATHER

CALEB C. ROBERTS;

AND

TO

CALEB CRESSON ROBERTS,

MY SON.

PREFACE TO THE SECOND EDITION.

THE purpose of the author, as stated in the Preface to the first edition, was to give to the profession in a condensed form the accepted doctrines and approved procedures of Modern Surgery. The criticisms of the author's efforts have seemed to indicate that he succeeded; and in the belief that a volume from a single pen may be more equable in its teachings than a composite book from many minds, he presents a new edition to his surgical colleagues.

Much space has been given to modern pathology and asepsis, without a knowledge of which no surgeon is equipped for work. Fractures and dislocations have been discussed in a specially practical and comprehensive manner, because of their daily importance to the practitioner of medicine and surgery. The articles on Appendicitis, Diseases and Injuries of the Joints, Diseases and Injuries of the Genito-Urinary Organs, Dislocations, Excisions, and Amputations have been entirely rewritten, and the text throughout has been carefully revised.

The volume has been indexed very thoroughly in order that it may be used with satisfaction as a book of reference.

The author is greatly indebted to his friend Dr. William S. Wray for valuable assistance in proofreading.

JOHN B. ROBERTS.

1627 WALNUT STREET, PHILADELPHIA.
October, 1899.

FROM THE PREFACE TO THE FIRST EDITION.

THIS treatise is the result of an effort to give the profession, in a condensed form, the accepted doctrines and approved procedures of Modern Surgery.

I have endeavored to write a practical work, giving the surgical principles and operative methods generally accepted and practiced by the leading surgeons of the world at the present time. The opinions of the best authorities, the methods of the most practical surgeons, and the well established facts of surgical science are discussed; but the consideration of theories, historical questions, traditional views and operations, and innovations of undecided value has been rigidly avoided.

The value of an author's discretionary power in such rejection or acceptance of material depends upon the carefulness of his analysis and the impartiality and soundness of his judgment. It has been my aim to bring these essentials to the work; hence, the statements of the volume represent my appreciation of the questions that have presented themselves.

In order to depict the present state of modern surgery I have consulted standard text-books and current surgical literature. The best and newest thought is usually found in the latest editions of monographs; therefore much use has been made of such works.

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PART I.

GENERAL SURGICAL PATHOLOGY OR PRINCIPLES OF SURGERY.

CHAPTER I.

INFLAMMATION.

DEFINITION, CAUSES, VARIETIES, EXTENSION OF INFLAMMATION.

Definition.—The term "inflammation" refers to the changes observed in living animal structure following an injurious influence insufficient to cause immediate loss of vitality. This initial factor may originate from without, extrinsically, as from a blow; or from within, intrinsically, as in inflammations due to deleterious elements circulating in the blood current.

Inflammation may be provisionally described as a peculiar molecular change in the walls of the small blood vessels, dependent upon an extrinsic or an intrinsic irritation, which increases the adhesion of the blood to the vessel walls and allows abnormal permeation of the blood elements through them. It must not be supposed, however, that an alteration can occur in the vessel walls without the tissues also being affected, for the lesion of the vessel wall is evidently not the essential feature of the process. Until the blood elements are allowed to escape by the abnormal permeability of the vascular coats, inflammation may be said not to exist.

Inflammation is a nutritive disturbance arising from damage to the tissues, and the object of the various phenomena produced is to overcome or lessen the effects of the injury. It is Nature's reparative effort to overcome the perturbations caused by an injurious influence on the living animal organism.

The microscopic changes in inflammation and in repair of wounds, for example, are nearly or quite identical; but repair need not show the clinical symptoms which are usually found in inflammation. This is well exhibited in the healing or repair of aseptic wounds. The symptoms observed clinically in surgical lesions, and to which the term inflammation is applied, are the result of bacterial infection of the lesion, either from within the vessels and tissues or from without the animal.

There are three terms, to which authors have given somewhat different applications, that, on account of their relationship to the process of inflammation, require explanation at this time. Hyperæmia is an unusual amount of blood in the vessels, due to any cause whatever. A hyperæmia due to physiological causation, as in glands during active secretion, in the skin in blushing, and in erectile structures, is called a determination of blood. Hyperæmia resulting from imperfect venous return, due to mechanical pressure on veins, gravity, or diminished cardiac power, is called congestion, which term should be employed only in this restricted sense. Hyperæmia produced by an increased amount of blood thrown into a part is often denominated "active congestion," but this tends to produce confusion. For practical purposes this form of hyperæmia is an early phenomenon in inflammation, and though often no sensible effusion occurs, it might, with considerable propriety, be styled inflammatory hyperæmia. The hyperæmia probably occurs because the damaged structures need reconstruction. It is possibly due to an alteration in the attraction between the blood and the tissues.

Hyperæmia and inflammation have a close relationship, since hyperæmia, whether physiological, mechanical, or active, if continued, leads to effusion and exudation, and inflammation at once exists. When inflammation subsides, hyperæmia is left as the last step toward restoration of the part to health.

To indicate inflammation of a structure the termination "itis" is added to the name indicating the structure affected, as peritonitis, pleuritis.

Causes.—The causes of inflammation are: the exciting or determining, which give rise to the actual outbreak of inflammation, and the predisposing, which have previously created a tendency that requires merely an exciting cause to initiate the inflammatory process. Exciting causes may be local, as in injuries, and constitutional, as in syphilis. Predisposing causes, in like manner, may be local, as in the weakness of an organ resulting from previous inflammations, and constitutional, as in inherited or acquired impairment of bodily vigor. A given cause may be at one time an exciting, at another a predisposing, cause. For example, hyperæmia due to increased functional activity of an organ may be the exciting cause of inflammation; again, the same hyperæmia of the same organ may be the predisposing cause to which an irritation, acting as an exciting cause, must be added to induce the outbreak of inflammation.

Inflammation due to external injury is called traumatic, that without definite assignable cause cryptogenetic or idiopathic. The latter term must not be understood as implying that inflammation can arise without a cause. Inflammation cannot spread unless its cause has extended its area of influence, nor can it persist without a similar persistence of its causation.

In considering the causes of inflammation it must be remembered that there are two factors in its etiology—the cause which exerts an exciting influence, and the tissue upon which such influence is exerted. In some cases the exciting cause acts without any predisposition of the tissue being present, while, at other times, the same exciting cause cannot produce inflammation unless the normal resisting power of the tissue is lowered. This impaired resistance of the tissue may result from either an acquired or an inherited predisposition. It is seen, therefore, that the predisposing cause of inflammation may be anything which has a tendency to lower the normal resistance of the body or any part of the body to irritating influences.

The exciting causes of nearly all inflammations may be classed under one of three heads: 1. Mechanical, as in injuries. 2. Thermal, as in burning and freezing. 3. Chemical, as in toxic inflammations, such as arsenical neuritis, and in inflammations due to the chemical products, or toxines, of micro-organisms. Among causes which may induce inflammation there are some which are perfectly obvious and easily detected. These produce what are often called simple traumatic inflammations. Under this head may be included mechanical and chemical injuries; injuries due to the application of heat or cold; those due to electricity, which causes electrolysis of the fluids, or to prolonged anæmia, or bloodlessness, of the part. Excessive functional activity and nervous influences are said to produce inflammation. Such inflammations do not tend to spread beyond the site originally subjected to injurious influences, nor to increase in severity after the application of the exciting cause has ceased. In fact, the height of the inflammation is reached soon after the receipt of the injury, and the inflammation rapidly subsides.

The irritation and consequent inflammation produced by a chemical agent does not, however, always show itself at the point at which the chemical agent gains admission to the body. Examples of this are seen in instances of inflammation of the internal organs, such as the kidneys and liver, produced by the absorption of drugs through the skin or stomach. Alcohol, for instance, produces chemical inflammation of the liver. Certain drugs, on the other hand, act injuriously on the kidneys, by which organ they are eliminated from the blood. These are instances of inflammation due to chemical causes, but widely different, of course, from the inflammation of the skin produced by powerful caustics, where the inflammation is produced at the point of application of the agent.

Rheumatic and gouty inflammations are perhaps due to a similar action of chemical agents in the blood. The inflammations due to what is ordinarily called exposure to cold or wet are probably associated with an irritation of the vessels, due to driving the blood from the surface of the body to the internal organs.

Many inflammations whose causation was formerly obscure, and which were, therefore, called idiopathic, are now known to be due to the presence of vegetable organisms. These fungi, which are variously called bacteria, microbes and micro-organisms, multiply in the fluids of the human body, and therefore furnish continuously acting causes. Inflammations resulting from these fungi, or microscopic plants are probably due to the chemical rather than the mechanical action exerted by them.

There is a very great variation in the severity or type of inflammation or disease due to these organisms; some of them are very virulent, causing at once gangrene, others cause a suppurative inflammation, and still others a chronic inflammation. The variety of inflammation may be fibrinous, suppurative, or productive. Some of them produce conditions which are not inflammatory. Tuberculosis, tetanus, anthrax, actinomycosis, glanders, abscesses and many other surgical conditions are caused by these fungi. Some fungi have a specific action and produce one disease which cannot be produced by any other organism. Other organisms produce different pathological consequences under varying circumstances. Some conditions, as virulent inflammation, may be produced by several varieties of bacteria.

Again, there are many organisms which, by entering the fluids of the body, do not, so far as known, produce any form of inflammation or disease. These are called non-pathogenic organisms in contra-distinction to those referred to above, which are called pathogenic organisms.

In studying the microbic, or mycotic, origin of inflammation it must be remembered that the inflammation is not due to the mere presence of the microbes within the body, because, under ordinary circumstances, the normal resistance of the tissues to pathogenic processes prevents the occurrence of inflammation. In other words, bacteria moving freely in the blood current may not inflame the tissues. Certain contingencies are requisite before their deleterious influence can be exerted. It is necessary that the organisms shall be arrested so as to be able to multiply and produce irritation; because, it requires a large number of these organisms in the tissue to produce a pathogenic change. Such arrest of bacteria may be caused by the processes of embolism and thrombosis, or by injury to a blood vessel by which an extravasation of blood takes place into the connective tissue surrounding the capillary vessels; or the organisms may be filtered out of the lymph current by the lymph glands. These processes which allow the micro-organisms to come to rest and settle may be the needed factor which will cause the advent of inflammation.

It may occur that, notwithstanding the arrest of bacteria, no inflammation occurs, because there is no predisposition in the tissue at the point of arrest, or in the general system of the patient, to suffer from microbic invasion. Sometimes the micro-organisms remain at one point, producing local irritation, but their chemical products or toxines enter the blood current and produce effects in distant parts of the body. This is a conspicuous characteristic of the bacterium which causes diphtheria.

This makes clear to us what is meant in the preceding paragraphs by "predisposing causes of inflammation." Any circumstance which results in a depression of the vital powers, such, for example, as the continued abuse of alcohol or prolonged anxiety and exhaustion, may induce a general or constitutional predisposition to inflammation. Bruises which cause extravasation of blood may act as a local predisposing cause; as, indeed, may any variety of wound. Wounds which are open to the air, by giving entrance to micro-organisms upon the surface of the body and in the air, are much more prone to inflammation than subcutaneous wounds, since the latter exclude the bacteria which are external to the patient's body.

Some bacteria will cause inflammation only when they gain access to a certain kind of soil which is favorable for their growth and development. Portions of the body, for instance, may be too cold for their development, in which event inflammation will not occur or will be arrested. If, however, these same organisms happen to become located in some part of the body which is warmer, they multiply and may at once excite inflammation. This illustrates what has been said before, that each organism has its peculiarity which must be accommodated in order to allow its development and pathogenic action. These microscopic plants are just as particular as to the kind of soil in which they grow and as to the circumstances surrounding their growth, as are the trees with which man comes in contact in the larger world.

Certain conditions of the blood, such as diabetes and Bright's disease, are particularly favorable for the development of certain forms of bacterial life and the consequent inflammations.

Again, the number of organisms which gain access to the tissues is a matter of importance. It can easily be understood that if but a small number infect the animal or human being they can be destroyed or rendered inert by the normal resistance of the tissue. The blood serum and the fluids of the tissues have a power of rendering micro-organisms inert, either by acting as an antidote to their toxines or by destroying the vitality of the germs. This protective agency is said to reside in the nucleins of the blood and tissues. It is known that the leucocytes and certain tissue cells, such as endothelial cells of vessels, have a tendency to surround germs and to destroy them. The force by which phagocytes are attracted towards the bacteria is called positive chemotaxis. At other times these cells appear to eat up the bacteria, and hence are called phagocytes. If, however, the dose of pathogenic organisms is very large, or relatively large compared with the resistant power of the blood serum, tissues and phagocytes, inflammation will be induced. The polynuclear leucocytes are apparently the most active phagocytes.

It is a curious fact that the growth of several organisms together may induce pathological results, which no one of them alone is capable of effecting. This is seen in the harmful effects resulting from the association of putrefactive organisms and pus-causing organisms. In this instance it is probable that the putrefactive bacteria destroying the granulation tissue which may be present allow the pyogenic fungi to gain access to the general circulation.

It is believed, also, that some organisms act antagonistically to other species of fungi. A patient inoculated with erysipelas becomes immune to infection with the anthrax bacillus. In a similar way the bacillus pyocyaneus antagonizes the pathogenic powers of the bacillus of anthrax.

The poison from micro-organisms may be attenuated by certain laboratory methods of handling the fungi. If they are cultivated outside of the animal body, and not passed through some animal for a long period of time, they soon diminish in virulence. There are other methods of cultivating these organisms, which in a similar way weaken or attenuate the poison. It is stated that the poisonous qualities may also be increased by similar manipulation in the bacteriological laboratory.

MICRO-ORGANISMS WHICH ARE ASSOCIATED WITH DISEASE.

The pathogenic vegetable parasites or fungi show no distinction between stem and leaf, and are without green coloring matter. They consist of one cell, and are of three kinds—bacteria, yeasts, and moulds. The first are the organisms to whose action most of the infective diseases are attributed. The disease called thrush, and which is characterized by grayish patches forming upon the mucous membrane of the mouth and adjacent parts, is due to a parasite which is one of the yeasts. It has recently been suggested that the malignant tumors called carcinomas may be due to a yeast. A number of skin diseases are caused by the growth of pathogenic moulds. Favus, tinea tonsurans, tinea sycosis, and pityriasis are instances of parasitic skin diseases due to moulds. Actinomycosis is due to a fungus probably belonging to this class.

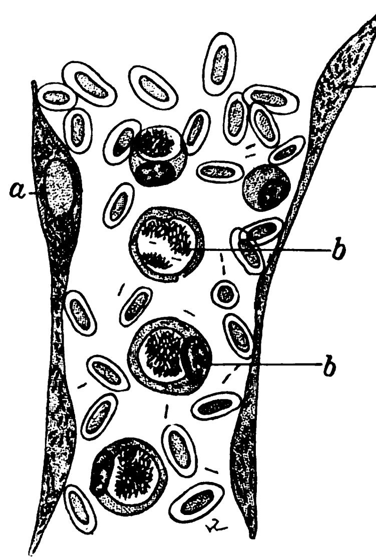
It should be remembered that the word bacteria is used very loosely by many to refer to all kinds of parasitic fungi. It is better, however, to restrict it to a single class, to which is also given the name schizomycetes. Bacteria are characterized by their method of multiplication, which is either by division or by the formation of spores. Yeasts, or sprouting fungi (blastomycetes), however, multiply by the budding process; while the moulds (hyphomycetes) have a more complicated method of multiplication or reproduction, and are characterized by numerous threads which interlace and form the mycelium.

Some of the protozoa, microscopic organisms belonging to the animal kingdom, infect animals and cause disease; but they are not important to the surgeon. Dysentery due to the amœba and malarial fevers due to the plasmodium are diseases of this character. Some malignant tumors have been thought to be due to protozoa. This has not been proved.

It is sufficient for our purpose to describe the different forms of cell which characterize the bacteria. If the cells are spherical or egg-shaped the fungus is called a coccus; if however the cells are straight rods the fungus is called a bacillus; if the organism is curved it is called spirillum. These three terms, then, are used to

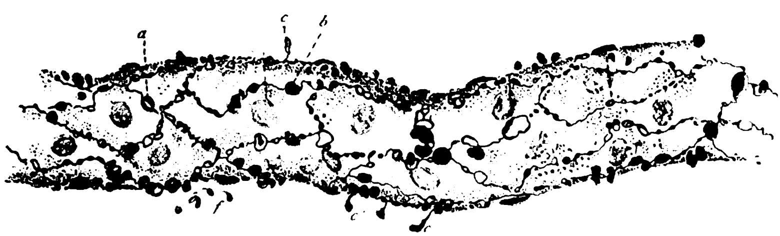
PLATE I.

FIG. 1.



Active Phagocytosis. Endothelial Cells enclosing the Bacilli of Swine Septicæmia, from an Hepatic Vein of a Pigeon: *a*, Endothelial Cells; *b*, Leucocytes. (Metchnikoff.)

FIG. 2.

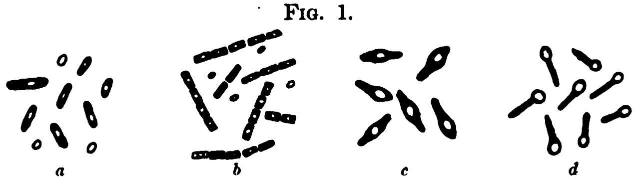


Small Vein showing Diapedesis of Leucocytes; *a*, Leucocyte escaping between Endothelial Cells; *b*, *c*, Leucocytes escaped; *f*, Leucocytes migrating toward centre of attraction. (Engelmann.)

give an idea of the shape of the plant, a single cell of which constitutes an individual. These cells may be grouped together in various ways. If the round or oval cells show a tendency to grow together in groups somewhat like bunches of grapes, the fungus is called a staphylococcus, or cluster-coccus; if the same shaped cells always grow in straight chains, like beads upon a string, the plant is called a streptococcus, or chain-coccus; if there is a tendency for two round or oval cells to keep close together, but separate from other cells, the fungus is called a diplococcus.

These remarks make clear the terms used to describe the fungi found in surgical diseases. The streptococcus pyogenes is, in accordance with its name, a pus-causing chain-coccus; whereas the staphylococcus pyogenes is a pus-causing cluster-coccus. There may be several kinds of staphylococcus or streptococcus, each of which has a distinctive adjective added to its name. Thus we have the white pus-causing grape-coccus and one of a golden color which has a similar pathogenic action.

FIG. 1.



a. Bacillus subtilis with spores. *b*. Bacillus anthracis with spores. *c*. Clostridium form with spores *d*. Bacillus of tetanus with end spores. (ABBOTT.)

In multiplying, the schizomycetes, or fission fungi, to which has been given the name bacteria, divide so as to form two or more individual cells. Some of them, however, multiply by the formation of spores, round or oval bodies, which grow within the cells, and subsequently become separate individuals.

Some of these micro-organisms have the power of motion and are called, therefore, motile forms. The various forms differ from each other in the character of food which they require; though carbon, hydrogen, nitrogen, phosphorus, sulphur, magnesium and potassium are needed, probably, by all. The presence of water is necessary for the development of fungi; therefore, thorough drying prevents multiplication of fungi, and, in some cases, kills them. Some require oxygen, which others can do without; hence they are called aërobic and anaërobic. The temperature to which they are exposed has also an important bearing on the life and development of nearly all forms. They are killed by boiling, or by a degree of heat very little above the boiling-point, provided that moist heat is used. Dry heat does not destroy them until it reaches a point considerably above the boiling-point. The bacillus of malignant pustule is of all pathogenic micro-organisms the most difficult to destroy by heat. Spores will resist a higher degree of heat and more changes of condition without loss of vitality than will fully developed fungi.

Bacteria are found in the air, in the water, in the earth, and upon the external surface of the human body. These organisms in large numbers, both pathogenic and non-pathogenic, are found under the nails and in the various folds of the skin, such as the axilla. They are also numerous upon the mucous membranes which come in contact with the air, such as the bronchial and intestinal mucous membranes and those of the mouth and œsophagus. In many instances they do no harm, even if pathogenic, because of the resistance of the tissues to their action, which is great when the vitality of the tissues is unimpaired; or because of the comparatively small number which gain access to the tissues. Under favorable circumstances, however, multiplication is very rapid, and one individual may develop into many millions in twenty-four hours.

The epidermis on the outside of the animal and the epithelium covering the mucous membranes constitute an armor-like protection against infection of the system by the entrance of bacteria. The secretions on the mucous membranes may also protect from bacterial invasion by exerting a germicidal influence, or by washing the germs away. A wound in the epidermis or epithelium is usually the atrium or portal of entry for the micro-organisms. Sometimes the wound may be so insignificant as to be overlooked; or it may have healed before symptoms of infection have shown themselves. Fresh wounds absorb bacteria and their toxines, or products, rapidly; but granulating wounds and those in which the vessels are closed with coagula, absorb them slowly. There may be no lesion exhibited at the portal of entrance, but the symptoms of infection may appear elsewhere. When organisms enter the blood a "septicæmia" is said to be present. Surgeons often employ the word "septicæmia" for a special form of infection.

It has previously been stated that the mere presence of pathogenic organisms in the blood current is not sufficient to give rise to disease. This, according to present pathological views, can only occur when the circumstances are favorable to their development within the body, and the resisting power of the tissue to their injurious action is imperfect.

The antagonism of the tissues to microbic invasion tends to prevent disease, unless the number or dose of infecting germs is too large to be successfully repelled. The leucocytes may form a wall or barrier around the bacteria, and, thus hemming them in, prevent their dissemination through the body; or they may be taken into the interior of the phagocytes and their vitality be destroyed. The blood serum is also antagonistic.

Some animals are immune to certain infections and particularly susceptible to others; and some individuals of a given variety of animals have immunity, either acquired or inherited, against certain infections. Erysipelas of the face, for example, is liable to recur, while a man who has once had typhoid fever is not likely to have it again, because he has acquired immunity. The formation of antitoxic substances in the body capable of neutralizing the poisonous products of the infecting bacteria is not yet well understood.

Varieties.—All forms of inflammation are either acute or chronic. The acute is rapid in course or severe in symptoms, the chronic slow in progress or less severe in symptoms. It will thus be seen that the terms acute and chronic each contain, perhaps improperly, two ideas—one referring to time, the other to severity. The word subacute is used to express an intermediate severity between acute and chronic, but has no reference to time. Hence inflammation, as to time, is termed either acute or chronic; as to severity, it is expressed as acute, subacute, or chronic.

Although inflammation is essentially the same in whatever tissue it may occur, the character of the exudate varies in accordance with the resistance of the tissue, the intensity of the injurious causative influence, and the time of action of that influence. These variations in the exudate may often be found in the same inflammation by examining different areas of inflamed structure.

Serous Inflammation.—In serous inflammation the exudate is characterized by a small amount of albumin and few leucocytes, being, indeed, very slightly different from the normal transudate of healthy tissues. This fluid does not coagulate. Instances of serous inflammation are seen in pleuritis with effusion, arthritis, hydrocele, and in inflammatory œdema of connective tissue. This form of exudate may be expected after slight or momentary injuries, in the early stages of more severe inflammations, and in cases where the blood is impoverished.

Fibrinous Inflammation.—Fibrinous inflammation gives rise to an exudate containing larger quantities of albumin and more leucocytes than that of serous inflammation, and hence is more coagulable. It forms, upon free surfaces and in the substances of organs, that which is clinically denominated "lymph." Lymph, then, is an inflammatory product consisting of fibrin and entangled leucocytes. It is sometimes called plastic lymph, to show that it is entirely different from the fluid called lymph which circulates in the lymphatic vessels.

The best examples of this form of inflammation are seen in the serous membranes, such as the peritoneum and pleura, and in the long continued or chronic inflammations of slight intensity in connective tissue. At times occurs a grade of inflammation intermediate between these forms, which may be termed sero-fibrinous inflammation.

These varieties of the inflammatory process may end by absorption of the exudate, which is accomplished by the leucocytes returning into the circulation by entering the lymphatic vessels, and by the fibrin and some of the leucocytes undergoing fatty degeneration previous to such absorption by the lymphatic system. The veins also take part in the absorption of the exudate.

Suppurative Inflammation.—In this very common form of inflammation the exudate contains the same elements as in the fibrinous, but does not coagulate. No lymph, therefore, is deposited, or, if any lymph has been deposited by the previous form of inflammation, it is destroyed by the accession of the suppurative stage. It is thus seen that the so-called varieties of inflammation are rather stages, or degrees, of the process. Suppurative inflammation is the result of a more irritative or longer continued cause than the serous or fibrinous forms. It is due practically always to pus-producing bacteria.

Acute suppuration is another term signifying the same process. If the suppuration is circumscribed in an abnormal cavity, the resulting condition is called abscess; if diffused in the tissues, purulent infiltration. Pus contained in a normal cavity, such as the pleural sac or knee-joint, is called a purulent effusion. If suppuration occurs upon a free surface of mucous membrane the condition is called purulent catarrh, provided the epithelium of the mucous surfaces is not destroyed; while it is called ulceration if the epithelium and subjacent tissues are destroyed. Suppuration attacking a cutaneous surface gives rise to what is also called ulceration.

Productive Inflammation.—When the exudate of a serous or fibrinous inflammation becomes converted into new connective tissue, the inflammation is termed productive, because of the formation of this new structure. The healing of a wound is a good illustration of productive inflammation. This process is accomplished by the fibrin disappearing and numerous leucocytes coming into the lymph, after which vascular loops from the capillary vessels of the inflamed structures penetrate the lymph and become surrounded by young cells. This new tissue, consisting of capillary loops and young cells, which have developed within the substance of the lymph, is called granulation tissue. The new tissue is produced most probably by proliferation of the native cells of the tissue rather than by proliferation of the leucocytes. Granulation tissue may be converted into connective tissue, often called scar tissue; it may degenerate into typical tubercles; it may become material looking like pus, but which is not true pus; or finally, it may actually break down into pus, the inflammation assuming the character of suppurative inflammation, which it then is. The third transformation of granulation tissue gives rise to what is variously called "chronic" or "cold" abscess, and to chronic suppuration in bone. The tubercle bacillus is practically always the cause of the second and third alteration.

Modes of Extension.—Inflammation cannot spread unless its cause extends before it; hence, inflammations due to mechanical and chemical irritants do not spread beyond the point at which the irritation was first exerted. All those inflammations which tend to spread from the original site are probably due to microbic causes. Such inflammations spread in three ways—by continuity of tissue, by the lymph current, and by the blood current.

When inflammation spreads by continuity of tissue, the bacteria which have settled there are spread into the surrounding tissues by being carried thither by leucocytes and by the lymph channels. This mode of extension of an inflammatory process is comparatively limited in its action.

When mycotic inflammation spreads by the lymphatic vascular system the bacteria are carried along by the current in the lymphatic vessels until they reach the first gland, where they are filtered out by the ramifications which the current makes in passing through the interstices of the gland. After being arrested thus they multiply and act as an exciting cause of inflammation, producing in the gland a secondary inflammation which is located at a considerable distance from the primary disease. This is quite different from the method of extension just described, where the fungi travel a short distance only in the lymph current, or are carried short distances by the white blood cells, choosing, as they do, the paths of least resistance. The blood current may carry bacteria to all parts of the body, but they are innocuous, as a rule, until they are arrested by extravasation, by clotting of the blood, or embolic plugging of the vessels. Under these circumstances, secondary or metastatic inflammation occurs. Pyæmia is a good example of such metastatic inflammation. The inflammation of mumps being carried to the breast and testicle is a similar example of metastatic inflammation. It is difficult to explain all cases of so-called sympathetic inflammation. It may be that the process is due to the infective agent being localized in certain organs; or to the absorption of the chemical products of inflammation in one organ being absorbed and having a special pathogenic influence on some other particular organ only.

PATHOLOGY, SYMPTOMS, AND TERMINATIONS OF INFLAMMATION.

Pathology.—The study of the pathological or essential nature of inflammation must be divided into a consideration of the rôles played by (1) the nerves, (2) the small blood vessels, (3) the blood, and (4) the tissues. The changes occurring in each of these, though in the main synchronous, must be investigated separately.

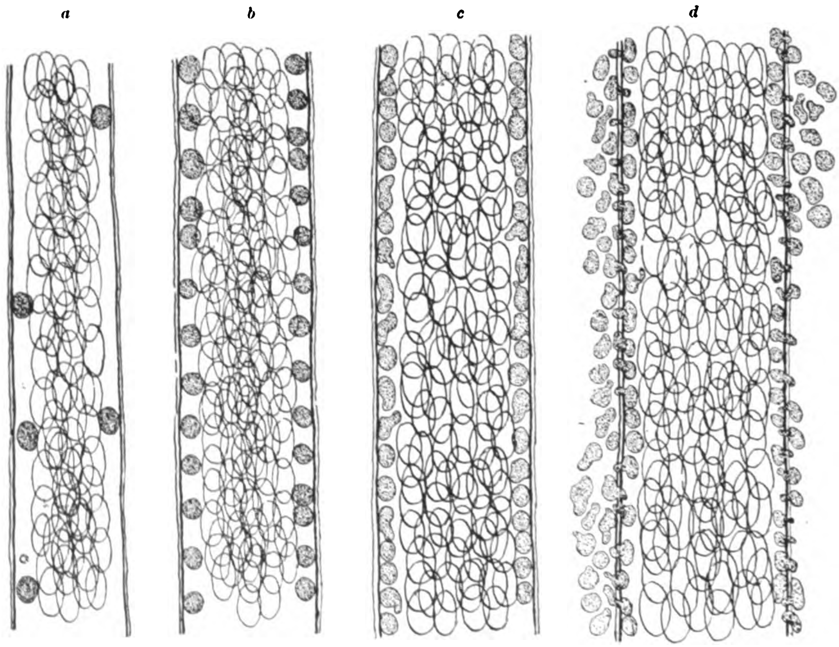
1. NERVES.—The agency of nerves is really unknown. It is not a vaso-motor influence. Researches show pretty conclusively that inflammatory phenomena depend on a direct injurious influence upon, and a vital alteration of, the walls of the blood vessels, without the necessity of any direct nervous agency.

2. BLOOD VESSELS.—As has been previously stated, the essential factor or lesion of inflammation is perhaps the change that occurs in the walls of the small blood vessels, by which the friction between the wall and the blood current is increased and the wall is made more porous. It is possible that the increase of blood in the inflamed region is the result of an alteration in the attraction between the blood and the tissues. It is denied by some writers that the essential feature of inflammation is the change in the vessel wall. In inflammation of non-vascular tissues, such as the cornea and cartilage, the same vascular alterations take place in the vessels which surround these structures, and upon which their nutrition depends. The vascular phenomena of inflammation are dilatation of the arteries, capillaries, and

veins and abnormal permeability of the vessel walls; followed by acceleration, with subsequent abnormal retardation, of the blood current. Mere acceleration of blood flow not followed by abnormal retardation and abnormal permeability does not constitute inflammation, though it may lead to it. *The dilatation of the vessels and the abnormal retardation of the current must be permanent.* A preliminary contraction of the capillaries is at times seen, but it is not an essential factor.

While vascular dilatation and blood retardation are being established, the white corpuscles accumulate, especially in the venules, and the red corpuscles generally in the capillaries, until stagnation or stasis of the current occurs. This stage of absolute cessation of motion is preceded by one in which is seen a mere oscillation of the vessel contents syn-

Fig. 2.



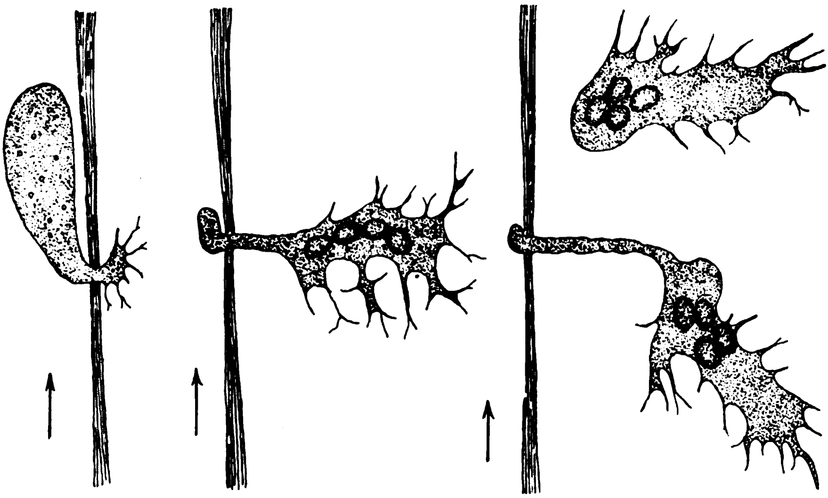
Diagrammatic view of inflammatory changes in a small vein: *a*, normal circulation, showing plasma-zone; *b*, *c*, *d*, successive changes, showing dilatation, accumulation of leucocytes, and emigration. (Dennis.)

chronous with the cardiac pulsations. Synchronous with these vascular changes there occur permeation of the blood elements through the vessel walls and increased absorption by the lymphatic vessels.

3. Blood.—The white corpuscles are relatively increased in inflammatory blood (leucocytosis) and show a tendency to keep near the walls of the vessels. They are less heavy than the red corpuscles, and hence are thrown to the margin of the blood stream. Inflammatory blood when drawn shows more fibrin than non-inflammatory blood.

This condition of hyperinosis and the buffy coat, formerly considered diagnostic of inflammation, have no diagnostic or therapeutic value. During inflammation white cells migrate through the walls of the venules, and red cells are pressed, as it were, through the walls of the

FIG. 3.



The process of emigration, observed under high power. The blood is supposed to flow on the left of the line in the direction indicated by the arrow. The tissue is on the right. × 1000. (After THOMA.)

capillaries into the surrounding tissues. This escape occurs through small openings (stomata) resulting probably from the contractile power of the endothelial cells composing the walls of the dilated vessels. There is no emigration from the vessels in which absolute stagnation has taken place, nor from the arterioles. The escape of the white corpuscles usually greatly exceeds that of the red, and the vessels soon become surrounded and obscured by the crowd of extra-vascular leucocytes. In intense inflammations in very vascular tissues the red escape in greater numbers than the white corpuscles, and a resulting hemorrhagic spot is visible to the naked eye. The number of migrating cells is increased in the later stages of the inflammatory process. It is possible for the emigrated leucocytes—(1) to be transformed into tissue cells; (2) to reënter the blood vessels; (3) to enter the lymphatic vessels; (4) to become pus-cells.

There also occurs an escape or exudation of fluid derived from the blood liquor and similar to it; which, when associated with the escaped white and red blood corpuscles and the proliferating cells of the inflamed tissues, constitutes the inflammatory exudate, or, as it has been termed by some writers, inflammatory lymph or fibrin. The escaping fluid differs from the simple serous or dropsical effusion, that occurs in congestion or mechanical hyperæmia, in that it contains more white corpuscles, more albumin, and is more prone to spontaneous coagulation. It differs from blood liquor, or liquor sanguinis, in having less albumin and less coagulability. This inflammatory fluid is well termed an exudation of lymph or simply an exudate; and the escape arising from venous distention a transudation of serum, or simply a transudate.

This exudate or inflammatory lymph is of paramount importance to the surgeon, for, by its organization and transformation into tissue analogous to that at the seat of injury or disease, hemorrhage is prevented, wounds united, abscesses circumscribed and limited, plastic surgery made possible, and other reparative surgical processes accomplished. At times, however, it produces morbid conditions, such as strictures and adhesions, alters structure by interstitial deposit, and is exceeding destructive to functional integrity.

It is well to apply the term exudate, or lymph, to effusions occurring from inflammation, even when they closely resemble the serous transudate of mechanical venous obstruction. The milder forms of inflammation give rise to a fluid containing so little albumin and having so little tendency to coagulation that it is impossible to distinguish it from the fluid of a non-inflammatory dropsy.

On mucous or serous surfaces the exudate is readily seen during the progress of inflammation; in some tissues it is exhibited as swelling; in the cornea and other non-vascular structures it is found surrounding the part, because it is the adjacent vessels which present the inflammatory alterations. *The blood phenomena of inflammation, then, are increase of white cells, retardation of current, migration, and exudation.*

4. TISSUES.—The tissues are swollen and infiltrated with the escaping blood elements, and the proper cells of the tissue involved show disordered nutrition, such as coagulation-necrosis and fatty degeneration. The impairment of nutrition may result in the formation of inferior tissue, suppuration, or gangrene. The peptonizing action of micro-organisms has to do with the inflammatory destruction of tissue; and thus aids the malign influence of the chemical and physical changes wrought by original injury, and the deluging of the tissues with escaping blood elements. Within the tissues there is proliferation or multiplication of the white blood cells which have escaped from the vessels, and also multiplication of the proper or native cells of the connective tissue. The proliferation of native cells, which takes place while repair or regeneration is going on coincident with inflammation of moderate intensity, must not be considered as a part of the inflammatory process. The nuclear activity of the *wandering* connective tissue cells, which differ from the *fixed* connective tissue cells, is very great in inflammatory disturbances. The great number of cells found arise from proliferation of the leucocytes, which have escaped from the vessels and these wandering connective tissue cells. This nuclear activity is termed karyokinesis or karyomitosis, and is shown by a division of the nucleus and the production of two cells from one. During inflammation the tissue elements are obscured by the intermingled white corpuscles and filaments of fibrin; and the structures are changed in

physical consistence, being sometimes softer than normal, at other times harder.

The tissue alteration of inflammation, then, may be described as *disturbance of nutrition associated with proliferation of cells.*

The phenomena of inflammation may finally be thus formulated:

1. Nerves: Unknown.

2. Blood vessels: Permanent dilatation of calibre associated with abnormal permeability of walls.

3. Blood: Permanent abnormal retardation of current associated with migration and exudation.

4. Tissues: Disturbances of nutrition associated with proliferation of cells.

Symptoms.—The local symptoms of inflammation are those exhibited at the point at which the process is going on; the constitutional or general symptoms are manifested by the patient's organism as a whole and are observable in functional derangement of the various organs without any necessary relation to the situation of the inflammatory changes. The general symptoms imply an existing inflammation, but do not indicate its locality.

THE LOCAL SYMPTOMS are pain, discoloration, swelling, heat, and disordered function. It requires the co-existence of a number of these abnormal manifestations to constitute inflammation, and one or more may be prominent or entirely absent, according to the variety of the inflammation and the nature of the inflamed tissues.

Pain is a subjective symptom of inflammation, while the other manifestations are, for the most part, really objective physical signs. The pain of inflammation is due to pressure of the exudate on nerve-endings and possibly to chemical irritation exerted upon them; is persistent; is increased by motion and the dependent position, and must be distinguished from the paroxysmal pain of neuralgia and spasm. Its severity depends more upon the tissue affected than the degree of inflammation, and is often inverse to the amount of swelling possible, because the pressure of the distended vessels and exudate upon the nerve filaments is increased when the structures are too dense to allow swelling. Pain may be reflected by nervous distribution to a part remote from the seat of disease, as occurs in coxalgia; in such cases it is not strictly a local symptom. Throbbing pain, which is due to increased tension at each pulsation of the heart, is usually indicative of the advent of suppuration.

The discoloration usually varies from the shades of red, the usual hue, to those of purple and blue. It is essential that the alteration in color be permanent, for the transient hyperæmia of merely physiological causation also produces redness. In the cornea, arachnoid, and similar non-vascular structures the change is manifested by a whitish opacity and a loss of lustre, while the surrounding vascular tissues present the usual inflammatory redness. In iritis there is a loss of lustre and a brownish discoloration.

The blackness of gangrenous tissue and the whiteness of necrotic bone have been erroneously instanced as illustrations of inflammatory alteration of color, but, since inflammation ends at the moment death of tissue occurs, these are not strictly inflammatory discolorations. The cause of the red discoloration in inflammation is the abnormal amount of blood in the vessels, and, perhaps, at times, a real staining of the tissues by the coloring matter of the corpuscles. As resistance to flow of blood increases because of change in wall of vessels and pressure from exudate, the parts become bluish, or mottled and pale.

The temperature of an inflamed part is usually increased. It is frequently above 100° F. There is no production of heat at the inflammatory focus, but the increase is due to the increased rapidity of the arterial circulation which brings more heat to the part and gives little time for its dissipation. A local increase of heat in chronic inflammation may be imperceptible; hence, for example, we speak of "cold" abscesses.

Inflammatory swelling is due to the increased amount of blood in the vessels and to the migration and exudation which occur. If the exudate consists principally of fluid the part is said to be œdematous, and a depression made in the surface by pressure of the surgeon's finger is apt to remain for a few moments as a little pit. This "pitting" does not show if the tissues are tensely stretched. It is most typical in œdema from mechanical hyperæmia. Usually the exudate is cellular rather than fluid and the swollen tissues are too hard to pit. Swelling is always great in those parts, such as the scrotum, formed largely of loose connective tissue, because there is less resistance to the escape from the vessels of inflammatory products. In dense resisting structures and under tense fasciæ much swelling is impossible; and hence, great pain is experienced during inflammation in such localities. The tissue-pressure thus induced may lead to gangrene by totally obstructing circulation, if not relieved by free incisions to allow escape of fluids and to relax distended structures. The occurrence of swelling is frequently beneficial by diminishing the intravascular pressure. If the exudate is small in quantity and the lymphatics carry it off, no swelling will exist. This occurs in slight grades of inflammation.

Disordered function is a symptom, sometimes subjective and sometimes objective, always present; and attracts attention when the other manifestations of inflammation are more or less in abeyance. The increased or impaired sensibility of the sense organs; the irritability of the hollow viscera; the modified secretions of the various glands; and the alteration of nutrition, shown by defective absorption, by atrophy and hypertrophy, are all well-known instances of functional disturbance arising from the inflammation. The injury inflicted upon every tissue by the morbid process readily explains the functional disturbance.

THE GENERAL OR CONSTITUTIONAL SYMPTOMS of inflammation are grouped together and called inflammatory or symptomatic fever, because the increase of the general bodily temperature is such a characteristic member of the group. The terms traumatic fever and surgical fever are sometimes employed as synonyms of inflammatory fever when the inflammation is due to an injury. Inflammatory fever varies with the intensity, extent, and locality of the process, and with toxic influences associated with it, and is practically absent in slight inflammations of unimportant localities and when microbic infection of the blood is prevented. It depends on the presence in the blood of products of the morbid tissue-change occurring at the seat of inflammation, or of poisonous principles manufactured at the seat of injury by micro-organisms of a vegetable nature. Inflammatory fever, in other words, is usually a poisoned condition of the blood due to micro-organisms. Inflammatory fever becomes prominent within twenty-four hours after the incipiency of the local symptoms. A moderate and very transient fever occurs with non-infected wounds at times, and is attributed to absorption of fibrin-ferment. It is called aseptic wound fever.

There are two types of constitutional disturbance in inflammation: the sthenic, representing excess of force; the asthenic, representing want of force. The irritative type, so-called, is not a special form, as all cases are necessarily either sthenic or asthenic. The respiratory, circulatory, digestive, nervous, secretory, and other general symptoms accompanying inflammation show modifications according to the type of the constitutional disturbance; hence, as the treatment must greatly vary in the two conditions, the necessity of an early recognition of the type is evident.

The constitutional symptoms of inflammation, when asthenic, resemble those of typhoid fever; hence, they are often said to belong to the "typhoid condition." The reader must remember, however, that typhoid or enteric fever and the "typhoid condition," though presenting similar symptoms, are different entities.

The following table shows the differential diagnosis of *typical* cases of sthenic and asthenic inflammatory fever:

	Sthenic.	*Asthenic.*
Patient	Usually of vigorous constitution.	Previously of weak constitution, though may have been vigorous.
Pulse	Full, bounding, 90–120.	Compressible, weak, 120–160.
Respiration	Oppressed, hurried.	Shallow (?), hurried.
Digestive organs	Constipation, loss of appetite, white furred tongue, thirst.	Bowels irregular, tendency to diarrhœa, loss of appetite, brown and dry tongue, sordes, thirst.
Skin	Dry and hot temperature, 100°–103°, chill at beginning.	Often clammy temperature, 99°–101°, chills and colliquative sweats.
Urine	Scanty, highly colored, uric acid abundant, chlorides diminished.	No marked difference from sthenic type.
Nervous system	Restlessness, headache, active delirium.	Stupor, not much headache, muttering delirium.
Muscular system	Pain in back and limbs.	Twitching of tendons.

Terminations.—There can be but two terminations of inflammation. First, gradual return of the tissues to health without destruction of their elements and functions; and second, death of these tissues, which may take place molecularly or in masses large enough to be readily seen. When inflammation terminates in the first manner the walls of the blood vessels are restored to their normal condition, the deposits absorbed and the damaged tissues regenerated. Resolution is then said to have taken place. In the second instance, if death occur molecularly, that is, if small particles die, it is called ulceration if in soft tissues, and caries if in bone; while death in mass of soft parts is termed gangrene, of bone, necrosis. It should be observed that pathologists apply the term necrosis to all forms of tissue-death, whether in bone or soft structures, in mass or in small particles.

Wounds or inflamed mucous membranes may become covered with an adherent fibrinous false membrane firmly attached to underlying necrotic tissue; they may have upon the surface a fibrinous pseudo-membrane loosely attached to the underlying tissue; they may present more or less extensive necrosis of tissue without a distinct false membrane. Such inflammations have been called "diphtheritic." They are not diphtheria. A wound may, however, in the same manner as a mucous membrane, become infected with the bacillus of diphtheria, and be covered with a false membrane. This is a true diphtheria. Diagnosis is only possible by bacteriological examination.

The results or sequences of inflammation, such as newly organized tissue, adhesions, effusions, exudations, pus, sloughs, and sequestra must not be confounded with its terminations. It can only terminate either in a return to health of the tissues inflamed or in the death of the same. The parts in the vicinity may continue in a state of inflammation, but the death of tissue, by either ulceration or gangrene, effectually terminates the inflammatory process in that particular tissue.

Resolution is the termination of inflammation which the surgeon ordinarily aims to secure, but in many instances it is impossible to obtain it, and suppuration, ulceration, or gangrene occurs.

Treatment.—The most important precept that can be taught in relation to the management of inflammation is this: Inflamed structures tend to recovery as soon as the cause of inflammation is removed. Hence, when the surgeon can remove the cause the rest of the treatment consists in merely waiting for the reparative efforts of nature, and in averting any secondary irritative action that may supervene. When the character of the cause precludes its removal, efforts must be made to avert the advance and the destructive effects of the inflammation, until the cause ceases to be operative.

Removal of the cause is to be effected on general rational principles: for example, a foreign body is to be extracted from the tissues; the patient himself is to be transported from unfavorable surroundings; or, if the cause lie in some vitiated state of the blood, remedies to remove that state are to be administered. Attempts to remove the cause are not justifiable, however, if they render the patient liable to conditions more dangerous to life than that for which he is being treated, for it must always be remembered that the surgeon is treating a condition rather than an entity. In non-infective inflammations recovery is prompt, because there is not a continuously acting cause as in mycotic inflammations. The so-called "antiseptic" treatment of inflammations aims to remove the bacterial cause, or prevent the conversion of a simple aseptic inflammation into an infective one.

Resolution, if possible, is to be induced by local and constitutional measures. The latter, of course, includes hygienic and dietetic as well as medicinal agencies. After injuries and operations the surgeon desires the presence of reparative processes, which will usually go on satisfactorily if bacterial infection is prevented. The prevention and arrest of microbic infection of wounds is the most important duty of the surgeon in this connection. The means by which these ends are to be accomplished will be discussed under Treatment of Wounds.

THE LOCAL TREATMENT of inflammation is properly discussed before the constitutional, because many cases of minor severity demand no constitutional treatment whatever. Inflammation is treated locally by (1) position and functional rest; (2) cold; (3) heat; (4) anodynes; (5) bloodletting; (6) drainage; (7) diminishing arterial supply; (8) antiseptics and necrotics; (9) stimulants and astringents; (10) counter-irritation; (11) compression, friction and massage.

POSITION AND FUNCTIONAL REST.—Rest from functional activity and that position which renders afflux of blood to the part most difficult are essential in treating inflammation, especially when acute. Elevation and immobility of the parts are, therefore, usually to be enforced, supplemented in many cases by confinement to bed.

COLD.—The depressant and sedative action of cold is utilized as a preventive of inflammation, and, in the earliest stages of the process, to limit its severity. It should not be employed when suppuration or mortification is to be feared, nor, as a rule, in chronic inflammation. Cold and moisture may be applied by cold baths, rapidly evaporating lotions, or by irrigation in which a constant application of water, simple or medicated, is maintained by allowing it to drop on cloths laid over the inflamed part. Dry cold is obtained by using tubes or rubber bags filled with cold water or ice. The cold should be moderate and probably acts by contracting the vessels and thus indirectly relieving engorgement. It should be continuously applied.

HEAT.—Heat is often combined with moisture. Hot dressings are properly used when there is pain and tension, a tendency to suppuration, and a probability of mortification. They aid in mortifying processes by causing separation of the sloughs, thus promoting the suppurative action beneath the dead tissue. Heat is usually indicated when cold is contra-indicated. It may be obtained by local baths of hot water or steam, fomentations, heated sand bags and hot-air apparatus.

Any warm or hot application combined with moisture acts as a poultice, if evaporation be prevented by rubber cloth, waxed paper, or other impervious covering. Layers of gauze, moistened and covered with rubber tissue, make the best poultice. Heat, perhaps, does good by dilating peripheral capillaries; but it is chiefly beneficial when suppuration cannot be avoided. It promotes blood flow, stimulates the activity of the leucocytes, and hastens and localizes the suppurative focus. When resolution without suppuration is possible, heat does good by favoring absorption of exudate, increasing the blood flow, and encouraging the cells to enter the lymph spaces. The protracted use of heat is objectionable because it causes relaxation of tissue. When suppuration is inevitable deep incision is preferable to poultices, because it relieves pain promptly, prevents destruction of tissue, and hastens cure.

ANODYNES.—The narcotics, especially the preparations of opium and belladonna, are frequently beneficial by relieving the pain of inflammation. Extract of belladonna, softened with water and smeared over the surface, and opium combined with acetate of lead are favorite prescriptions.

LOCAL BLOODLETTING.—The direct abstraction of blood from engorged vessels and the opportunity of escape afforded deposits infiltrating the tissues are the means by which puncture, scarification, incision and wet cupping act as potent agencies in combating inflammation. At times it is not practicable to incise the vessels and tissues of the inflamed organ, and then wet cupping or leeching at an adjacent point is done to relieve the hyperæmic structures. Local depletion is probably most beneficial after stasis has occurred in the capillaries. Before that event attempts should be made to diminish the arterial supply by local and general sedatives. As a rule the bloodletting should be applied at the focus of inflammation, and the bleeding encouraged by warm applications. The advantage of incision over poulticing has been mentioned previously.

DRAINAGE.—This is accomplished by incisions, and the insertion into wounds of tubes, strands of cat-gut or horse-hair, or gauze wicks. Drainage relieves tension, evacuates irritating fluids, and removes albuminous fluids in which contaminating germs would develop.

CUTTING OFF ARTERIAL SUPPLY.—This is done by applying pressure upon, or by ligating in its continuity the main artery, and thus diminishing the supply of blood to the inflamed member.

ANTISEPTICS AND NECROTICS are adapted to the treatment of wounds, and are usually employed as prophylactics to prevent excessive inflammation liable to occur from pyogenic or putrefactive bacterial infection, or from inoculation of animal poisons.

The use of carbolic acid, corrosive sublimate, formaldehyde and similar agents will be described in discussing the antiseptic treatment of wounds. The most efficient necrotics to prevent absorption of the poison of hydrophobia, snake bites, etc., are the actual cautery, strong nitric acid, potassium permanganate and solution of nitrate of mercury. Immediate excision is preferable when it can be adopted.

STIMULANTS AND ASTRINGENTS.—These local remedies, of which nitrate of silver and acetate of lead are examples, occupy a high rank in the treatment of inflammation, especially of mucous membranes. The more chronic the inflammation the stronger must be the stimulant and astringent impression.

COUNTER-IRRITATION is applied at a point more or less remote from the inflammatory focus, and varies in degree from mere redness of the skin to vesication, suppuration and complete destruction of the skin as by the actual cautery. Except in the mildest form, as obtained by sinapisms, counter-irritation is seldom used in acute inflammation. It probably acts by abstracting blood from, and lessening the textural excitability of, the inflamed organ.

COMPRESSION AND FRICTION.—Compression, by means of muslin or elastic bandages or adhesive strips, and friction or massage, either with or without oils and liniments, are most efficient means of relieving muscular spasm and of producing absorption of deposits in chronic and the late stages of acute inflammation.

Constitutional Treatment.—The general or constitutional management of inflammation comprises: 1. Abstraction of blood by venesection. 2. Increase of secretion and elimination by cathartics, diaphoretics, diuretics, and emetics. 3. Diminution of vascular tension by cardiac depressants. 4. Increase of vascular tone by tonics and stimulants. 5. Decrease of nervous excitement by anodynes. 6. Reduction of temperature by antipyretics and the general application of cold. 7. Correction of morbid conditions of blood by alteratives and specifics. 8. Regulation of sanitary surroundings and diet.

These measures, however, as well as the local means, are not all to be employed in each instance of inflammation, for, while some are appropriate to the sthenic type, others are adapted to asthenic cases. Moreover, it is to be remembered that many medicinal agents have a combination of activities, being, at the same time, evacuants, anodynes and cardiac depressants; hence, one or two remedies will often meet all the requirements.

VENESECTION.—In the early stages of acute sthenic inflammation, when the after-depression from loss of blood will be less detrimental than the threatened destruction of the integrity of a vital organ, general bloodletting is beneficial. Venesection acts mechanically by lessening the amount of blood in the system; and, therefore, relieves inflammatory engorgement, which may be the most disastrous factor of the inflammatory process demanding treatment. This is especially true of pulmonary and cerebral inflammations. Vascular engorgement, however, is the result, not the cause of inflammation, and removal of blood is not removal of inflammation. Venesection should not, as a rule, be employed when the pulse is feeble and frequent and the symptoms those of asthenia, nor when it is probable from the activity of the inflammatory attack, as in blood-poisoning, that depression will shortly follow.

CATHARTICS, DIAPHORETICS, DIURETICS, AND EMETICS are internal remedies of value; because they increase glandular secretion, which is arrested in inflammatory fever, act as derivatives by attracting blood to other organs, deplete by drawing away the watery constituents of the blood, expel irritating substances from the system, and have a refrigerant or cooling effect.

DEPRESSANTS.—Aconite, veratrum viride, and nitroglycerine are the cardiac sedatives and remedies most frequently employed to reduce the high vascular tension, exhibited by the full, bounding, frequent pulse of acute inflammation occurring in robust, plethoric persons. They are selected when the depressing influence of venesection is considered unwarrantable.

TONICS AND STIMULANTS.—Asthenic inflammations, on the other hand, require from the first, quinia, iron, strychnia, digitalis, alcohol, and highly nutritious food, to increase cardiac power and sustain life under the depressing effects of the inflammatory process. The same remedies are usually needed after the subsidence of active sthenic symptoms, which leave the patient emaciated and exhausted by the severity of the structural changes that have taken place.

ANODYNES.—Pain, restlessness, and general nervous excitability call for the administration of opiates, chloral, the bromides, sulfonal, hyoscin, phenacetine, and kindred drugs, to give physiological and functional repose. The beneficial effect on inflammatory fever of a few hours' profound sleep is familiar.

COLD.—Sponging the surface of the body, cold packs, and cold baths are certainly effectual in diminishing bodily temperature, and are employed advantageously in inflammatory affections. Phenacetine, acetanilid, guiacol and similar drugs with a known ability to lower the general temperature are often valuable remedies.

ALTERATIVES AND SPECIFICS.—Certain inflammatory lesions are best combated by specific remedies, which have some alterant or eliminating blood action and which should be given as soon as the diagnosis is established. As examples may be mentioned mercury and the iodides in syphilitic inflammations, quinia and arsenic in malarial, and colchicum in gouty lesions. The removal of inflammatory products in chronic conditions is certainly effected by the so-called sorbefacients, among which the preparations of mercury, iodine, and ammonium chloride stand preëminent.

SANITARY AND DIETETIC MEASURES.—Cleanliness of person and of surgical dressings, freedom from microbes and deleterious atmospheric influences; regulation of the temperature of the room; proper ventilation; freedom from noise and anxiety; good nursing and judicious diet are more important than any one requirement heretofore mentioned under the constitutional treatment of inflammation. Acute sthenic cases may require some restriction of diet, but not the starvation treatment of past generations of surgeons. Asthenic inflammation invariably requires concentrated, easily digestible food at frequent intervals.

In conclusion, a recapitulation of the differential therapeutic indications of sthenic and asthenic and of acute and chronic inflammations may be instructive.

Sthenic cases present symptoms of overaction, and require depleting, depressant, and non-stimulant remedies, with restricted diet.

Asthenic cases present symptoms of depression, and require corroborant, tonic, and stimulant remedies, with abundance of nutritious food.

Acute inflammations, being either sthenic or asthenic, require treatment according to their type, with depleting and soothing applications locally.

Chronic inflammations, being usually more or less asthenic in type and characterized by much inflammatory deposits, require tonic and alterative treatment, with stimulating applications locally.

CHAPTER II.

DESTRUCTIVE INFLAMMATORY PROCESSES.

SUPPURATION, ULCERATION AND GANGRENE.

WHEN the microbic cause of an inflammation is sufficiently intense or sufficiently prolonged in its action, the process goes beyond the minor grades of serous and fibrinous inflammation, and becomes suppurative. The organisms which have been arrested in the capillaries multiply, if they find conditions favorable to growth and give off the products of their metabolism. The fibrinogen of the exudate is converted into peptone and the formation of fibrin in the exudate is prevented.

For the clinical purposes of the surgeon pus only occurs in association with micro-organisms, and, therefore, does not occur in inflammation of a simple traumatic kind, unless the seat of the inflammation becomes infected with fungi. There are about two dozen vegetable parasites which are known to cause the formation of pus; those most frequently found are the staphylococcus pyogenes aureus, the staphylococcus pyogenes albus, and the streptococcus pyogenes. The first two are cluster-coccusses, while the streptococcus is a chain-coccus; the two former usually produce circumscribed suppuration and abscess, while the streptococcus is usually the cause of spreading and diffuse suppuration.

Some pus-producing fungi always act as pus producers, if they exert any pathogenic influence; others only occasionally act as pyogenic organisms, having usually a different and often a specific influence. Among the former or obligate class of pus germs are those already mentioned, the gonococcus, the bacillus coli communis, the bacillus pyocyaneus and the bacillus pyogenes fœtidus. The facultative pus producers include the bacillus typhosus, bacillus proteus, bacillus diphtheriæ, bacillus tuberculosis, bacillus œdematis maligni, bacillus anthracis, bacillus mallei, etc. The bacillus pyocyaneus causes pus of a bluish or greenish tint. The tubercle bacillus gives rise to a peculiar curdy greenish-white fluid, due to softening of tubercular tissue which is not quite like true pus. It is a puriform or pyoid fluid. The germ may perhaps at times cause the formation of true pus. Some of the lower forms of animal life, such as the amœba and coccidia, may cause pus.

The importance of the connection between organisms and suppuration is very clear, because it indicates at once that great care must be taken to prevent infection, in simple traumatic inflammations, with germs from the hands of the surgeon, his instruments, or dressings.

Pus is a yellow or greenish-white, alkaline fluid, presenting characteristics varying with the peculiarities of the inflammation producing it. It consists of a liquid in which float corpuscles, principally multinuclear leucocytes. The pus liquor is composed of water, albumin, fats, and salts, and is derived from the blood, the liquid portion of which it may resemble, though it often differs greatly. It contains, however, the pus-forming micro-organisms and their chemical products, disorganized tissue and the altered offspring of connective tissue cells. Pus serum contains leucin, tyrosin and peptone. The micro-organisms are not usually found within the pus cells except in gonorrhœal pus, where the gonococcus is often seen within the protoplasm of the cell. The corpuscles are, in part, the migrated leucocytes referred to in the section on the pathology of inflammation, which have now lost their vitality. Some of them are still capable of changing their shape and migrating, and are considered to be the white blood cells which have just escaped from the vessels. As usually seen under the microscope the corpuscles are dead, and have lost the amœboid movements of the living cells. Pus is recognized as such by the naked eye, if there be at least 40,000 to 60,000 cells in a cubic centimeter.

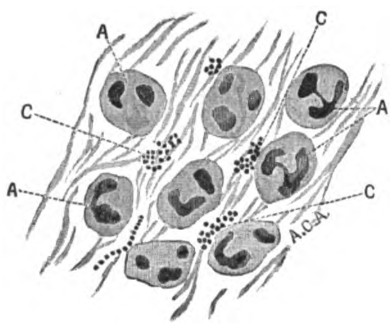
Suppuration has a tendency to cause liquefaction and disintegration of the tissues. Pus may occasionally be absorbed after fatty metamorphosis, or be changed into a caseous mass; as a rule, however, if not evacuated by operation it is discharged through an opening produced by its disintegrating action on the overlying tissues. It may come from a free, unbroken surface, as in inflammation of mucous membrane; and constitutes most of the discharge in cases of ulceration, unless the ulcer has been kept aseptic. Then a serous exudate is the product of the ulceration.

Varieties.—When a granulating surface in a healthy person is progressing favorably toward cicatrization the pus excreted is of a creamy consistence, and has a specific gravity of about 1030, a yellow color, and little or no odor. These features, therefore, pertain to what was formerly called healthy or laudable pus. The so-called unhealthy pus was frequently, though not always, thin, of low specific gravity, of a dirty yellow or reddish color, and had a putrefactive smell and a tendency to irritate the skin. It was termed ichorous pus. Sanious pus was an ammoniacal or strongly acid pus mixed with blood. Other adjectives are used to describe various conditions and appearances of pus; thus, curdy, gummy, scrofulous, sanguinolent, contagious pus and muco-pus are terms often heard, but most of them are indefinite and unscientific. At the present time the occurrence of pus is believed to be due to infection of the wound by micro-organisms; hence no pus can be called healthy.

Gonorrhœal infection is a condition which is due to the gonococcus, and produces, when a mucous membrane is affected, a discharge of pus. The mucous membrane of the vagina or male urethra is most frequently the seat of the primary infection, but the mucous membranes of the eye and nose are sometimes affected primarily. The eyes of children are frequently infected during passage through the birth canal. This is the ophthalmia of newborn children. With gonorrhœal infection there is often combined a pyogenic infection. Other symptoms of gonorrhœal infection are arthritis, pleuritis, salpingitis, metritis, peritonitis. It is a true infection.

Tests.—Pus mixed with other fluids can be detected by the addition of solution of potassa, with which it forms a gelatinous mass. Microscopic examination discloses the characteristic spheroidal semi-transparent motionless corpuscles, about $\frac{1}{2500}$ of an inch in diameter, containing granules and broken up nuclei. The nuclei are made more distinct by the addition of dilute acetic acid. Examination with suitable illumination and sufficiently high oil-immersion lenses will bring to light the micro-organisms to whose presence the suppurative action is due.

FIG. 4.



Preparation from pus, showing pus-cells, *A*, and staphylococci, *C*. (ABBOTT.)

ABSCESS.

Definition.—An abscess is often described as a collection of pus circumscribed by a wall of lymph or as an abnormal cavity containing pus ; while suppuration occurring within the meshes of the connective tissue without such limiting wall is called a purulent infiltration, and a secretion of pus from a mucous, serous or granulating surface, a purulent effusion. These distinctions are, however, frequently ignored. It would be less confusing to define an abscess simply as a cavity containing pus, without any restrictions as to a limiting wall or to the nature of its surroundings.

Varieties. ACUTE ABSCESS.—When pyogenic organisms are arrested in the capillaries they multiply and cause coagulation-necrosis in the tissue cells. This local death of tissue at the center of an abscess is the direct result of the poison or toxine of the micro-organism and is the starting point of the abscess. To prevent the injurious effects of the organisms a large number of leucocytes appear in the region affected, rapidly multiply, and, by their endeavor to prevent encroachment of the micro-organisms upon other tissues, form a barrier around the group of germs. This wall made by condensation and cell-infiltration of the surrounding tissues is not a distinct membrane.

The bio-chemical antagonism between the organisms and the leucocytes is kept up until the wall of granulation tissue created by the action of the white blood cells is too dense for the micro-organisms to penetrate. It is thus that the suppurating focus is circumscribed; within this wall the tissue cells break down, and under the peptonizing influence of the micro-organisms the formation of fibrin in the exudate

PLATE II.

Abscess in Kidney of Rabbit after Intravenous Injection into an Ear-vein of Culture of Pyogenic Cocci. Dense mass of cocci surrounded by area of coagulation necrosis due to their toxic activity. Outside this a zone of phagocytes. [Park.]

is prevented. The cavity of the abscess, therefore, contains dead leucocytes, micro-organisms and their chemical products, and destroyed tissue cells, in addition to inflammatory exudate. These constituents make up the creamy liquid which is called pus.

The tendency of the pus contained in this cavity is to soften the surrounding tissue and to spread in the direction of least resistance until it is discharged through an opening upon a free surface. This is called the pointing or spontaneous opening of an abscess. Such a spontaneous opening relieves the tension, which has been one of the causes of the continuance of the inflammation, and permits the pus and micro-organisms to be evacuated. The collapse of the walls of the abscess and the adhesion of the opposite surfaces readily complete the cure, if the admission of putrefactive bacteria is prevented. The various tissues differ in the rapidity with which they soften under suppurative influences. Hence masses of tissue, infiltrated with purulent material, and softened structures may remain for a time without complete disintegration and retain their general form. These masses are called sloughs and are found especially in diffused abscesses. Putrefactive germs aid in prolonging the suppurative action perhaps by interfering with formation of granulation tissue.

Healing of the abscess may be hastened by the surgeon opening the cavity and evacuating its contents long before the pus reaches the surface; but, in this event, it is equally important that the operation should be done antiseptically.

Very rarely the pus of an acute abscess may become encapsulated and undergo caseation or calcification; the mass encapsulated in a sort of sac may then remain in the tissues as an innocuous tenant for many years, though it forms a spot of least resistance at which inflammation may readily be set up at any future time.

Diffuse suppuration frequently occurs and causes what is often called diffuse abscess. The process is of similar pathological nature to that just described, but the pus is not enclosed in a distinctly limited cavity. The condition is due to a more intense inflammation, and is usually believed to be due to the presence of the pyogenic streptococcus, which has a more intense peptonizing influence on the cells than the mycotic causes of such suppurations as are limited by a distinct barrier of cells. Sloughs and shreds of gangrenous tissue are often found commingled with the pus of diffused suppuration. The term phlegmon or phlegmonous inflammation is often applied to diffused abscesses. It is sometimes applied to the circumscribed process described above, which is usually the result of infection by the staphylococcus pyogenes aureus.

The acute or phlegmonous abscess necessarily corresponds in symptoms with acute inflammation, of which it is a result. The advent of suppuration in the progress of acute inflammation is often marked by rigors and great constitutional disturbance; after which the throbbing local pain, the shining red skin, and the acuminated appearance indicate that an abscess is being formed. The fluid contents give the sensation of fluctuation to the examiner's fingers, if the pus has reached a point near the surface of the body. The pus usually produces softening of structure, and tends to escape toward a free surface. The consequent elevation of the overlying tissues is distinctive of an abscess about to point, and, as the skin becomes thin over the advancing pus, the characteristic yellow color becomes apparent, after which a small slough is separated, leaving an orifice through which the pus is discharged. The walls of the abscess then collapse, and the cavity is filled up like an ulcer by the granulating process; in fact, an abscess within the tissues has been called a "closed ulcer." Deep abscesses may produce very little change upon the surface, except a localized œdema.

METASTATIC ABSCESSES are essential elements of pyæmia, and will receive consideration under that heading.

The so-called CHRONIC or COLD ABSCESS, which is usually a lesion of tubercular inflammation and is therefore slow in progress, does not exhibit very active local symptoms. It is apt to occur in connection with bones and lymphatic glands and in persons of the so-called scrofulous habit, but may be found in any region and in any patient. There is no heat of skin, little or no cutaneous redness, no pain, and generally no tendency to pointing. The skin finally becomes thin over the puriform collection and an orifice by which the contents escape may form after a long time; but, instead of the pointed elevation of an acute abscess, there is seen a general rounded protrusion of thin and purplish integument. The puriform liquid is confined by a thick wall, forming a tough sac lined with velvety elevations; and is usually thin in consistence, and contains cheesy masses, ill-formed corpuscles, and cholesterin crystals. It is not pus in the strict sense, and should be discriminated from that which is found in acute abscesses. Chronic or tubercular abscesses often become very large, because they do not tend to spontaneous evacuation. If we do not consider the fluid in these so-called chronic abscesses to be pus, and it certainly differs from pus, the term abscess is inappropriate. The term, however, is still retained because of its convenience. The lesion is possibly due to an infection with both tubercle and pyogenic germs.

Diagnosis.—Acute abscesses are diagnosticated by the history of preceding acute inflammation, the superficial œdema, the throbbing pain, the appearance of pointing, the sense of fluctuation; and in cases of doubt by the use of an exploring needle or by the withdrawal of some of the pus with a hypodermic syringe or aspirator. Chronic abscesses are distinguished by the absence of symptoms pointing to aneurism, cystic tumor or malignant growth, by the negative history, the possibly depraved constitution of the patient, œdema, fluctuation, and by aspiration. Fluctuation is the wave caused by the displacement of fluid when pressure is suddenly made upon the swelling. It shows the existence of liquid contents, but gives no indication of their character. It may be obtained by placing the fingers of the two hands on opposite sides of the suspected abscess and making intermittent pressure or striking sudden taps. In small collections it is better to grasp the swelling between the thumb and fore-finger of one hand, and make the parts tense, while intermittent pressure is make by the fore-finger of the other hand. The transmission of the impulse proves that the contents are fluid, but other symptoms must be investigated to determine whether pus, serum, or blood is contained in the tumor.

Treatment.—Since abscess is the result of mycotic inflammation, the local and constitutional means previously described, as appropriate for the cure of inflammation by resolution, should be adopted when suppuration is threatened. A blister is often very serviceable, and seems to dissipate the suppurative inflammation. If it is found that resolution is impossible, rapid maturation and evacuation of the abscess are to be obfained, and restoration of the parts to a normal condition promoted. Hot and moist applications, such as wet gauze covered with rubber tissue, soften tissue and encourage rapid migration of leucocytes; hence they are proper when resolution and absorption seem hopeless. Poultices are less employed since the advent of the antiseptic era; and more early operative interference than formerly is usual. Ointments are sometimes serviceable, such as resorcin, gr. v, ichthyol, gr. x, mercurial ointment, gr. xxxv, wool lard, gr. l.

To relieve the pain and tension and prevent disfiguring scars and destruction of tissue, early evacuation, by means of a free incision made with a sharp knife, is imperatively demanded in all cases of acute abscess. As a rule, the incision is not followed by serious bleeding, because the vessels are thrombosed by the inflammation. Incision made before pus has actually formed will often cut short the suppurative process, and, if made sufficiently free to relieve tension, always lessens the pain. The opening of an abscess must always be an aseptic procedure. After the incision, the interior of the sac should be thoroughly scraped out with a curette and made perfectly aseptic by means of irrigation. This removes all pus and micro-organisms. The cavity, if small, may then be sewed up so as to bring the walls together and allow healing. If the abscess be a large one it may be needful to provide for drainage by the use of drainage-tubes. This is especially necessary in large cavities that cannot be thoroughly scraped and disinfected. Dressings should be antiseptic in character, and should exert some pressure so as to cause collapse of the walls of the cavity. If there is danger of wounding large vessels the abscess may be opened on a grooved director, or it may be torn open with a blunt instrument after incision of the skin. Sometimes this last procedure is well done by inserting the end of a pair of closed forceps and forcibly opening the ends of the blades. In all cases where the cavity is large the orifice should be kept open by a tent made of a piece of antiseptic gauze, or by a drainage tube; and permanent pressure should be applied by means of a bandage, in order to hasten contraction and granulation of the sac of the abscess. Counter-openings may be necessary when the pus infiltrates the connective tissue or burrows or gravitates into pouches which prevent its ready escape. The original opening should be large and so placed as to favor drainage by gravitation. Abscess in a bone will require chiselling to open it. Pus under tense fascias, as in the palm of the hand or under the periosteum, demands early and very free incision.

In tubercular abscess the treatment is the same. The evacuation of many fluid ounces of puriform liquid may, by exposing the wall of the abscess to the air with its septic influences and by the sudden relief of pressure to which the surrounding capillaries were accustomed, lead to rigors, exhaustive fever, and grave constitutional symptoms. Hence, as the fluid is sometimes, though very rarely, absorbed, and chronic abscesses may remain without pointing for indefinite periods, it was formerly the custom with many to abstain from operative interference. This is injudicious, for withdrawal of the so-called pus by the aspirator, and the application of firm pressure, or incision and disinfection under the strictest antiseptic precautions, are best.

Supporting remedies and anodynes are important in all cases of severe or prolonged suppuration. The blood serum of animals made immune by repeated inoculation with streptococcus pyogenes has been proposed as a remedy, to be administered hypodermatically, in cases of phlegmonous abscess. Its value is at present doubtful.

The local treatment of all abscesses, then, whether acute or chronic, should be early and free incision with strict antiseptic precautions. Good watery solutions to use in washing out small abscess cavities are corrosive sublimate (1 : 1000 to 1 : 5000), carbolic acid (1 : 50 to 1 : 100) and formaldehyde (1 : 500). As there is some risk of poisoning if large quantities of the sublimate solutions remain in large and irregular cavities, that drug must be used with caution. Solution of iodoform in ether (1 : 10 to 1 : 50) is a good material for injecting the cavities of tubercular abscesses. Some surgeons prefer a solution of iodoform in olive oil in the proportion of 1 : 10. This solution can be sterilized with heat. It would be dangerous to heat an ethereal solution. In all cases the solution, of whatever character, is subsequently allowed to flow from, or is pressed out of, the abscess cavity.

SINUS AND FISTULA.

When an abscess has been evacuated it may not contract and heal completely, but, especially when drainage is imperfect and the muscles prevent perfect rest, may leave a long, narrow, and sinuous canal through the tissues. This is lined by a membrane having somewhat the character of mucous membrane, from which pus is discharged. If the canal has only one orifice it is called a sinus; if more than one, a fistula or fistule. They are practically tubular ulcers. The term fistula is sometimes limited to such a canal communicating with one of the hollow organs, as the bladder, rectum, or lachrymal sac. The orifice of a fistule or sinus is usually surrounded by exuberant granulations projecting as a papilla. Sinuses and fistules are cured by destroying the adventitious lining membrane and setting up acute inflammation, in order to cause healthy granulation to take place from the bottom. This may be done by irritating injections, the actual cautery, curetting, or by laying the track open with the knife or elastic ligature; and in many cases still better by dissecting the whole canal out and approximating the healthy wound so made with sutures. Any source of irritation, such as diseased bone or foreign material, must be removed at the same time. Injection with muriatic acid, ♏ iv; pepsin, gr. viij water, f ℥j, may be beneficial by acting as a sort of digestive agent to destroy the lining membrane.

The term fistule is also applied to a communication between two hollow viscera, due to injury or sloughing. Such abnormal openings are cured by plastic operations. Congenital sinuses are minute tubular canals due to imperfect coalescence of fœtal structures. The congenital orifices in the neck, due to incomplete closure of the branchial clefts, are examples. Such sinuses may become the seat of inflammation.

ULCERATION.

When inflammation does not terminate by resolution in a return to health, death of the part by either ulceration or gangrene must take place. Ulceration is death in small particles or molecules; gangrene is death in masses large enough to be seen. Similar processes in osseous tissue are called caries and necrosis, and will be described under diseases of bone. The causes of ulceration are the same as the causes of inflammation, to which ulceration always owes its existence. It may occur superficially, as in the skin and cornea; or deeply, as in the substance of organs, for abscesses and sinuses are practically but the results of ulceration. The ulcerative process is more common in skin, mucous membranes, cartilages, lymphatic glands, lungs, and bone (called caries), than in fibrous, serous, or muscular tissue. Ulceration consists in softening and disintegration of structure, followed by the removal of the débris by absorption and ejection. When removal of tissue is effected by absorption alone, as is seen in erosion of tissue from aneurismal pressure, the term interstitial absorption is applicable since ulceration causes removal chiefly by discharges. Sloughs and foreign bodies in the tissues are usually thrown off by ulceration.

Suppuration is often an accompaniment of ulceration; because pyogenic infection is likely to be the cause of the inflammatory process which has given rise to the ulceration. If the slough or foreign body is removed from the living tissues by an aseptic process, and no pyogenic contamination occurs, no pus is found. The word ulceration is used somewhat carelessly at times and gives rise to confusion. Ulceration produces on a free surface the anatomical lesion called an ulcer or open sore.

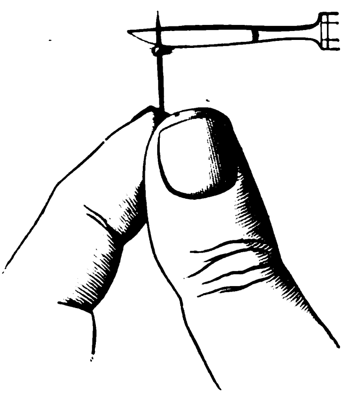
ULCERS.

Definition.—An ulcer is a breach of continuity of surface, covered by granulations. The nature of the granulations and of the discharge determine the character of the ulcer. The solution of continuity may be due to the process of ulceration, to gangrene, or to a wound; for in gangrene the slough is separated by ulceration, and wounds that do not heal by first intention become ulcers as soon as granulation is instituted. A solution of continuity called an ulcer is usually deeper than the epidermis or epithelium; if not, the terms abrasion, desquamation, or excoriation are commonly applied.

Ulcers are healthy or unhealthy, aseptic or septic. The healthy ulcer is typically illustrated by the sore produced when granulation has begun in a wound made by cutting out a portion of tissue. The edges are regular and smooth, and slope gradually toward the granulations, which are red, painless, do not bleed under gentle pressure, secrete a serous non-purulent fluid, and do not protrude much, if at all, above the surface of the skin. The granulations at the circumference are being converted into a bluish-white cicatricial pellicle of epithelium, while the skin surrounding the ulcer is purplish and somewhat hardened by inflammatory infiltration. All ulcers must be brought to this condition before cicatrization can occur, and so long as the ulcer continues healthy, healing goes on spontaneously and steadily, if the surface be only protected from infection or other injurious contact.

Unhealthy ulcers are those accompanied by some condition which prevents their exhibiting the characteristics above mentioned. If undue inflammation be present, as shown by great heat and pain, œdematous surroundings, engorged granulations, and discharge of pus mixed with blood, it is an inflamed ulcer. When this process is violent and rapid, destruction of tissue and extension of ulceration occur, a pultaceous mass is seen covering unhealthy-looking granulations, and the edges become irregular and sharp-cut. This constitutes a phagedenic, or sloughing ulcer; which is a rather contradictory term. The devitalized skin or muscle is often found in the discharge from such an ulcer, as shreds and tags of tissue.

FIG. 5.



Method of cutting small skin-grafts by means of needle and scalpel.

When the granulations are exuberant and project like excrescences beyond the level of the skin the ulcer is called a fungous ulcer. The callous or indolent ulcer is deeply excavated, has indurated, whitish, and undermined or inverted borders, is surrounded by thickened and congested skin of a bluish color, shows imperfectly-formed pale granulations covered with a foul-smelling thin pus, and is usually insensible to painful contact. Such ulcers are of long duration, and may well be termed chronic. Ulcers may be complicated with, or may depend upon, varicose veins, impeded circulation, and diseased bone, or may be the seat of hemorrhage or malignant processes. Ulcers, otherwise healthy, are often the seat of a purulent discharge, because pyogenic germs have been allowed to come into contact with the ulcerated surfaces.

Chronic ulcers of the front of the leg are common; and are due to poor circulation, chronic inflammatory processes and general debility. Chronic ulcers above the level of the knee are usually syphilitic, tubercular or epitheliomatous. Their syphilitic origin should always be suspected, if they are clearly not due to injury.

The infrequent lesion called perforating ulcer of the foot probably includes more than one form of ulceration. It usually occurs on the sole near the metatarso-phalangeal joint of the great toe or where there is pressure. It is a chronic, painless ulcer, with thickened edges and overhanging epidermis, and shows a tendency to extend upwards into the foot. This lesion has been found associated with neuritis, leprosy and syphilis. It should not be confounded with senile gangrene or ulcerated corn of the sole.

Treatment.—The criterion in the treatment of all ulcers is the condition of the edges. If the borders are pinkish and smooth, and gradually slope down to florid granulations, or perhaps are separated from them by a narrow line of bluish-white epithelial cicatricial tissue, it is certain that the ulcer is in a healthy state, and only requires protection from irritation. Hence, it may be dressed with any bland non-irritant application. Carbolized ointment of the oxide of zinc (carbolic acid, gr. x; ointment of oxide of zinc, ℥j) is, in my opinion, one of the best, if the ordinary aseptic protective silk or rubber, covered with a gauze dressing, is not used. Cicatrization usually takes place from the edges toward the center; and therefore, in large ulcers, even when healthy, the action of the cutaneous cells at the margins may be insufficient to complete the process, or if able to do so, may be very slow in causing healing of the entire ulcerated surface. Centers of cicatrization may be established upon the ulcer at any number of points by applying aseptic grafts of skin (Fig. 6).

Skin-grafting is readily performed by thrusting the point of an aseptic sewing-needle under the epidermis of the inner surface of the arm or thigh, previously made aseptic, and, after putting the skin on the stretch by raising the needle, cutting out a minute portion of the true skin with a sharp scalpel or scissors. The graft taken in this almost painless and bloodless manner is then to be gently passed upon the healthy granulations with its epidermic surface upward, and a gauze dressing applied. Any number may be engrafted. The grafts at first shed their cuticle and become almost invisible, but in a few days bluish-white spots of cicatricial tissue are seen at the points where some grafts have taken root. These islands grow eccentrically by epithelial cell proliferation, and stimulate the periphery of the ulcer to similar activity, so that the cicatrizing process is greatly expedited by the new points of cutification, which gradually coalesce with one another and with the marginal skin.

The process is not attended with much success unless the ulcer be healthy. Long and thin shavings of skin cut from the thigh or arm by means of a sharp razor may be used in a similar way. This method causes much more rapid healing, but the pain is rather severe when the shavings are cut. When cutting skin grafts it is wise to wash away the antiseptic solution, used to sterilize the skin and ulcer, with a sterilized solution of sodium chloride of about the specific gravity of blood serum. This prevents the vitality of the grafts being lowered by contact with the antiseptic. The salt solution should be 0.6 per cent. (approximately ʒj to f℥xvj), and rendered sterile by boiling. The razor should be dipped in this artificial serum and may also be greased with sterile oil. The skin may be put on the stretch with hooks or the fingers, to enable the operator to cut long thin shavings of skin. The shavings, 4 inches long and a-half inch wide, are placed upon the open wound or scraped ulcer to be covered, with their edges overlapping. A piece of sterile rubber tissue is then laid upon the grafts and gauze applied. The dressing is not disturbed for five or six days. The shavings should not include the entire thickness of the skin. Mucous membrane may be transplanted in a somewhat similar manner to remedy defects in mucous surfaces. The whole thickness of the mucous membrane is used. Skin may be taken from a living frog's abdomen and laid upon the ulcer. Plastic operations may be performed to hasten the healing of intractable ulcers by the transfer of healthy integument to their surfaces.

FIG. 6.

Skin-grafting in traumatic ulcer of the scalp.

The treatment of all unhealthy ulcers must be directed to transforming them into healthy ulcers, and is both constitutional and local. If they depend upon syphilis, specific remedies, such as mercury, and the iodides, must be given internally; if the sores are tubercular, iodine and its derivatives, cod-liver oil and tonics, are required. In all cases digestive and other constitutional vices must be investigated and treated. Any local exciting cause, such as bone disease and varicose veins, must be removed or at least palliated, after which local treatment is to be regulated by the condition of the ulcer. An ulcer accompanied by acute inflammation must be managed on the principles already laid down in the treatment of acute inflammation.

Antiphlogistic internal remedies are demanded, while elevation and rest of the part, scarification, lead water and laudanum, warm water dressings, or weak astringent solutions are used locally. When the inflammation is severe enough to cause sloughing ulceration, supportive treatment and poultices, to hasten separation of the sloughs, or other mild applications are demanded. The local irritability and pain which characterize many ulcers are often greatly lessened by the application of solid nitrate of silver, or strong solutions of the same (gr. xx to f℥j of water). Subnitrate of bismuth is an excellent local remedy. A moist antiseptic gauze dressing, covered with oiled silk or rubber tissue to prevent evaporation, is far better than the old-fashioned poultice. It is, in fact, an antiseptic poultice. Applications of pepsine or pepsine and dilute hydrochloric acid, as in the treatment of sinuses, may be valuable to aid in digesting and removing sloughing tissue. Ulcers should be made clean and kept so ; frequent washing and dressing may be demanded for this purpose. Soap and warm water is often of great value. Antiseptic lotions have similar value.

Fungous ulceration is treated by caustics, such as deliquesced chromic acid, or by the surgeon cutting away the exuberant growth with the knife, or scraping it away with a sharp spoon. Ulcers exhibiting pale, œdematous, semi-transparent granulations require stimulating applications of nitrate of silver and sulphate of copper, in solution or undiluted. Boroglyceride is sometimes valuable.

Callous or indolent ulcers are the most rebellious to treatment. The hard elevated edges must be softened and depressed, and the accompanying venous congestion, shown by the livid skin surrounding the sore, removed. A good plan is to apply pure carbolic acid, nitric acid, or some other chemical cauterant, to the insensitive edges and to the foul and semi-devitalized tissue covering the depressed and unhealthy granulations. Then a moist antiseptic dressing is applied for a few days to separate the slough thus produced and to soften the callous borders. Subsequently scarification around and through the ulcer relieves the engorged venous capillaries. The pressure of strips of adhesive plaster properly adjusted or of an elastic bandage, smoothly applied from the distal extremity upward, prevents a repetition of the congestion and stimulates absorption of deposits and cicatrization of the ulcer. Astringents and disinfecting lotions may be used beneath the elastic bandage. Instead of using the caustic, the surgeon may get rid of the callous margins by paring them away, and then treat with antiseptic dressings and pressure; or the whole ulcer may be scraped away with a curette and treated as a recent wound. Chronic ulcers of small size may be frequently cured with rapidity by dissecting them out, freeing the surrounding skin from its deeper attachments, and uniting the edges of the wound by sutures. Solution of hydrogen dioxide renders a foul ulcer aseptic by oxidizing the devitalized and putrefying discharges. It penetrates the grease, if ointments are being used and is an efficient cleanser before the daily dressing is applied. Very weak solutions of formaldehyde may be serviceable.

Tubercular ulcers may be treated with powdered iodoform. Curetting or excision is often necessary.

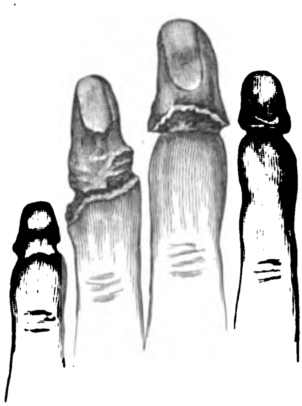
As soon as unhealthy ulcers approach the healthy condition cicatrization begins, and may be hastened by skin-grafting. In order to maintain a healthy state of the sore and prevent œdematous and fungous granulations, slightly stimulant lotions of chloral (gr. v or x to f℥j), sulphate of copper (gr. iij–v to f℥j), sulphate of zinc (gr. v to f℥j), or nitrate of mercury or subnitrate of bismuth in solution, ointment, or powder should be employed. When in a few days or weeks the ulcer gets accustomed to the effect of one agent and becomes "inactive," the dressing must be varied, for a new impression will be beneficial. Mucous ulcers are to be treated like cutaneous sores.

MORTIFICATION, OR GANGRENE.

Definition.—Mortification, or local death, is the complete and permanent cessation of vital functions in a part, and differs from ulceration in the devitalized portion being more extensive. Ulceration is molecular death, while mortification is death of appreciable areas of tissue, that is, of tissue in mass. The two processes are, however, allied, and may co-exist, as in hospital gangrene, or sloughing phagedæna, where ulceration is too rapid for disintegration to take place. The dead tissue is called a slough or eschar. Necrosis is often used by pathologists to signify death of animal tissues in mass without reference to the character of the structures, but in surgery necrosis is usually applied to bone and cartilage; and mortification, gangrene or sphacelation to soft tissues.

Causes.—Mortification is due to defective nutritive supply and to destruction of cellular activity. The former condition may be caused by obstruction in the arteries, as from ligation, rupture, embolism, plugging by great numbers of bacteria, or diseased arterial walls; obstruction in the veins, as from tight bandaging; obstruction in the capillaries, as from pressure of tumors or inflammatory deposits, or ergotism; cardiac weakness, which is merely an accessory cause, decreasing the activity of the circulation; inflammation, which by its intensity induces permanent arrest of circulation.

FIG. 7.



Raynaud's disease; symmetrical gangrene; digiti mortui. (LANCERAUX.)

The causes which induce mortification by destroying the vitality and activity of the cellular elements are:—injuries, which disorganize tissue; chemical agents, such as acids and alkalies; the toxines of specific germs; and excessive heat or cold. Mortification is often due to a combination of several of the causative influences. Defective innervation has been considered a cause of mortification, but it is probable that it acts only indirectly by diminishing circulatory activity or by rendering parts less cognizant of the contact of irritating agents. The power of the cells to resist gangrenous causes varies in individuals and in tissues. Diabetics are particularly prone to gangrene.

Varieties.—Mortification may be moist or dry, acute or chronic, according to the causation and circumstances attending the process. If the parts contain much fluid, as is the case when the mortification is associated with venous obstruction and when evaporation is prevented by the integrity of the cuticle, the process resembles the ordinary putrefaction of animal substances seen in dead bodies. This is called moist gangrene. The local symptoms are due to the fact that ordinary putrefaction is occurring because putrefactive fungi have gained access to the dead tissue through the skin. If the gangrene is due to slowly progressive arterial obstruction while venous and lymphatic absorption is not decreased, or if rapid evaporation occurs on account of the destruction of the cuticle, the parts become shrivelled and dry, and dry gangrene is said to exist. Acute gangrene is usually moist, because it dies quickly when full of blood, while chronic mortification is generally dry. Soft and vascular tissues mortify much more rapidly than dense, non-vascular structures, such as tendons and cartilages. Bed sores due to pressure are good examples of gangrene.

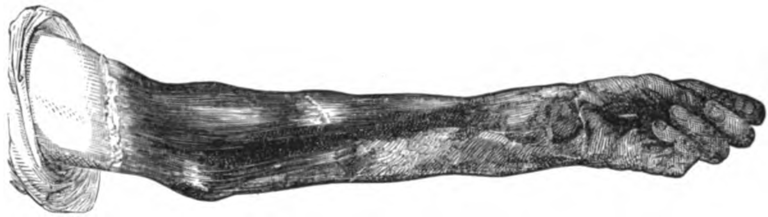
The infarctions found after embolism of renal and other arteries, the caseous change that occurs in tubercular products, and similar pathological conditions are examples of what has been called coagulation-necrosis, which is a change of protoplasm into a material resembling the fibrin of the blood.

Symptoms.—The constitutional symptoms of gangrene are almost invariably asthenic, probably because the blood becomes deteriorated by the admission of septic products derived from the sloughing tissues. The feeble circulation and general nervous depression accompanying a very limited area of mortification are often remarkable.

The local symptoms of moist and dry gangrene differ and must be discussed separately. In the moist variety the parts become green, bluish, or black, lose their normal sensibility and temperature, and become softened and covered with blebs containing reddish-brown fluid. The epidermis is easily rubbed off, leaving a dark, smooth surface. Pressure causes a crackling sound, due to the presence in the tissue of the gases generated by putrefactive decomposition. The gases, which are principally sulphuretted hydrogen, ammonia, and carbonic acid, cause great local emphysema and puffiness of the parts, and with the other products, such as butyric acid, give the characteristic odor of putrefaction. The red streaks along the course of the vessels in the incipiency of gangrene, and the deep color of the parts during its existence are due to the transuded coloring matter liberated by the destruction of the blood corpuscles.

In dry gangrene the appearance of a small brown or black spot, especially upon the toes, where the affection is most frequently seen, is often the first sign of disease; though at times cramps and stinging pain and feeble local circulation are premonitory symptoms. The discolored point, instead of being brown, may be a mottled white, and sometimes a vesicle forms at the beginning of the disease. The dark-

FIG. 8.



Chronic dry gangrene of arm.

ened area becomes blacker and slowly extends with very few accompanying inflammatory symptoms. The dead tissue is dry, without offensive odor, and gradually becomes shrivelled and hard. The loss of sensibility and the lowered temperature of the dead tissue present in moist gangrene, of course, exist here. This form of mortification is frequently called senile gangrene, but improperly so, since it may occur from chronic ergotism without reference to the patient's age, and because moist gangrene may occur in the aged in similar regions of the body.

In all forms of mortification, if the patient survive long enough, the dead tissues are separated by the process of ulceration from those whose vitality resists the destructive influence. The living structures become reddened at the line of junction with the slough, and thus constitute the line of demarcation which indicates the extent to which the devitalizing process has been able to exert its influence. Sometimes a row of vesicles forms along this margin. The line of demarcation soon becomes converted into a groove which is lined by granulations. This is practically a linear ulcer, and is the line of separation, where the ulcerative and granulating processes gradually push off the dead tissues by a species of natural amputation and leave an ulcer to heal by cicatrization. Hemorrhage is prevented by coagulation within the arteries and fibrinous deposition due to the inflammatory action. The inflammation accompanying mortification often gives rise to great pain, which is located in the living or partially devitalized structures. This increases the general depression due to the septic influence of the gangrenous parts. When mortification occurs in deep structures, the slough is thrown off through fistulous orifices, as occurs in carbuncle, and as is attempted by nature, though often unsuccessfully, in necrosis of bone; or, it may become encapsulated and thus be kept apart from the surrounding living structures. The latter mode of separation is seen in infarctions of the internal organs.

Treatment.—The general treatment of all forms of gangrene, to be judicious, should be directed to fulfil two indications: first, to remove the cause and thus arrest the progress of the gangrenous action; and, second, to sustain the patient until separation of sloughs has occurred. Unfortunately, the constitutional cause is often difficult of removal, but an effort should be made to bring the system into that condition, which will render the causative factors as inoperative as possible and limit the mortification. If the peripheral circulation is poor because of a feeble heart and degenerated arteries, remedies such as quinia, iron, opium, digitalis, strychnia, alcohol, and nitroglycerine should be administered and the patient protected from cold and other depressing influences. When there is a tendency to a sthenic type it is possible that slightly depressing agents may be advantageous, but these are seldom needed and should be used with great caution, since the advent of gangrene is soon followed by nervous and circulatory prostration.

During the stage of separation of sloughs the flagging powers of the patient must always be supported by active medication with tonics, stimulants, and concentrated nutritious diet. Depressing antiphlogistic remedies are never justifiable, and if nervous irritability and pain exist opium in full doses is to be employed. Cleanliness, disinfection, and ventilation are necessary hygienic measures. The local treatment of mortification is very important.

If gangrene is threatened on account of the tension produced by rapid and intense inflammatory swelling, it may often be averted by free incisions several inches in length through skin and subcutaneous and fascial structures. This treatment relieves local tension by permitting gaping of the wound and affording a free escape of blood and inflammatory products. Much tissue destruction is thus avoided by removing the obstruction to capillary circulation. Parts prone to slough from deficient circulation should be kept normally warm. When gangrene has occurred disinfectant lotions of carbolic acid of an unirritating strength (1 : 20 or 30), corrosive sublimate (1 : 1000 or 3000), chlorinated soda, formaldehyde (1 : 300 or 500), or desiccating powders of a disinfectant nature, should be used to destroy the fetor of the parts. These should be combined with antiseptic gauze dressings, perhaps made moist and covered with oiled silk or waxed paper, in order to encourage and hasten separation of the devitalized tissues. The sloughs may be removed in pieces with the forceps and scissors after the line of separation has divided the vascular attachments. Tendons and fibrous tissues, as they contain no vessels of importance, may be carefully cut, for in this manner the decomposing masses can be removed somewhat earlier. No special dressing is to be applied to the line of separation. The ulcer left after the slough has been detached is to be dressed with mild applications, such as carbolized oxide of zinc ointment, ointment of petroleum and boric acid, or antiseptic gauze, as in ordinary ulcers. Cicatrization is to be encouraged.

When mortification depends on a known local cause, such as crushing of the parts or ligation or rupture of the main artery, amputation should be performed, except in cases due to frost-bite or burns, above the location of injury without waiting for the line of demarcation. If the gangrene is due to constitutional causes, such as deficient circulation or ergotism, or to the presence of an embolus whose location is unknown, the surgeon must wait until the line of separation is well marked before attempting operative interference, since the extent of the gangrenous influence cannot otherwise be estimated. In traumatic cases where gangrene is inevitable, amputation should be promptly performed.

HOSPITAL GANGRENE.

Hospital gangrene, or sloughing phagedæna, is a rapidly-spreading mortification or gangrenous ulceration which attacked wounds in which the epidermis was broken, when patients were subjected to the foul air of overcrowded hospitals and the wounds were infected by bacteria. It was exceedingly infectious, and at times began as a vesicle if the parts were not much denuded of cuticle. The constitutional symptoms, which were secondary, were markedly asthenic. The disease was of local origin, due to wound infection.

Fortunately the aseptic and antiseptic methods of modern surgery have made hospital gangrene practically unknown, and there has been no opportunity to study it by modern bacteriological methods. It may have been a violent infection, with the ordinary pyogenic germs, of tissues with greatly lowered resistance.

In gangrene of an emphysematous character the gas bacillus (bacillus aërogenes capsulatus) has been found on at least one occasion.

MALIGNANT ŒDEMA.

A very virulent gangrenous inflammation, to which the designation malignant œdema has been applied, is known to be due to a special bacillus, the bacillus of malignant œdema. It gives rise to an œdematous swelling, which crackles from the contained gases when pressure is made. The overlying skin is brownish and streaked with blue veins. Death occurs quickly and putrefaction is very rapid. Free incisions, antiseptic disinfection of the tissues and stimulating remedies are demanded.

CHAPTER III.

TRAUMATIC FEVERS AND COMPLICATIONS OF WOUNDS.

SAPREMIA, SEPTICEMIA, PYEMIA, ERYSIPELAS, TETANUS.

Definition.—There are four febrile conditions found after wounds which ought to be distinguished; though it is admitted that a clinical diagnosis is frequently impossible.

1. ASEPTIC WOUND-FEVER arises in connection with aseptic wounds, and is due largely to the heat-producing action of the so-called fibrin ferment. This is given off during the disintegration of leucocytes and the absorption of blood clots and bruised, but aseptic, tissue. The inflammatory fever usually seen is, however, one of the forms of septic poisoning mentioned below. If the wound is absolutely aseptic the wound-fever is always inconsiderable. Aseptic wound-fever subsides in two or three days; seldom reaches more than 101°, though it occasionally goes a little higher; and should be treated by laxatives, such as calomel and salines, and cold sponging. It often needs no treatment. Fever after aseptic operations may be due to the use of carbolic acid or iodoform, to tension due to tight sutures, or to auto-intoxication from unevacuated material in the bowels.

2. SAPREMIA, putrid poisoning, or septic intoxication, is a febrile condition, due to soluble chemical toxines, or ptomaïnes; and is developed by putrefaction of animal tissues. These poisons gain access to the blood by development and retention in insufficiently drained putrescent wounds. The poison is the result of mycotic action, of course, for putrefaction is due to fungi of putrefaction. The symptoms of sapremia occur immediately after inoculation, but it requires a comparatively large dose to produce a toxic effect.

3. SEPTICEMIA, or septic infection, is a fever due to infection by putrefactive and pyogenic micro-oganisms, which enter the blood by the mucous membranes or a wound, usually by the latter, and do not produce symptoms until they have had time to multiply and produce toxines. The clinical symptoms are similar to those of sapremia; but a most minute dose is sufficient to lead to violent symptoms, because the number of organisms rapidly increases.

The condition, formerly called hectic fever, in which there was a habitual daily tendency for the temperature to rise quite high and then fall to normal, corresponds with what is now called septicemia. Surgeons restrict the term septicemia to an infection of the blood by putrefactive and pyogenic germs. Pathologists use it to describe infection with any organism.

4. PYEMIA is an infection in which the general febrile disturbance, similar to that in septicemia, is due to pyogenic germs, and in which

secondary foci of inflammation or suppuration, called metastatic abscesses, are formed in the lungs, liver and other organs. These abscesses in distant organs are due to the transportation in the blood stream of emboli infected with pus-causing bacteria.

Pathology.—The poison, which by introduction into the blood causes sapremic conditions, is the result of putrid decomposition of albuminous fluids. It is the toxines of putrefactive bacteria; or perhaps, it may be said, of putrefactive and pyogenic bacteria. Septicemia and pyemia are due to infection by the micro-organisms themselves. The three conditions appear to be due to the activity of the organisms usually grouped together as pyogenic. It is impossible to differentiate between the bacteria of decomposition and those of pus formation, as far as the causation of these blood conditions is concerned. This difficulty is not surprising when it is remembered that the staphylococcus pyogenes aureus is a saprophyte, or putrefactive organism, as well as the commonest of the pus producers. It is known, however, that the proteus vulgaris, the proteus mirabilis, and the proteus Zenkeri, which do not multiply or develop in the living body, are very common putrefactive bacteria and produce, when growing in decomposing dead tissue, a virulent toxine. This toxine, used experimentally, has produced typical symptoms of sapremia. The occurrence of septicemia and pyemia is promoted by such conditions as favor the contact of wound surfaces with particles of decomposing animal tissue, or of dust containing pyogenic bacteria, such as necessarily circulate in ill-ventilated apartments containing numerous surgical patients. It is necessary, however, in order to infect the system, that the poisonous principle be absorbed. A recent wound or one covered with unhealthy granulations allows rapid absorption of the poisonous substances, while healthy granulations seem to act as a barrier to septic infection. The blood in septicemic conditions is less coagulable than in health and tarry; and the red corpuscles show a tendency to congregate in irregular masses, and to undergo ante-mortem disintegration. In addition, congestions of organs and stasis of the blood current or thrombosis are frequently observed. The autopsy frequently shows softening and degeneration of the liver and spleen, ecchymosis and even inflammation of the serous membranes, and changes in the glands and mucous membrane of the intestines. The fluids of the body especially perhaps those from the liver and spleen, are infectious, except in sapremia. Cultures are easily made from them, and pricks made with the instruments used by the surgeon or pathologist are liable to cause infection of the injured person (Fig. 9).

FIG. 9.

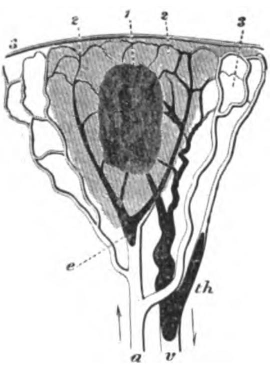


Diagram of a hemorrhagic infarct: *a*, artery obliterated by an embolus (*e*); *v*, vein filled with a secondary thrombus (*th*); 1, center of infarct which is becoming disintegrated; 2, area of extravasation; 3, area of collateral hyperæmia. (O. WEBER.)

Pyemia may be provisionally considered as septicemia with the addition of disseminated spots of inflammation and suppuration. These consist of metastatic abscesses in lungs, liver, spleen and other viscera, due to embolism and bacterial infection; and suppuration in joint cavities or inflammation of cellular or serous tissues, caused either by embolism or the blood change. Metastatic abscesses commence as small, reddish and usually pyramidal sections of solidified tissue, which are found most frequently near the periphery of the lungs, liver and spleen. These soon break down into pus, producing abscesses, which are always small, and which are surrounded by indurated tissue. These multiple or metastatic abscesses result from the process of embolism as follows:—At the seat of the original inflammation coagulation takes place in the vessels; and on account of softening of these clots or thrombi, due to septic influences, small particles of the thrombi are washed into the circulation, carrying along with them pyogenic bacteria. These emboli lodge in the capillaries of the lungs or other viscera, cause impairment of circulation, and by their mycotic nature give rise to numerous suppurative points called metastatic or embolic abscesses. Such transportation of emboli may occur from a thrombophlebitis, a thrombo-arteritis or a septic endocarditis.

FIG. 10.

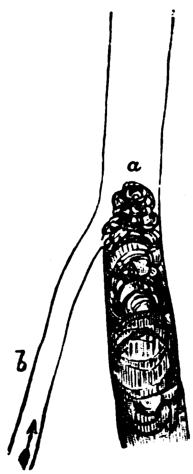
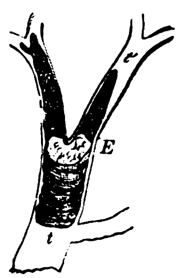


Diagram of thrombus in a vein. *a*, central end of a venous thrombus projecting into a large trunk. *b*, small branch. The blood flowing from small branch may readily detach a part of the thrombus.

FIG. 11.'



Embolus (*E*) impacted at the bifurcation of a branch of the pulmonary artery. Secondary thrombi (*t* and *t'*), behind and in front of embolus, extending to the first collateral branches.

Causes.—The exciting cause of these septic fevers is the toxines generated by mycotic growth in albuminous fluids. Chemical poisons, called sepsin and cadaverin, have been isolated, and are believed to be the active poisonous agents. Infection usually depends upon the existence of a wound, though it is possible that sepsis may result from septic changes in the fluids of the body, due to agencies introduced by absorption through the mucous membranes. Hemorrhage, protracted shock, erysipelas, osteomyelitis, puerperal lesions, overcrowding of patients affected with suppurative diseases, and bad hygienic surroundings are important predisposing causative factors. Idiopathic pyemia is impossible. The so-called case is one in which the origin is undetected. Suppuration in the bone marrow, appendix, endocardium, or some other unobserved place, has been the starting point.

Symptoms.—The first symptom of septicemia or of pyemia is often a sudden rigor preceded or accompanied by a rise in temperature, which is followed by exhaustive sweating with rapid lowering of bodily temperature. These phenomena resemble those of malarial fevers, but the hot stage between the rigor and the sweating is less marked. The temperature during the chill may rise to 104°–107°, and during the sweating period may fall, though rarely, to normal or below. The rigors and great temperature changes are repeated at more or less irregular intervals.

The chills are likely to be more frequent and the temperature range greater in pyemia than in septicemia. In some cases the temperature is low, even subnormal; and the septic death may be attributed to shock of operation. This condition has been called ammonemia; and is ascribed to absorption of ammonia compounds, produced by the bacterial infection. The irregular course of fever in pyemia has been attributed to successive escape of organisms and toxines into the circulation. The pulse is increased in frequency, but diminished in force, beating 90–120 per minute; and respiration is similarly affected, being more frequent and less deep. The breath and emanations from the body have a sweetish odor which is of some diagnostic value in late septic states. The tongue is usually furred, while nausea, vomiting, and diarrhœa are frequently present. The skin, which has a pale or yellowish hue, due to pigment from disorganized corpuscles, may present sudamina, and even an ecchymotic or a pustular eruption. Albuminuria is not infrequent and delirium is common. As the disease progresses the symptoms assume the asthenic or typhoid character as shown by rapid emaciation, great exhaustion, twitching of the tendons, drowsiness, low muttering delirium or coma, dry and brown tongue, sordes upon the teeth, colliquative diarrhœa and sweating. The wound during this time usually, but not always, assumes an unhealthy character of granulations and discharge. In most cases the discharge of pus decreases, and it may entirely disappear. Infection of small wounds, such as needle punctures, may be made evident by early lymphangitis and perilymphangitis, associated with severe pain and lymphadenitis. About the sixth or tenth day, if pyemia and not mere septicemia exist, the formation of metastatic abscesses and the occurrence of other inflammatory foci give rise to jaundice, cough, pain, which is often intense in the joints, and suppurative or inflammatory signs in the viscera and elsewhere. Death may take place in two or three days in acute cases before changes of special importance are seen in the wound.

The lobular pneumonia, hepatitis, pleuritis, pericarditis and other inflammations that at times occur give rise to their characteristic symptoms. The prognosis is always unfavorable, as in acute cases death takes place, as a rule, in from one to two weeks, and in chronic cases in from one to two months. Recovery, however, does at times occur after a protracted convalescence. It is often impossible to discriminate between cases of septicemia and pyemia until the autopsy proves or disproves the existence of metastatic abscesses. The symptoms have, therefore, been grouped together as representing conditions which are often indistinguishable during life.

Diagnosis.—Septicemia or pyemia may be confounded with malarial or typhoid fever. The suddenness and intensity of the rigor and of the temperature rise, the irregular occurrence of these phenomena, the great fall in temperature, which seldom reaches the normal before the occurrence of another rise, the profuse sweating which follows the rigor without the intervention of a marked hot stage, and the association of these symptoms in many instances with a wound, usually serve to render a differential diagnosis possible. Microscopic examination may reveal the parasite in the blood of malarial cases; and quinine will usually modify malarial conditions but not septic ones. Many of the symptoms of typhoid fever resemble those of septicemia, because the intestinal lesions of the former disease lead to septic infection of the patient. The Widal serum diagnosis of typhoid fever may aid in determining the true condition. Rheumatism is at times distinguished with difficulty from chronic pyemia, but the acute forms of the diseases differ, because rheumatic effusion into the joint cavities is seldom purulent as in pyemic synovitis. Again, the sour odor of acute rheumatism is replaced by the sweetish smell often noticed about septicemic cases. The rapidity of emaciation and the usually fatal issue in severe cases of septicemia and in pyemia, as well as the evident existence of secondary inflammations and metastatic deposits in the latter disease, proclaim the nature of the affection with no doubtful voice. It is, however, difficult at times to certify that visceral symptoms are really due to metastatic abscess, and not to simple inflammatory lesions. In cases presenting a febrile temperature after operation it is well to suspect septic complications, unless the fever is very moderate and disappears in two days after the wound has been made. Opening the wound will often show decomposing clot or serum between its surfaces, the removal of which will cause a rapid fall of temperature.

Treatment.—The indications of treatment are to remove the exciting causes of septic conditions by general and local prophylactic measures, and to support the system until the poison is eliminated. An abundance of fresh air, sequestration of pyemic, erysipelatous and similar patients, sterilization of clothing and instruments, and the aseptic or antiseptic treatment of all wounds are important factors in preventing the occurrence of the disease in hospitals. It is especially necessary, moreover, so to treat every patient that he may not be liable to self-infection from generation of the septic poison in the discharges of his own wound. Hence, union by first intention is to be obtained if possible. The surgeon must be on his guard, however, lest in this endeavor he allow purulent accumulations and burrowing to occur; for pus, serum, or blood exposed to the air soon decomposes, and putridity is the source of septic infection. Hence, free incisions, counter-openings, and perfect drainage of the lowest depths of the wounds, with copious antiseptic irrigation, are absolutely essential. Amputations and excisions may be demanded, and if done promptly enough may get rid of a nidus of septic contamination, that otherwise would be a continuous source of danger. Free laying open of irregular, lacerated and dirty wounds, even before suppuration occurs, especially if serous cavities be involved, is often the most scientific treatment, although, to the inexperienced mind, it seems like protracting the cure by increasing the wound surfaces. Such wounds should be thoroughly washed out with sublimate solution (1 : 500 to 1 : 5000), carbolized water (1 : 40), solutions of chloride of zinc (1 : 100 or 1 : 50), or some similar antiseptic lotion, before suturing or dressing. In very large wounds corrosive sublimate may cause toxic symptoms if used in strong solution. Shreds of devitalized tissue, decomposing blood-clots and unhealthy pus confined in any portion of such wounds will cause septic or pyemic symptoms with great readiness. Continuous immersion in hot water is a successful way of keeping wounds clean and washing away bacteria and their toxines. All abscesses forming in the neighborhood of the original wound must be opened promptly. Mopping the surface with undiluted carbolic acid may, perhaps, become an important preventive agent in certain cases, where infection is feared, as it probably seals the vessels and hinders septic absorption.

In very foul gangrenous wounds applications of bromine or undiluted nitric acid or formaldehyde may by destroying the tissues get rid of a dangerous source of contamination. Such powerful caustics have a reputation in the treatment of hospital gangrene for this reason. The injection of large amounts of sterile salt solution into the subcutaneous tissues or directly into a vein at the elbow has been recommended. This method of treatment is supposed to act by diluting the blood and increasing the action of the skin and the kidneys.

To support the system after septic infection has occurred, tonics, stimulants, and nutritious food must be employed. At first a laxative may or may not be required. The appearance of the tongue and state of the bowels indicate or contra-indicate its use. Quinine, strychnine and tincture of chloride of iron, brandy in amounts varying from two to twelve fluid ounces daily, and opium, if pain demands it, in one- or two-grain doses every second or fourth hour, will be the line of medication suited to the majority of cases. Frequent administration of cream, milk and animal broths, given in small amounts, day and night, is absolutely essential. An astringent combined with opium (as for example, tannic acid, gr. ij ; opium, gr. j ; capsicum, gr. $\frac{1}{4}$) ; atropia sulphate, gr. $\frac{1}{60}$; turpentine, ♏ x, or some other remedy may be needed at varying intervals to combat diarrhœa, profuse sweating, or dry tongue and tympanites. In fact symptoms must be met by appropriate remedies, since no specific to eliminate the poison is of recognized value, though many have been advocated. Salol in large doses (gr. xxx), mercuric chloride (gr. $\frac{1}{50}$), bismuth salicylate (gr. iii), and similar antiseptic internal remedies may be tried. The nucleins are supposed by some to be valuable remedies in septic conditions.

ERYSIPELAS.

Definition.—Erysipelas is an acute infective, rapidly spreading, inflammation of the capillary lymphatic vessels, which has no tendency to limit itself by the exudation of plastic exudate.

Pathology.—It is caused by the streptococcus erysipelatis, which is believed by some bacteriologists to be identical with the streptococcus pyogenes. Erysipelas is most frequently seen in the tegumentary structures, but it may attack mucous and serous tissues. It occurs by inoculation of a wound with the organism. In the so-called idiopathic cases the atrium of infection has been overlooked. The disease may be endemic. It appears to be allied to septicemia. The organism is found especially in the small lymphatic vessels. Simple or cutaneous erysipelas involves the skin alone, while in the phlegmonous or cellulo-cutaneous variety the subcutaneons tissue is also inflamed. If the inflammatory process spreads through the cellular or connective tissue without invading the skin, it is called diffuse cellulitis or cellular erysipelas.

Many believe that suppuration occurring in the course of erysipelas is indicative of a secondary infection with pus fungi, and that the condition is then a mixed infection.

Symptoms.—The constitutional symptoms may be of a sthenic type, but unless the disease is very mild and short in its course, they soon present the characteristics of asthenia. Fever, rigors, nausea, vomiting, coated tongue, constipation, and perhaps delirium, are the early symptoms. They are followed by frequent quick pulse, muttering delirium, dry tongue, sordes and often by diarrhœa; and not very infrequently by death. In the cutaneous and cellulo-cutaneous forms the burning or throbbing pain, the scarlet or dusky-red shining skin, with a distinctly elevated margin, the œdematous or brawny character of the swollen part, the tendency to spread in a zig-zag manner like the irregular edge of a piece of burnt paper, and the lymphatic glandular involvement make the diagnosis sufficiently distinctive. The skin has a yellowish tinge when the blood is pressed out of the capillary blood vessels with the examiner's finger. Vesicles may form and be succeeded by a brawny desquamation. Sometimes in the cellulo-cutaneous variety suppuration or gangrene of the connective tissue occurs; then the skin is apt to become less scarlet in color, and the parts have on palpation an œdematous or boggy feel. There is no sign of pointing, but incision discloses a diffuse form of abscess in the areolar tissue, and gives escape to shreds of gangrenous tissue and unhealthy, foul-smelling pus.

When erysipelas attacks a wound, the pus from it becomes lessened, the granulations degenerate, the union breaks down, and the local symptoms, mentioned above, are presented about the wound. Cellular erysipelas, often called diffuse cellulitis, resembles the cellulo-cutaneous variety, but presents fewer characteristics of inflammation of the skin. Its evident relationship to erysipelas is admitted, but the term cellulitis seems preferable to cellular erysipelas. This variety of erysipelas may attack the areolar tissue in the pelvis and other internal regions if they be opened by a wound. The probability of causing puerperal septicemia by inoculation from erysipelatous cases must always be borne in mind by the obstetrician or surgeon.

An attack of erysipelas lasts from one to two weeks, and in persons of fair health previously is usually followed by recovery. The subcutaneous forms have a much more unfavorable prognosis than the cutaneous. The disease sometimes shows a metastatic tendency. Thus erysipelatous meningitis or peritonitis may occur at a distance from the original inflammation. At times there is a tendency to repeated attacks. It has been suggested that this may be a sort of autoinfection and that convalescents should be placed in another bedroom after the disease subsides.

Attacks of erysipelas have in some cases seemed to cause cure of malignant growths previously present. From this circumstance has arisen the proposal to treat inoperable malignant growths with hypodermic injections of the erysipelas toxines. Some sarcomas have apparently been cured by this method.

Treatment.—Preventive measures consist in ventilation, and sterilization of instruments and dressings; and the isolation of the erysipelas patient. If possible the surgeon should not go from the infected patient to other surgical or puerperal patients. At first a purge should be given and light diet ordered, but, as a rule, depressing treatment is inapplicable, because the disease soon assumes a low type. Hence ten minims of tincture of iron every two or three hours, combined perhaps with two grains of quinia and one-sixtieth of strychnia at each dose, is the best treatment. Opiates and stimulants may be demanded. Milk and beef essence, or meat juices, are the best articles of diet. A mixture of one part of laudanum, one part of lead-water, and two parts of water, a combination of lime-water and sweet oil, or a non-irritating antiseptic lotion or ointment, should be applied locally. Dusting powders of starch and zinc oleate in equal parts, or an ointment of equal parts of ichthyol and wool lard may lessen the burning pain of the inflamed skin. Efforts to prevent the spreading of the dermatitis have not been effective; though hypodermic injections of two per cent. solutions of carbolic acid and solutions of mercuric chloride, and various applications at the borders of the inflamed area have been employed. If suppuration and gangrene threaten or if great tension is present, numerous incisions, which will gape widely, should be made aseptically and be followed by antiseptic gauze dressings. When pus burrows, as in the subcutaneous forms of the disease, the cavities should be injected with carbolized water (1: 40) or solution of corrosive sublimate (1: 2000), drainage-tubes inserted and counter-openings made. The hypodermic administration of antistreptococcic serum has been employed, but its value is problematical.

TETANUS.

Definition.—Tetanus is an infectious wound-disease, characterized by persistent and painful muscular contraction with irregular exacerbations; and is caused by the tetanus bacillus.

Pathology.—Hyperemia, extravasation, exudations and softening have been described in the spinal cord and brain, but the post-mortem findings have not been distinctive. Sometimes the nerves near the infected wound have shown an ascending neuritis.

Causes.—The bacillus of tetanus is found in the upper layers of the soil, especially in rich black loam. This accounts for the relative frequency of tetanus after wounds of the feet and hands. Idiopathic or the so-called rheumatic tetanus is a misnomer. Tetanus can only arise from infection with the specific bacillus. A wound is practically always an essential in the etiology of the disease, but the wound may be hidden or insignificant, or healed before the period of incubation is past. It has been asserted that infection may take place through the bronchial mucous membrane. The endemic character of the disease at times is explained by its bacterial causation. Tetanus of the newborn child is due to infection of the stump of the umbilical cord.

FIG. 12.

Tetanus bacilli, showing spore-formation. (KITASATO.)

The bacillus of tetanus is an anaërobe, that is, grows without oxygen; and has spores developed at one end. In the spore-forming stage the micro-organism resembles a tack or nail.

Symptoms.—The time of appearance of tetanus is usually from five to ten days after the receipt of the injury; though the initiatory symptoms may be exhibited in a few hours, or delayed until several weeks have elapsed. The early cases are apt to be more acute in their progress, violent in symptoms, and fatal in prognosis. Digestive disorders or general and indefinite uneasiness may perhaps be observed or possibly the wound may become dry and unhealthy before the characteristics of tetanus are developed. In many instances, however, nothing unusual attracts attention, until stiffness and pain in the muscles of mastication or pain in the epigastrium proclaim the advent of this serious complication. The patient may ascribe the early difficulty in swallowing to a "sore throat." It is rarely that the muscular spasm shows itself primarily in the wounded limb. Pain in the epigastrium, from spasm of the diaphragm, or painful rigidity of the muscles that close the mouth or of those at the back of the neck is the usual initiatory symptom. The muscles thus primarily affected are those supplied by the motor branch of the trifacial, the facial, and the spinal accessory nerves. The muscular spasm is continuous, or tonic, though there are occasional clonic paroxysms of increased contraction. The contraction is exceedingly powerful. The voluntary muscles, except those of the hands, feet, eyeball, and tongue, generally become rigid soon after the incipiency of the disease. It is believed by some that death may occur from cardiac spasm. This and the diaphragmatic spasm are possible examples of the tetanic spasm occurring in muscles of involuntary innervation. The pain accompanying the muscular spasm is severe, resembling that of ordinary cramps, and shows exacerbations at the times when the rigidity increases. When the posterior muscles are more especially affected the patient's head and legs are bent backward, until he assumes such an arched position that, if placed in the supine posture, only his occiput and heels would touch the bed. This condition is called opisthotonos. The term emprosthotonos is employed to designate a similar flexion forward and pleurothotonos to denote lateral deflection. Opisthotonos more or less marked is the common posture ; the others are very rare. The trismus, or inability to open the mouth, gives tetanus the popular name of lockedjaw. The power of tetanic spasm must be seen to be appreciated. Muscles may, at times, be ruptured by the violent contraction, and the patient become unconscious from the unendurable pain.

The patient suffers from difficulty in swallowing, dyspnœa, and sleeplessness. There is sometimes aphonia, and occasionally the tongue is bitten by a sudden paroxysmal spasm of the temporal muscle. On account of this danger the surgeon should avoid requesting the protrusion of the tongue. Viscid saliva may collect in the mouth and annoy the patient. The mind is perfectly clear, but the facial expression is characteristic. The sardonic grin of tetanus, as it is called, consists in retraction and elevation of the corners of the mouth, closed teeth, transverse furrowing of the forehead, dilatation of the nostrils, and a fixed, anxious expression of the eyes. Constipation and retention of urine are usually present. Reflex excitability is so great that the noise of a suddenly closed door, a draft of air, the touch of the surgeon's hand, or a flash of light may induce an exacerbation of spasm. Respiration is embarrassed and quickened, and the pulse feeble. In the early stage there is little fever, but toward the termination of the disease high temperature and profuse sweating are not infrequent. Instances of very high temperature have been observed, and cases have been reported in which the bodily heat rose even after death.

The exhaustion arising from the continuous muscular action is very great, and is often the cause of death. The fatal issue may occur from spasm of the respiratory muscles, and possibly from spasm of the heart. Fatal cases terminate usually in from three to five days. Muscular relaxation may take place before death.

Diagnosis.—Local rigidity of the masticatory muscles, due to cold or diseased teeth, is distinguished from tetanus by the absence of pain, the non-occurrence of paroxysmal increase of spasm, the absence of hardness of the abdominal muscles and of other tetanic symptoms, and, finally, by its curability, particularly after removing the cause. Spinal meningitis has a different history, gives rise to rigidity of the extremities and neck rather than to trismus, and is followed by paralysis.

In hydrophobia we see a convulsed and restless face instead of the knit brow and grinning mouth of tetanus. Moreover, there is delirium, and the spasms are intermittent or clonic. The profuse secretion of saliva and the convulsive attacks following attempts at deglutition are not a part of the clinical history of tetanus.

Hysteria assumes the characteristics of tetanus. It may be differentiated by considering the sex and character of the patient, and by observing the absence of pain, the intermission or irregularity of the tonic rigidity, and the transient nature of the spasm when the application of the actual cautery is suggested.

Strychnia poisoning, particularly when produced by the repeated administration of small toxic doses, greatly resembles tetanus. Here, however, spasm occurs in the limbs sooner than in the jaw, epigastric pain is absent, and opisthotonos arises at an earlier time than in tetanus. There is, moreover, no history of traumatism. In most cases of strychnia poisoning, death or recovery occurs within a short period; and there can usually be elicited a suspicious history of suicide or homicide.

The neurosis called tetany is an entirely different disease from tetanus, though the similarity in name and the tonic spasms occurring in the disease may lead to confusion. Tetany is a non-infectious disease usually unconnected with wounds. It does, however, occur after removal of the thyroid gland. The spasms are tonic, without clonic exacerbations, are apt to be limited to the extremities, and there is comparatively little fever. It is a rare disease in America.

Prognosis.—Tetanus arising within nine days of the time of injury is almost invariably fatal. Recoveries from tetanus, which are rare, are usually instances of the disease that have arisen nine days or more after the receipt of injury, and that have shown symptoms of but moderate violence. If the patient survives the fourteenth day of tetanus, recovery may be expected. High temperature is an unfavorable symptom.

Treatment.—Although the death-rate of tetanus is very high treatment that lessens peripheral irritation and diminishes spinal excitability always palliates suffering, and may at times be followed by cure. The patient should be kept in a quiet, darkened room, free from draughts of air, and should be supplied with concentrated liquid food because of the exhaustive character of the disease. Food can be introduced by a flexible tube passed between the cheek and the teeth, so that the liquid may enter the mouth behind the molars ; or by a similar tube passed into the pharynx through the nostril. Usually, however, there are crevices between the teeth which admit the entrance of milk or soup. Such alimentation is preferable to rectal feeding, though the introduction of partially digested liquid food into the rectum may be valuable. Freedom from noise may be obtained by putting cotton in the patient's ears.

Iron, quinine, and stimulants may be desirable to sustain the failing powers. Laxatives or enemas may be required. Active purgation is injurious. The best remedy to control reflex excitability is hydrate of chloral, which should be given in ten- or twenty-grain doses every one, two, or three hours. These doses may be increased if the patient does not become quiet and sleep. Extract of physostigma (gr. j every two hours and increased), or its active principle eserine, hyoscine and urethan, are worthy of consideration if chloral in large doses does not seem satisfactory. These remedies should be given early, and in doses as large as experience shows can be tolerated before resorting to other drugs. Chloral has been successfully used by enema, and eserine is very readily administered by hypodermic injection. Opium has some reputation in the treatment of tetanus, but it is probably better to use it as an adjunct to the chloral, to relieve pain. Bromide of potassium, cannabis indica, conium and similar substances, and the inhalation of anæsthetics have been advocated.

Wounds treated antiseptically and kept aseptic are not likely to become the atrium of tetanus infection. If wounds have been smeared with soil and tetanus is feared, a valuable application is silver nitrate in solution which is said to disinfect the wound by killing bacilli and spores.

The curative serum, or antitoxine, obtained from the blood of animals made immune by repeated inoculation with attenuated cultures or small doses has been advocated as a remedy. It is administered hypodermatically. Its value is not fully established.

HYDROPHOBIA, RABIES OR LYSSA.

Definition.—Hydrophobia is a disease of fatal prognosis, characterized by sudden spasm of the respiratory muscles upon attempts at deglutition and by other nervous phenomena ; and which is due to inoculation with a specific virus contained in the oral secretions of rabid animals. It is an infection.

Cause.—The cause of hydrophobia is a peculiar poison contained in the secretions of the mouth of animals affected with rabies. It is not known whether it is bacterial, protozoal or of some other character. The disease is believed to be generated spontaneously only in the canine family, in the cat, and a few other animals ; but it can be communicated by inoculation to others, whose oral secretions then become virulent. It has not been proved that it can be communicated from one human being to another. Inoculation with other fluids of affected animals does not produce the disease. It has been suggested that bites by female animals in heat are, perhaps, more likely to cause hydrophobia than those of males or females under other circumstances. Many persons bitten by rabid dogs experience no unusual sequences, possibly because the saliva was absorbed by the clothing through which the injury was inflicted.

Pathology.—Changes, such as congestion, extravasation, softening, and granular degeneration have been found in the medulla oblongata, cord, and brain of patients dying with hydrophobia. These lesions are apt to be conspicuous in the medulla oblongata and its vicinity. They may, however, be secondary, and not the essential morbid changes of the disease.

Symptoms.—Rabies is first exhibited in dogs by listlessness followed by restlessness, but there is no disposition to bite. Afterward the animal may become excited, as is exhibited by barking in a hoarse tone, snapping at the air and biting and licking sticks and stones; or he may show symptoms of melancholy and refuse to eat, drink, or observe his surroundings. Paroxysmal excitement, spasm of respiration and deglutition, protruding tongue and constant escape of saliva from the mouth, paralysis of the legs, convulsions and tremors may precede death. Rabies is not more common in summer than in any other seasons, nor do mad dogs have the dread of water which is exhibited by men with hydrophobia. Much of the animal's excitement is doubtless in many cases due to his being chased by persons desirous of destroying him.

In man the period of incubation is usually, it is said, not longer than seven months. Cases have been reported when only a few days elapsed, and others are recorded in which no symptoms were shown until years had passed. Many of these cases will not bear searching investigation. The wound made by the teeth of the rabid dog usually heals readily; but may, just before the advent of the general symptoms, become the seat of stinging pain or of inflammation.

The initiatory symptoms are physical and mental discomfort, stiffness of the throat and tongue, anxiety and irritability of disposition. Then occur spasms of muscles of deglutition and respiration, especially when attempts at swallowing water and other fluids are made. This symptom gives the name to the disease. Solids are swallowed more readily than fluids. Cutaneous and sensory hyperæsthesia, wild delirium, convulsed features, hawking and spitting of an abundant viscid fluid, attacks of suffocation caused by drafts of air and attempts at deglutition, hoarse cough, sleeplessness, maniacal excitement, and at times paralysis or general tetanoid or epileptoid convulsions complete the distressing picture. The pulse is frequent, the temperature high, and the urine often albuminous or saccharine. Death occurs from spasm or exhaustion about the third day. It is said that dread of water is not always present, and that this symptom may occur in other affections.

Diagnosis.—Hydrophobia may very greatly resemble tetanus, and, indeed, a variety of the latter disease has been described as hydrophobic tetanus. The differential diagnosis of tetanus and hydrophobia has been discussed in the preceding article. Hysteria may assume the aspect of hydrophobia, but there is a want of consistency in the symptoms and an absence of high temperature. Moreover, the hydrophobic patient tries to conceal his fears from his friends, while the hysterical one endeavors to call attention to them. Hysterical hydrophobia is developed soon after the injury to which the symptoms are attributed.

Treatment.—The preventive measure to be adopted after an injury has been inflicted by the teeth of a mad dog or other animal is immediate excision of the tissues around the wound, or suction followed by cauterization with strong nitric acid or better with the red-hot iron. The application of a tight bandage to the limb above the wound until excision or cauterization has been effected is proper. The fears of the patient may be allayed by these precautions, even if the time elapsed has been too considerable to give an opportunity to prevent absorption by such means. The animal should never be killed, but kept in confinement that the existence of rabies may be verified or disproved. Bromide of potassium in large doses has been recommended during the period of latency. When the symptoms have appeared, treatment exerts, as a rule, little influence in averting death. Nourishment and perhaps stimulation by the rectum, ice to the spine, perfect quiet and freedom from excitement are indicated. Worara (grain $\frac{1}{12}$ to $\frac{1}{8}$) or pilocarpine (grain $\frac{1}{8}$ to $\frac{1}{4}$) given hypodermatically, nitrite of amyl or chloroform by inhalation, chloral, morphine and bromide of potassium, hyoscine hydrobromate, and similar remedies may be tried, but must be employed in large doses.

Pasteur has shown that dogs and some other animals may be protected from rabies by inoculation with attenuated virus of rabies in much the same way as men are protected from smallpox by vaccination. Human beings who have been bitten by rabid animals may, it is asserted, be protected from the disease by a similar preventive inoculation during the period of incubation.

CHAPTER IV.

TUBERCULOSIS, ACTINOMYCOSIS, ANTHRAX, EQUINIA.

TUBERCULOSIS.

Definition.—Scrofula, or struma, was formerly believed to be a constitutional condition in which there existed an abnormal tendency to inflammations of unusual chronicity; and in which the inflammatory products were not readily absorbed, but infiltrated the tissues and underwent cheesy degeneration. It is, however, simply tuberculosis, usually of the infiltrated, and not of the nodular, form. Lupus vulgaris, also, is simply an example of cutaneous tuberculosis. It is thus seen that these three conditions, which formerly were considered separate diseases, are now included in one category.

Tuberculosis is an infective disease due to a bacillus. It is one of the infective granulomata, to which group belong syphilis, actinomycosis, equinia, leprosy and rhinoscleroma. The nodular lesions produced by these infections somewhat resemble tumors in appearance, and consist of a scanty matrix in which lie cells varying in size from lymphoid cells to giant cells. The irritation due to the growth of the fungus seems to cause chronic inflammation.

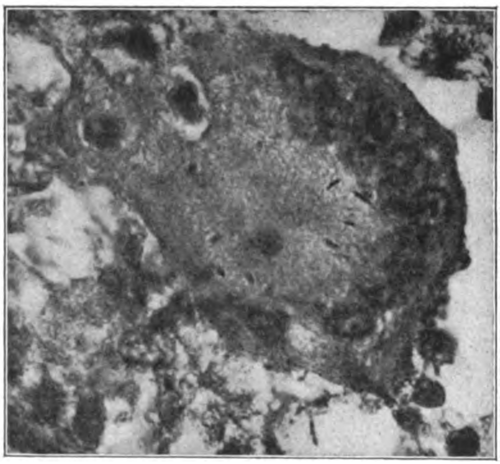
Pathology.—Its lesions may be so numerous as to justify the term general tuberculosis; or there may be a single lesion, when it is known as local tuberculosis. The original infection, of course, is usually a single lesion, but it is often the focus from which further infection originates, causing lesions in distant parts of the body.

Chronic inflammation due to the bacillus tuberculosis may give rise to small nodular masses, or may assume the infiltrating form. The inflammatory lesions due to the antagonism of the tissue to the microbic irritation are small masses of granulation tissue called tubercles, because they usually make small shot-like protuberances. Tubercles are described from their color as gray and yellow; the latter, however, are simply a later stage of the former, because the gray tubercles usually finally undergo cheesy degeneration.

Tubercles are found in the skin, the subcutaneous tissues, the mucous membranes, the serous membranes, the cancellated structure of bones, the lymphatic glands, the lungs, the liver and testicles; in fact, in almost every structure, though most frequently in those just mentioned.

Gray or miliary tubercles are minute inflammatory shot-like tumors or growths, not larger than a millet seed, consisting of granulation tissue and resulting from infection of the system by the bacillus tuberculosis. The general infection occurs through the blood and lymphatic currents, and is due to the transfer of the organisms from some wound or local tubercular inflammation which may have remained many months without infecting the rest of the body. The tubercles undergo cheesy degeneration, as, indeed, may any structures which have little vascularity and great abundance of cells, and become yellow tubercles. Miliary tubercles may not only be due to some previously existing caseous tubercular center, but become caseous themselves. The term yellow tubercle is often applied to cheesy masses, without much reference to their causation. Gray tubercles show microscopically a network of large, branched, many-nucleated cells, called giant cells, associated with a small-celled structure resembling adenoid tissue. Differences occur, however, with variation in locality of the tuberculous lesions. The bacilli are found within the tubercle, and especially in the giant cells. Cheesy or calcareous degeneration, encapsulation of the bacilli by fibroid or scar tissue, and breaking down into puriform fluid, causing the so-called cold or chronic abscess, may occur as secondary changes.

FIG. 13.



Giant cell with bacilli. Miliary tubercle. (STENGEL.)

The chronic or cold abscess of the old pathology is due to tubercular infection which is the first step in the process. It is probable that pyogenic germs gain access to the spot and that the puriform fluid, which differs in appearance from true pus, is the result of a mixed infection—tubercular and pyogenic. It is true that the tubercle bacillus is a facultative pus germ, but it is believed that, as a rule, tubercular abscesses are due to a mixed infection.

Causes.—Tuberculosis is an infection by the tubercle bacillus, which finds an entrance through the mucous membranes or a wound. Infection occurs most frequently in those persons in whose tissues it finds a suitable soil for its growth. Such a soil is furnished by the ill nourished and weak, whose tissues prove least resistant to mycotic invasion. Tuberculosis exists much more frequently among children and young adults, but no age is exempt from such affections.

The chief avenues of entrance are the bronchial and the digestive mucous membranes, whence the bacilli are carried to the lymph nodes and show their presence by the consequent enlargement of these bodies. The tonsils and carious teeth are believed to be frequent portals of entry. Milk from tuberculous cows used as a food and the inhalation of dust laden with dried tubercular sputum are probably the chief sources of infection. It is believed that carcinomatous and syphilitic ulcerations may afford opportunity for tubercular infection and that thus the two diseases may be found at the same spot. This mixed infection may be the cause of antisyphilitic treatment not causing entire disappearance of the lesion.

Symptoms.—The affections which are apt to occur among those called tuberculous are characterized by protracted inflammation and degeneration of the tissue, often giving rise to a puriform liquid. The products of this chronic inflammation, instead of being rapidly absorbed, accumulate and often become cheesy. Enlarged lymphatic glands, which may degenerate into caseous masses or soften and give rise to thin curdy puriform fluid, are frequent. Other lesions are chronic catarrh of the various mucous membranes; cold abscesses which burrow, and discharging leave ulcers with livid ragged edges, that in turn are followed by irregular and puckered cicatrices; phthisis, synovitis and arthritis; caries and necrosis; corneitis; ulcers and cutaneous inflammations.

Treatment.—Inherited predispositions to tubercular infection must be so treated as to prevent the possibility of infection; when infection has occurred the original lesion must be so managed as to obviate general infection. The best possible condition of nutrition must be obtained by good diet, warm clothing and out of door life in equable climates, combined with bathing and friction of the skin. The digestion must be carefully watched and regulated by alkalies, laxatives, mineral acids, tonics and proper exercise. Each case demands especial study. Cod-liver oil, syrup of iodide of iron, quinia, iodide of potassium, iodoform, iodine, arsenic, mercury, chlorate of potassium and rarely alcohol are the medicinal agents usually required, but they are secondary to the hygienic measures mentioned. The use of Koch's tuberculin, a substance obtained from cultures of tubercle bacilli, as a remedy to be administered hypodermatically has not fulfilled expectations. To hasten the cure of the chronic inflammation, local measures, such as recommended under that heading, are required. Early and complete excision of the tubercular lesion is often the safest course. The puriform fluid of tubercular, or cold, abscesses is sometimes absorbed, but it is better to evacuate it with a knife or aspirator than to have a deformed cicatrix result from spontaneous evacuation. Glandular masses, if small, may be enucleated. To avert an impending tuberculous general infection, excision of bone, arthrectomy of a joint or even amputation of the limb may be necessary. Such operations, however, must not be done too hastily, though in certain cases their expediency is unquestioned.

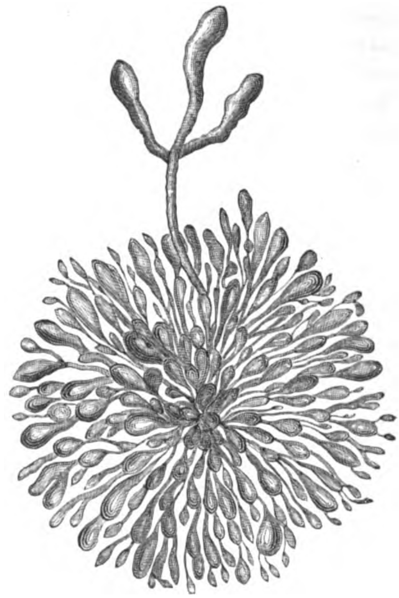
ACTINOMYCOSIS.

Actinomycosis is an infective disease, causing tumors resembling sarcomatous, tubercular or syphilitic growths. It is not very common

FIG. 14.

Actinomycosis in man. (MUSSER.)

FIG. 15.



Actinomyces (ray fungus) with one branching filament separated from the others. (PONFICK.)

in man, but is sufficiently well known in cattle as "lumpy jaw." It is caused by a ray fungus called actinomyces, which is probably a mould. The organism has a yellowish color, a tallowy consistence, and may be seen with the naked eye as sulphur colored granules in the cheesy or puriform fluid coming from the swollen part. It gives a gritty sensation to the fingers. Microscopic examination shows the fungus to consist of radiating branches coming from a common center and having clubbed ends. It occurs in man in the jaw, lungs and other organs. The tumors are likely to soften and break down and exhibit sinuses. The characteristic fungus in the discharge then suffices to establish the diagnosis. The resemblance to sarcoma is otherwise very great. The treatment is excision. Potassium iodide has been said to be beneficial.

ANTHRAX AND EQUINIA.

Anthrax, or splenic fever, contracted from cattle suffering with murrain and equinia, or glanders, caused by inoculation from horses having the affection are important infectious diseases derived from the lower animals. Anthrax is especially found in tanners and butchers and is characterized by a vesicle at the point of inoculation; which is soon followed by the so-called malignant pustule, and violent inflammatory complications, such as lymphangitis, cellulitis, and gangrene. The degree of asthenia accompanying this furuncular inflammation is profound and shown by its usual symptoms. The affection is due to the presence of a vegetable organism, the anthrax bacillus, contained in the blood and other fluids. Sometimes the general symptoms are very profound and the local inflammation comparatively slight. The treatment consists in excision, or free incision, followed by thorough cauterization with corrosive sublimate or carbolic acid. Saturating the cellular tissues with injections of iodine has been considered valuable. Stimulant, supportive, and anodyne remedies internally administered are required. Free incision through the swollen and infiltrated tissues involved are indicated, even after the early stages.

Glanders, or equinia, is another mycotic disease, and is characterized by asthenia and by multiple indurations and ulcers of the surface, inflammation and suppuration of the salivary glands, and profuse nasal discharge; though the last symptom is not always prominent in the disease in man. Its cause is the bacillus mallei. The treatment should be conducted on general principles, as there is no special remedy for the condition.

The prognosis in malignant pustule and glanders is unfavorable in the majority of cases.

CHAPTER V.

SYPHILIS.

Definition.—Syphilis is a constitutional disease resulting from a blood poison, of unknown nature, introduced by inoculation or by hereditary transmission. The acquired form has a period of incubation, and appears to be to some extent self-protective—that is, a person who has once been inoculated is not apt to be affected by subsequent exposure to the virus. The words venereal disease are often used to include syphilis, chancroid disease (improperly called local syphilis), and gonorrhœal urethritis. The term should be rejected because these affections are by no means always acquired through sexual intercourse, and are so mutually distinct that any classification of them under one heading induces mistaken ideas of pathology.

In this discussion of syphilis and its primary lesion, hard chancre, incidental mention will be made of chancroid disease, or soft chancre. This is a distinct affection, resembling the first manifestation of syphilis, but not resulting from constitutional infection. It, as well as gonorrhœa, will be fully considered under local diseases of the genito-urinary apparatus.

Causes.—Syphilis, when not congenital, can only be produced in healthy individuals by inoculation with the specific virus. Inoculation may occur directly, from contact, usually of an abraded surface, with the secretions of primary or secondary manifestations of the disease situated upon another person; or indirectly by the discharges of such lesions being transferred by means of drinking-cups, surgical or dental instruments, tobacco-pipes, towels, etc. In the vast majority of cases of acquired syphilis, inoculation occurs during sexual intercourse from chancres or mucous patches upon the genitals. Inoculation may occur from the blood of syphilitics, taken during the eruptive period of the disease, being introduced into the system by vaccination, or skin-drafting, and, perhaps, by contact with the menstrual blood of women infected with constitutional syphilis, who have at the time of coitus no lesion of the genital organs. It is doubtful whether the saliva, milk and semen can cause syphilis, unless mixed with the discharges and blood coming from mucous patches or other lesions. The discharge from tertiary ulcers or gummy tumors is not capable of inoculating other persons. It is not absolutely necessary that a break of the skin or mucous membrane exists to permit admission of the virus. A woman, previously healthy, may, it is said, become infected from carrying a fœtus which is syphilitic from the semen being furnished by a syphilitic father. The woman, if this is true, is infected by the man, not directly, but secondarily through the medium of the fœtus and the placenta.

A prolific cause of syphilis is heredity. Two syphilitic parents are almost certain to have, if repeated abortions do not interfere, children who subsequently exhibit symptoms of constitutional syphilis. If only one parent is syphilitic the child is less liable to infection, particularly if the diseased parent is the father. Hence marriage of syphilized subjects is to be discouraged; though if the acquired disease was mild and well treated and no lesions have appeared for two or three years, the risk of contaminating the wife or husband and of producing children with syphilitic constitutions is reduced to a minimum. Tuberculous children are probably frequent witnesses of such marriages; which in truth have not produced hereditary syphilis, but have brought forth a posterity with a lowered resistance to tubercle infection.

The cause of syphilis is almost certainly a micro-organism, though up to this time it has not been definitely and certainly found.

Clinical History.—A study of the symptoms of syphilis reveals the existence of:

1. *A stage of incubation* lasting two or three weeks; followed by

2. *A primary stage,* marked by chancre and bubo; which, at the end of two or three months, is followed by

3. *A secondary stage,* characterized by eruptions and inflammations of the mucous membranes; which, at the end of six or twelve months or a longer period, is succeeded by

4. *A tertiary stage,* exhibiting itself by ulcers and other severe cutaneous lesions, bone diseases and gummy deposits; and which often is followed, if the patient marries, by what may be called

5. *A quaternary stage,* exhibited in his children. The quaternary form, or hereditary syphilis, presents lesions similar to the secondary and tertiary stages of acquired syphilis.

Symptoms.—*The stage of incubation* is the period between the time of contact with the virus and the appearance of chancre. It varies greatly, but lasts, on the average, two or three weeks. It often is represented by the patient to be longer than this, because he fails to recognize the advent of a small chancre.

During any portion of the incubation period local inflammation of the parts may arise, due to simultaneous contact with irritating discharges (chancroid, etc.) or to injury, which has no pathological relation to the syphilitic chancre that is subsequently developed. The local disease may persist even after the stage of incubation has passed and the initial lesion (chancre) is exhibited.

If the syphilitic inoculation was effected at the same point at which the inflammatory ulceration, due to irritating discharges, is in progress, the patient will have the two lesions combined at that locality. This fact has induced many observers to believe erroneously that chancroid may be followed by syphilis.

PRIMARY STAGE.—The initial lesion of acquired syphilis is always chancre, which is soon followed by lymphatic involvement, causing adenitis. The inflamed and enlarged glands constitute a swelling or tumor, called bubo. It must be remembered that when chancre appears the patient has already been syphilitic for two or three weeks ; that is, during the time of the incubation stage. The chancre is the result of his syphilitic condition, and is not a local sore, which generates the poison that infects the system. The chancre, which must not be confounded with the chancroid sore (chancroid, soft chancre, non-infecting chancre), presents different appearances, according to its situation and the depth of the tissue involvement. Very frequently it is a small, superficial papule, having a reddish color and a circularly or elliptically ulcerated apex. Sometimes there is no ulcer whatever, but it is rare that some ulceration does not appear. It is possible that the ulceration is usually due to infection of the surface of the syphilitic lesion by pus bacteria. Abrasion, perhaps, removes the epidermis from the papule, and pyogenic organisms infect the part so that suppuration and ulceration occur. When the ulcer exists it is not much excavated, and secretes a serous fluid, containing epithelial and other particles, but no pus unless active inflammatory processes have been developed by irritation. The papule, with or without ulceration, has at its base a thin layer of hardened tissue, which is sharply defined, and resembles to the touch a disk of cartilage or parchment, buried under the skin. This induration is less apparent when the chancre is located on a mucous than when on a cutaneous surface, and in some cases does not persist long. At other times the chancre is a deep ulcer, with elevated edges and a surface covered with a sloughing material ; still the discharge is not purulent, but watery and, perhaps, slightly sanguinolent. The induration is deep and slightly outlined, and gives the sensation of a split pea between the finger-tips. This indurated base lasts a long time after the ulcer has been healed ; but, finally, when cicatrization and absorption have occurred, there remains a cicatrix with comparatively little depression. The ulceration does not destroy the tissue of the part as much as it appears to do, since it is the newly-formed inflammatory lymph that disintegrates.

Both these forms are true chancres, but the deep ulcer seems to be due to a more virulent infection, as it appears sooner after inoculation than the superficial chancre, and, as a rule, does not follow inoculation from secondary syphilis, which is more apt to cause superficial chancre, such as described above. Either form of chancre may assume phagedenic action under local irritation, or on account of a depressed state of the system of the patient.

The secretions from these indurated, hard, or infecting chancres, whether superficial or deep, will not produce similar sores when applied to other parts of the patient's body, for he is protected against further syphilitic inoculation. How long this protection lasts is not definitely determined. On this account chancre is single, unless inoculation at several points has occurred at the same time. Chancre of the lips and of a surgeon's examining finger is not rare.

Coincident with the stage of induration of chancre, enlargement and induration of the nearest lymphatic glands appear, constituting the syphilitic bubo. These buboes are usually situated in the groin, because the common location of the chancre is upon the genitals. Buboes, however, are found in the axilla, above the internal condyle of the humerus, under the jaw and elsewhere, according to the position of the chancre. If the initial lesion is near the middle line, a bubo will, probably, be found on both sides. If the lymphatic vessels from the inoculated spot lead to internal lymphatic glands, as in uterine chancre, no external bubo will be manifested. Induration of the glands is, probably, always present in syphilis, but cannot occur unless chancre has preceded it. Syphilitic bubo appears, about three weeks after inoculation, as a chain of hardened and enlarged glands, which are painless, or nearly so, and show no tendency to suppuration. The inflammation affects the glands only, and not the surrounding tissue, hence they retain their characteristic almond shape, and do not suppurate unless there be some cause of pyogenic infection, such as coexisting chancroid disease, or an infected wound. Then the suppuration is not syphilitic, though, if due to chancroid, the pus may have the contagious properties of that *non*-syphilitic sore. If it be due to other inflammatory causes, the pus is as innocent as the pus from common acute abscesses, or ordinary so-called sympathetic suppurating buboes; that is, it contains pus organisms, but not the syphilitic poison.

The chronic and indurated bubo of syphilis may continue for many months after the chancre has disappeared. The clinical history of true syphilitic bubo is very different, as will hereafter be seen, from that of bubo following chancroid disease.

SECONDARY STAGE.—About six weeks after the appearance of the chancre, the patient becomes more or less feverish, has, perhaps, headache and general uneasiness of an indefinite character, and then discovers, in the course of five or six days, the existence of an eruption, sore-throat, mucous patches, cervical adenitis, falling of the hair or iritis. These are the symptoms of the secondary stage, which usually occurs at the time mentioned and is preceded by the prodromes described. It may be delayed until the sixth month, and often overlaps the period of primary syphilis, which is prolonged by imperfect resolution of the chancre and bubo.

The cutaneous lesions of syphilis are called syphilides or syphiloderms, whether occurring as symptoms of the secondary or tertiary stage. In secondary syphilis, the eruption is usually macular or papular in form; though the scaly, vesicular, pustular and tubercular syphiloderms may occur. The last two varieties are more common in the later periods of secondary syphilis, or in the tertiary stage. Syphilitic skin affections usually become somewhat brownish in color about the time of their disappearance, are accompanied by very little itching, often present several varieties at the same time, and are not confined to a single portion of the patient's body. Mucous tubercles or patches are flattened and elongated elevations, a quarter or half an inch in diameter, found on the mucous surfaces, at the muco-cutaneous junctions or where the skin is very delicate, and covered by a whitish exudate. They appear at first as reddish elevations, from which the epithelium is removed, and upon which the exudate soon occurs, giving the surface an appearance similar to that produced by touching mucous membrane with nitrate of silver. The sore mouth and throat of secondary syphilis are due to these mucous patches, to superficial inflammation and ulceration, or to a combination of these lesions. Inoculation of syphilis occurs more frequently from these mucous patches about the genitals and mouth than from the secretions of chancre itself.

Inflammation and chronic enlargement of the lymphatic glands, especially of those situated along the posterior margin of the sterno-mastoid muscle, are very frequent symptoms of the secondary stage. These have no necessary relation to the existence of marked cutaneous lesions in the neighborhood. Falling of the hair of the scalp and other regions, and inflammation of the iris are frequently present in secondary syphilis. The papular eruption often occurs as an accompaniment of the iritis. Other symptoms may present themselves in the secondary stage, but the most common have been mentioned.

TERTIARY STAGE.—There is no distinct separation between the secondary and tertiary stages, but the latter is characterized by more chronic and less contagious lesions, which affect, as a rule, the deeper tissues of the body. It is convenient to consider lesions originating after the lapse of six months as tertiary symptoms. Tertiary symptoms are not exhibited in all cases, because the disease may be so mild or so judiciously treated that it subsides or becomes latent with the disappearance of the secondary troubles. Very often, however, the disease remains in abeyance for many months or years, and then tertiary lesions supervene.

The lesions produced by tertiary syphilis may be classified under the following heads: 1, Fibroid degenerations; 2, gummy deposits; 3, changes in the arterial walls. The fibroid indurations occur in limited areas surrounded by normal tissue, and are found in periosteum, sheaths of nerves and of organs, in the connective tissues and in muscle. Gummy tumors or deposits are yellowish masses of firm consistence, due to degenerated cell-products, surrounded by a fibrous area, which is in turn encircled by a cellular and vascular zone intimately inherent to adjacent structures. They are the most characteristic formation of syphilis and occur in the tegumentary structures, muscles, fasciæ, bones, and internal organs. They may become caseous, but often, in a manner not well understood, cause suppuration around themselves, break down and cause the deep intractable ulcers of tertiary syphilis. The change in arterial walls occurs in the inner coat and causes diminution in calibre, which interferes with circulation and may induce degenerative changes. The tertiary syphiloderms are usually pustular, tubercular or ulcerous. The ulcerations and suppurations found in syphilis are probably the result of the low vitality of the cells, affording a place of least resistance for the harmful localization of pyogenic fungi circulating in the blood stream. The germs cause suppuration there, when to healthy tissues they would be unable to do injury. The rupial ulcer, with its acuminated scab, is especially characteristic, as are the deep ulcers due to destructive changes in gummy tumors. Similar lesions of the oral and other mucous membranes are frequent. Periostitis, osteitis, arthritis, nodes due to lymph or gummy deposits under the periosteum, and all causing bone-pains (osteocopic pains) especially at night; caries and necrosis; iritis, retinitis and choroiditis; falling of the hair; onyxitis; orchitis; cerebral and spinal inflammations; and, in fact, inflammation of any organ or tissue may be induced by constitutional syphilis. Many of these lesions depend on the deposition of gummy material, others are due to the fibroid and arterial changes mentioned.

FIG. 16.

Notched teeth of hereditary syphilis. Boy, ten years, who had periostitis of tibia. Lower teeth show normal serrations of second dentition, and are elongated, probably because the imperfect upper teeth do not oppose them.

FIG. 17.

Upper incisors of boy with symptoms of inherited syphilis from infancy. Typical notches.

QUATERNARY STAGE. — This seems to me a good name to apply to hereditary syphilis, though syphilitic children may be born to parents who have not yet advanced beyond the secondary stage. It is unnecessary to discuss the method by which children inherit the syphilitic cachexia, but it is recognized that the disease is more certainly derived from a syphilitic mother than from a syphilitic father, and from two more certainly than from one syphilitic parent.

The child may not present any distinctive symptoms until a few weeks after birth, when its unhealthy looking and shrivelled skin, its aged appearance, the nasal catarrh and stomatitis due to the inflamed mucous membranes, and the possible discovery of cutaneous eruptions, or of mucous patches about the anus and genitals will point unequivocally to its syphilitic parentage. The syphilis so exhibited is of the secondary form; and by its ability to inoculate other subjects, and its greater or less protective power against further inoculation of the same subject, it proves its identity with ordinary acquired syphilis.

If death does not remove the child, further secondary and tertiary symptoms will in time follow. Interstitial keratitis, periostitis, bone disease and many other syphilitic affections may in time be developed. The low cell-vitality of syphilitic children makes easy the assaults of the tubercle bacillus. The resistance of healthy tissues is wanting. The peculiar notched condition of the upper central incisor teeth of the permanent set, first described by Hutchinson, of London, is often seen. These two teeth and at times others are poorly developed; having a conical shape, and a cutting edge, which is marred by an irregularly bevelled anterior surface or even distinctly notched by the breaking away of the central portion. This notched condition must not be confounded with the normal serrated edge of newly extruded teeth of healthy children. The teeth of syphilitic children are often irregularly placed, and look like the end of a screw-driver or are mere pointed pegs. Syphilitic women are liable to abort frequently because of the diseased condition of the placenta, and it is only after the woman has regained a fair degree of health that the fœtus is carried until full term.

Diagnosis.—The diagnosis of syphilis rests upon the general clinical history of the disease rather than upon any one symptom or upon the statements of the patient. The distinction between chancre and the local affection called chancroid disease is often difficult, and at times impossible, unless time be given to watch the progress of the symptoms. The diagnosis is to be founded upon the following characteristics:

Chancre.	*Chancroid.*
Time.—No noticeable lesion until two or three weeks after exposure.	Irritation early and sore developed within a week after exposure.
Number.—Single unless several points inoculated at time of exposure.	Multiple, because pus is auto-inoculable and produces other ulcers.
Character.—Papule, superficial abrasion, or an elevated ulcer, with edges sloping towards center, which coalesces with adjacent tissue and discharges a scanty, serous, non-purulent fluid. Permanent, indolent, non-inflammatory induration at base of sore, feeling like a disk of parchment or a split pea beneath the integument. No tendency to phagedena. Heals spontaneously. No pain.	Ulcer, with edges steep as if a piece of tissue had been punched out or ragged and irregular; does not coalesce with adjacent tissue and is covered with a drab-colored deposit. The secretion is purulent, very copious, and inoculates surrounding surfaces, thus producing multiple chancroids. No induration. Liable to phagedena. No tendency to heal. Somewhat painful.
Bubo.—Always present, involves a chain of glands, is indurated, usually bilateral, and seldom suppurates. If it does suppurate pus is not inoculable.	Often absent, involves but one gland and one side. Very prone to suppuration, furnishing pus which readily inoculates and produces other chancroid ulcers. The suppurating bubo is practically a chancroid.
Pathological nature.—Due to a constitutional disease, which is soon manifested by other symptoms. Protects the patient from subsequent inoculation; hence, surgeon cannot produce another chancre on him by inoculation with the discharge from the suspicious sore.	A local affection never followed by constitutional symptoms and, therefore, does not protect against subsequent inoculation; hence, surgeon can produce many other chancroids by inoculating patient with pus from original sore.

This table gives the usual clinical history of the two affections, but it must be remembered that the time of appearance and the physical characteristics may vary somewhat. Thus, a chancre may be so infected by pus fungi as to furnish a purulent secretion, and a chancroid may have a slightly indurated base by reason of repeated applications of caustics.

Chancre is to be distinguished from epithelioma by the earlier glandular involvement it causes, the effect of anti-syphilitic treatment, and the concomitant constitutional symptoms. Many doubtful cases of cancer and of chancroid can be diagnosticated by the collateral evidence obtained from confrontation of the patient and the person by whom he is supposed to have been inoculated.

Secondary and tertiary syphilitic lesions are to be differentiated from non-specific affections by the history, the co-existence of multiple pathological changes, the exclusion of other causative factors and the response to anti-syphilitic remedies.

Treatment.—Syphilis is a constitutional disease and demands general treatment. Cauterization or excision of the chancre is valueless, since constitutional symptoms are not the result of the chancre, but the latter is a lesion due to general infection dating from the time of inoculation. Hence, the local treatment of chancre should consist of measures that prevent the irritation of the ulcer, such as is caused by rubbing against the clothing and infection with pyogenic microbes. Antiseptic protection of the primary induration before the epithelium is abraded is eminently proper. Cleansing with soap and water and a dry dressing of sublimate cotton, so applied as to permit urination, is judicious treatment. Iodoform dissolved in collodion (gr. x to f℥j) is a convenient application, as it makes an impervious coating. It should not be applied until the sore is made aseptic by washing with soap, and sublimate solution or solution of hydrogen dioxide. Dusting with calomel powder, or equal parts of calomel and bismuth subnitrate is a good method of treatment. If the chancre becomes phagedenic, which is rarely the case, strong caustics, such as undiluted nitric acid or solution of nitrate of mercury, may be employed to arrest the destructive action. The actual cautery destroys the micro-organisms better than any of these. It must be applied to every crevice of the sore. Bubo, as a rule, demands no local treatment, for it is painless and merely an expression of the constitutional implication. Moreover local treatment is useless because it, as a rule, effects no result. If suppuration occurs about the indurated glands, the pus should be evacuated as if the abscess were non-specific, which, indeed, it really is.

The special constitutional remedies for syphilis in all its stages are mercury and iodine; of these mercury is the more important and efficient. The manner of using these drugs is important, but the preparation employed may vary with the fancy of the surgeon and the convenience of the patient. It is absolutely essential that the effect of the remedy be maintained for two or three years, if the tendency to secondary and tertiary manifestations is to be eradicated. Mercury is the better remedy for the primary and secondary lesions, and iodine probably the better one for the tertiary affections; though this dictum may at times be invalidated by individual experience. A combination of both drugs is frequently employed.

As soon as the diagnosis of syphilis is established, mercurial treatment is to be instituted, and, even in doubtful cases, some prefer to give the patient anti-syphilitic remedies. Many syphilographers prefer to wait until the diagnosis of a doubtful sore is absolutely established by the occurrence of secondary symptoms. The yellow iodide of mercury (often called the protiodide) may be given in quarter-grain pills three times daily after meals; or a corresponding amount of blue pill or calomel may be substituted. If it is found in the course of a few days that unusual looseness of the bowels is produced, one or two grains of tannic acid or a sixth of a grain of opium may be added to each pill. This amount of mercury will probably be tolerated for several weeks without causing tenderness of the gums or undue salivary excitation. As soon as either of these effects is induced the amount must be decreased or the drug entirely suspended for a week. In cases where the disease is violent in its first manifestations an early decided mercurial impression is necessary. Blue pill in doses of one to three grains daily, or calomel to the amount of one-half to two grains daily, or a similar amount of yellow iodide continued until evidences of moderate constitutional effects become evident, is judicious treatment. If no beneficial effect is observed from the ordinary doses, and the condition of the gums will warrant it, the amount must be increased. In this tentative manner the maximum quantity which the patient can take without causing gastric, intestinal or oral irritability is determined. This he must continue during nearly three years, occasionally omitting treatment for one or two weeks, but never suspending it entirely, even if no further constitutional symptoms have shown themselves. There is no danger of taking these small or tonic doses of mercury for too long a period in this way, but there is often a tendency to tire of what seems unnecessary tediousness of treatment.

If the surgeon prefers, some other mercurial preparation may be used, or the drug may be introduced into the system by inunction, fumigation, hypodermic injection or suppository.

For inunction thirty or forty grains of the official ointment of mercury may be rubbed into the thin skin of the inner side of the arms or thighs at bedtime. Fumigation is accomplished by volatilizing a half drachm of calomel by means of a lamp placed under a metal plate upon which the drug is spread. Any apparatus which will allow this arrangement, and at the same time furnish an atmosphere warmed and filled with steam, is all that is required. The patient is divested of clothing and surrounded by a rubber cloth extending from his neck to the floor. Under this covering the generator of mercurial vapor and of steam is placed, and thus the moistened cutaneous surface is subjected to the remedial influence. Such fumigation may be repeated every day for fifteen minutes, and is especially available for syphilitic skin affections. Internal treatment may be used in connection with these mercurial baths. The corrosive chloride of mercury in doses of from one-thirtieth to one-tenth of a grain may be given hypodermatically. All these methods, however, are too inconvenient for prolonged use, and will never supersede the ordinary mode of administration, except in especially selected cases.

At certain times, because of the inefficiency or undesirability of mercury, the preparations of iodine must be utilized. The iodides of potassium, sodium and ammonium are usually adopted because of their cheapness, convenience and efficiency. Iodoform is too offensive in odor, and many other preparations are too expensive or bulky. The iodides seem more valuable in the late lesions of syphilis than in the primary and early secondary affections. They are to be given in ten- to sixty-grain doses three or four times daily, after meals, and preferably, perhaps, in alkaline solutions. The sodium iodide will often produce less coryza and mucous irritability than the commonly employed potassium salt, though the remedial power of the drugs is about equal. Upon some persons the iodides act as a poison, and in very small doses produce coryza, conjunctivitis, cough, and a papular eruption. Usually, however, these disagreeable effects can be obviated by combining a small amount of morphia with each dose, or by resorting to some other preparation of iodine.

Before leaving the constitutional treatment of syphilis, it is necessary to remind the reader that many patients are so broken down by the effects of the syphilitic poison, or by previous conditions of ill health, either acquired or hereditary, that the use of corroborant remedies is imperatively demanded. Such cases require quinia, iron, mineral acids, stimulants, cod-liver oil and concentrated food. It is often possible to keep up this line of action while administering the small doses of mercury, or the iodides. If these remedies seem to interfere with digestion and produce anæmia, they must be suspended or reduced in amount for a time, and the reliance of the surgeon be upon the tonic and supporting regimen. It is a mistake, however, always to consider the prolonged course of mild specific medication a depressing agency, for in the majority of cases it is the syphilis that depresses, and the specifics which neutralize this poison are really the proper drugs to increase the health equation. Agents which tend to eliminate morbid matters from the blood are doubtless valuable; hence, Turkish baths and secretory stimulants probably are beneficial in the treatment of syphilis.

Again, it is very often of advantage to combine the mercurial and iodine treatment when either agent alone does not beget favorable results. In very late lesions, unusually large doses of iodide of potassium, such as a half drachm or a drachm, largely diluted and taken after food three or four times daily, will occasionally work astonishing cures of painful conditions due to periostitis and of nerve lesions. I usually give about thirty grains of the potassium iodide before each meal, and a half to one grain of the yellow iodide of mercury with a grain of tannic acid after each meal. These remedies should not be taken at the same time, as red iodide of mercury might perhaps be formed and poison the patient. Five or six hundred grains of an iodide daily may occasionally be required.

Hereditary syphilis must be treated with mercury and iodine, combined with or occasionally replaced by tonics in the same manner as acquired syphilis. The syrup of iodide of iron in twenty- or thirty-drop doses is often an eligible preparation. Warm clothing, good diet and hygienic surroundings of the best character are important factors in bringing syphilitic children to adult life. It is probable that the subjects of inherited syphilis are more or less protected against inoculation with syphilitic virus.

The local treatment of syphilitic lesions is important, but far less so than the general treatment, except in the case of iritis. In iritis it is absolutely essential to drop immediately into the eye a strong solution of atropia (about four grains of atropia sulphate to the fluid ounce of water); because, if this is delayed, the iris will become glued to the anterior capsule of the lens, and the permanently contracted pupil be occluded by the deposit of inflammatory lymph. Hence, wide dilatation of the pupil must be obtained at once, after which, or indeed during the same time, constitutional remedies are administered.

Mucous patches and ulcerations should be touched with fused silver nitrate or a solution of nitrate of mercury (1:10). Cutaneous ulcers will heal more rapidly if slightly stimulated with diluted ointment of nitrate of mercury (1:10), or with some astringent, such as copper sulphate, silver nitrate, boroglyceride, iodoform, or chloral. The various remedial measures described under ulcers are applicable.

The falling of the hair, technically called alopecia, may require stimulating applications to the scalp, such as alcohol, ointment of the nitrate of mercury, tincture of cantharides, tannic acid and ammonia, suitably diluted. Lymphatic glandular involvement may be benefited at times by pressure, absorbent plasters and lotions, and by interstitial injections of alcohol or iodine. Periostitis, which often causes excruciating pain, may be relieved by blisters, or by subcutaneous incision of the periosteum, which relieves tension. Other operations may, at times, be required for the removal of diseased bone or irrevocably degenerated members.

CHAPTER VI.

RACHITIS OR RICKETS.

Definition.—Rickets is a diathetic affection, and, therefore, should not be described under disease of bone, but in the present connection. Its characteristic is an abnormal deposition of cartilaginous material, with incomplete ossification. The effects of this constitutional condition are shown in softening and distortion of bones, and in changes resembling amyloid degeneration in the liver, spleen and other organs.

Pathology.—Rickets seems to depend upon malnutrition, which causes deposition of abnormally large areas of soft, cartilaginous tissue which cannot be at once perfectly ossified by calcific transformation. Hence the bone is thickened by soft, subperiosteal, cartilaginous deposits, which do not add to its strength, because the medullary cavity is simultaneously increasing. The bones are, therefore, easily bent out of shape. The epiphyseal cartilages are enlarged in a similar way, and, becoming imperfectly ossified, allow deformity in the vicinity of the joints. Marked deposition is apt to occur about the edges of the cranial and other flat bones. After a time excessive deposit of bone salts occurs, and sclerosis, or abnormal hardening, of the bones takes place. The visceral changes resemble amyloid or waxy degeneration. The red corpuscles of the blood are decreased in number; and leukocytosis is present, with the mononuclear cells especially numerous.

Causes.—The etiology of rickets is unknown. Heredity, food deficient in organic salts, and the presence of lactic acid or phosphorus in excessive amounts have been named, but not established, as causative factors. Deficiency in amount of fresh food is an important factor in its production. Inherited syphilis has been suggested as a cause.

Symptoms.—Rickets is a disease of childhood, and appears about the second or third year of life. The premonitory symptoms are not distinctive, and no definite diagnosis can be made until the enlarged extremities of the long bones, the nodules at the junction of ribs and costal cartilages, and the bending of the bones by muscular traction and the weight of the body in walking point out the rachitic condition. The child may be restless, sweat profusely about the head, show digestive derangement, exhibit irregularity in dentition, and complain of muscular pain upon moving or being handled. There is often no febrile movement. The liver and spleen are often enlarged, and the child listless, emaciated and somewhat sluggish in mental development. Osseous deformities of the limbs, anterior thoracic region, spine and pelvis are commonly exhibited in tuberous enlargements and curvatures. Partial or complete fracture may occur. The fontanelles close slowly; and the cranial bones may become thinned, or present spaces in which the bone is substituted by a parchment-like membrane. This condition is termed cranio-tabes. These symptoms may abate, as if convalescence was at hand, and be followed by recurrence of symptoms. It is not usually a fatal disease, but recovery slowly supervenes, accompanied by abnormal induration of the distorted skeleton.

Treatment.—The treatment must consist of feeding with the most nutritious food, as mother's milk, cow's milk, and broths, and the administration of cod-liver oil (fʒss–ij three or four times daily), syrup of iodide of iron (♏x–xxx), quinia (gr. i–ij), syrup of hypophosphites (ʒss–fʒij), or syrup of lacto-phosphate of lime (♏x–fʒj). Fresh a r, bathing and friction are valuable adjuvants.

During the stage of softening, deformity of the bones should be averted by prohibiting locomotion, and by the application of splints or plaster-of-Paris dressings. After convalescence, slight curvatures will often be corrected by muscular action during the growth of the child. If the deformity is great and permanent, osteotomy may be demanded to relieve lameness or to improve appearances.

CHAPTER VII.

TUMORS.

Definition.—A tumor, or morbid growth, is a circumscribed enlargement of living tissue, abnormal to the part and having no physiological function, which, in its growth, is independent of the adjacent structures, and which is not the result of an inflammation. It is an atypical new formation. Most cysts are not strictly tumors. Condylomata are inflammatory formations, not tumors.

Causes.—The cause of all morbid growths is abnormal activity of the cellular elements from which they originate, but the factors or primary causes inducing this morbid activity of preëxisting cells are not easily discoverable.

It is probable that the cause of tumors is local rather than general, for, although blood alterations and hereditary conditions may influence their progress, the development of such morbid growths seems to depend on peculiarities of the tissue-cells. These peculiarities may be due to inherited cellular eccentricity which readily responds to any existing cause, or to local irritation from injurious impressions or from the immigration of foreign elements coming from primary morbid growths situated at a distance. Many efforts have been made to prove the dependence of tumors, especially malignant growths, upon micro-organisms, but thus far unsuccessfully. Coccidia, which are unicellular organisms, have been suggested as the cause of carcinomas, and bacteriologists have recently been investigating the possible etiological relation of yeasts to these malignant tumors. The most tenable theory for benign growths is that there has been left imbedded in the tissues a few embryonic cells, not employed in the development of the animal in the prenatal stage of existence, which, in after-life, assume activity and develop into tumors. It has been suggested that the occurrence of carcinomas is due to the normal resistance of connective tissue being reduced until epithelium, which has an active power of growth, invades it.

Pathology.—Tumors are always developed from cells which have previously existed, either at the present seat of the growth or at some distant spot from which they have been transported to the locality occupied by the tumor. The tumor in the former case is a primary, in the latter a secondary, morbid growth. The histological structure and development of every tumor resemble, in a greater or less degree, some normal or physiological tissue—that is, all pathological formations belong to some physiological type. The resemblance is not exact, however; they are atypical. These axioms may be clearly illustrated by saying that no tumor can be formed from cloth or straw, but in its construction and growth must resemble some animal tissue. The original elements from which tumors are developed are cells of connective tissue, of epithelium, of glands, of muscle or of nerve. The morbid growths originating from muscle- and from nerve-cells are rare, those arising from epithelial and glandular origins quite common, and those developed from a connective-tissue basis exceedingly frequent.

A tumor whose structure is similar to the part from which it originated or in which it lies is called homologous; one which differs from the tissue that gave it birth, or in which it is situated, is termed heterologous. These terms are somewhat relative; for example, a cartilaginous tumor growing from the larynx would be homologous, but if appearing in the testicle it would be heterologous. Heterology is especially characteristic of malignant growths because they spread into tissues different from their original site, and are even transported, by the blood and lymph currents, to distant parts of the organism, such as the internal viscera.

An important point in regard to the relation of the new growth to the adjacent tissues is the presence or absence of infiltration. If the tumor blends with the surrounding parts so that the microscope discloses tumor cells involving the muscular and cellular tissue of the neighborhood, infiltration exists and the tumor is diffuse. This infiltration is very common in malignant tumors, but may not be apparent to the unaided eye. A circumscribed growth is one which is definitely separated from the adjacent structures, which it has pushed apart during its development. It is often isolated from them by a capsule of condensed fibrous tissue. Such growths may, during their progress, become diffuse. Microscopic examination is the only test of the absence of infiltration even in growths which appear to be encapsulated.

Tumors occasionally disappear by atrophy or absorption, and at times reach a certain bulk and remain stationary; but usually they increase in size. This increase frequently occurs rapidly, even though the patient is losing weight. They may undergo changes, such as fatty degeneration, calcification, pigmentary, colloid or mucoid degeneration, inflammation, ulceration, and mortification, in a manner similar to tissues not pathological in their origin.

The tendency which certain morbid growths have to be reproduced, either at the original site after excision, or in other regions by infiltrating or infecting the tissues, is designated malignancy. Hence, tumors are malignant and non-malignant. Malignant tumors, as previously stated, are capable of infiltrating neighboring tissues with their cells; and by this and perhaps other means they influence such abnormal activity in the part that similar growths arise at the circumference of the original tumor. Hence, it is not unusual to see a neoplasm surrounded by a series of small nodules. Malignancy is shown in a second way. When the surgeon removes a malignant tumor he may leave tissue which has recently been infiltrated with the tumor cells, but which appears to be normal. These cells, either by their own proliferation or by influencing proliferation in the native cells of the part, cause a similar tumor to appear at the cicatrix and its vicinity. The development of secondary tumors from malignant growths may occur in another way. The lymphatic circulation through the original disease may carry cells of the tumor to the nearest lymphatic glands, where they are arrested, and, as in the former case, induce secondary growths similar to the primary. A fourth manner of inducing secondary tumors is a similar transference of cellular elements by means of the blood-current passing through the growth. These tumor cells are arrested by arteries or by veins in some distant capillary system, often the nearest, and, as in the lymphatic method of infection, induce secondary growths.

Thus, it is evident that malignant tumors produce others like themselves by infiltration and by lymph and blood infection. Other methods may at times, though rarely, be operative. Tumors often show a decided preference for one or other of these methods of reproduction. The secondary growths may, in the same way, act as parents and produce a progeny with characteristics similar to their own. This transference of cellular elements explains the circumstance that malignant tumors are frequently heterologous.

It must not be forgotten, as it often is, that multiple tumors, even when malignant, may not be secondary to another, but may be synchronous or due to the same original cause.

From the description given of the processes by which reproduction of malignant growths is accomplished, it is evident that the most malignant growths would be those containing the greatest number of cells, the most juice, and the greatest abundance of lymphatic vessels and blood vessels. The reverse of this picture would give non-malignant or benign tumors, which, as they approach the characteristics of the other group, become more or less malignant in nature. In fact, there is no absolute line drawn by nature dividing the malignant from the non-malignant; although it is admitted that tumors with one histological structure are usually malignant, and others usually benign, either class may occasionally assume the clinical nature of the other.

Classification.—Tumors are classified according to their histological structure, which always resembles, in a greater or less degree, some physiological tissue of either adult or fœtal life. The imperfect knowledge that we possess of the development of many tissues and the varying degrees of relative importance attached by pathologists to the microscopic elements seen in a growth prevent a universal acceptation of a single classification.

Classification of Tumors.

I. *Tumors whose general structure or type resembles one of the modifications of fully developed connective tissue.*

Special types:

1. Fibrous tissue.	Fibrous tumor.	Fibroma.
2. Adipose tissue.	Fatty tumor.	Lipoma.
3. Cartilage.	Cartilaginous tumor.	Chondroma.
4. Bone.	Bony tumor.	Osteoma.
5. Mucous tissue. (Not mucous membrane.)	Mucous tumor.	Myxoma.
6. Neuroglia.	Tumor of connective tissue of central nervous system.	Glioma.

II. *Tumors whose general structure or type resembles that of one of the higher or more complex tissues than fully developed connective tissue.*

Special types:

1. Muscular tissue.	Muscular tumor.	Myoma.
2. Nervous tissue.	Nerve tumor.	Neuroma.
3. Blood vessels.	Vascular tumor.	Angioma.
4. Lymphatic vessels.	Lymphatic vessel tumor.	Lymphangioma.

III. *Tumors whose general structure or type is that of the undeveloped connective tissue of the embryo.*

Sarcomas.

These are named according to the shape and size of the predominant constituent cell (round-cell, giant-cell, etc.); or according to the character of the stroma (osteo-sarcoma, myxo-sarcoma); or according to the retrogressive changes that occur in the tumor (melano-sarcoma, calcifying sarcoma).

IV. *Tumors whose general type is that of epithelial tissue.*

1. Papillæ of skin or mucous membrane.	Papilloma.
2. Glands.	Adenoma. / Carcinoma.

Under carcinomas, then, are:

1. Acinous carcinoma.
   a. Scirrhoma, or chronic carcinoma.
   b. Encephaloma, or acute carcinoma.
2. Epithelial carcinoma.
   a. Squamous epithelioma.
   b. Columnar-cell epithelioma; often called adenoid carcinoma.
3. Colloid carcinoma.

V. *Tumors consisting of a sac with contents (cystomas, or cystic tumors), and teratomas.*

Tumors due to inclusion and imperfect development of one fœtus within another, or abnormal development of a single fœtus. Dermoid cysts belong in this division.

The tumors of classes I., II. and III. arise from the mesoblastic tissues, those of class IV. from the epiblastic and hypoblastic tissues.

Clinical History.—Tumors present innumerable varieties as to size, form, consistence, number, situation, and other physical characteristics. These clinical attributes have much to do with the symptoms of the growth; for example, a small tumor passing on a nerve-trunk will produce more pain than a large one in another locality; one overlying an artery will receive transmitted pulsation, another pressing upon a vein will cause mechanical dropsy. Certain tumors, especially the carcinomas, have a tendency to ulcerate and become the seat of hemorrhage.

Those growths whose clinical history is conspicuous because of their infiltration of adjacent structures, recurrence after removal, and reproduction in distant regions of the body, are called malignant. The carcinomas and many of the sarcomas usually present this feature of malignancy; the other groups, as a rule, are not malignant. There are, however, occasional exceptions, for sarcomas and even circinomas sometimes act as non-malignant growths, while others, ordinarily benign, at times assume a decidedly malignant expression.

Causes of Death.—Death may occur from morbid growths on account of hemorrhage, asthenia due to excessive discharge, nervous irritation, mechanical interference with nutrition, asphyxia, and profound involvement of the nervous centers. Many tumors have no tendency to impair the general health.

Treatment.—The treatment of tumors depends on their character. Malignant growths, and those suspected to have that character, should, as a rule, be removed by operation as early as possible. The excision should extend far beyond the apparent outlines of the tumor, because infiltration has probably taken place, though not appreciable to the eye of the surgeon. Benign growths may be allowed to remain if they neither interfere with the functions of the part nor cause indirect deterioration of health. If they show indications of probable injurious influences in the future they should be removed while small, provided the excision can be done without great risk. If the tumor is more serious in its present or future aspects than the operation, operation is justifiable. Aseptic surgery is so free from risk that nearly all tumors are properly subjected to early operative attack, even if small and benign.

In excising tumors involving deep structures and having firm attachments, the operator should endeavor at once to become master of the situation by coping at first with the most troublesome portions of the growth. It is unsurgical to spend time freeing superficial adhesions and tying vessels which will in a moment be cut again at a lower level. A sufficiently large incision should always be made.

When tumors cannot be removed, relief of pain may often be obtained by open or subcutaneous division of the fascias binding them down, or by excision or stretching of nerve-trunks.

Excision of insignificant tumors is often proper, because of the unsightliness produced by them and the mental perturbation induced by their existence. Doubt as to a possible future malignancy is a good reason for early operation.

SPECIAL TUMORS.

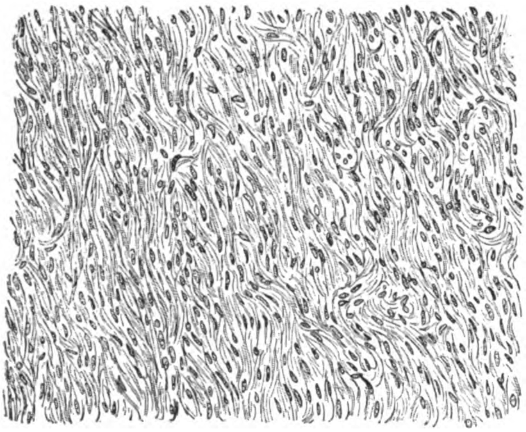
I. *Tumors whose general structure or type resembles one of the modifications of fully-developed connective tissue.*

Growths of this class are non-malignant; and when any of them, such as fibroma, enchondroma and osteoma, occasionally assume a malignant expression, it is found on microscopic examination that they are wholly, or in part, sarcomatous. This accords with the well-known fact that a tumor may present in its different parts the structure of several varieties of morbid growth.

Fibromas or Fibrous Tumors.

These growths may be divided into soft and hard fibromas. The former grow somewhat rapidly, are smooth, rather soft and elastic, and often pedunculated; they are at times diffuse, though often circumscribed and encapsulated, and give rise to no pain or inconvenience except from their weight. On section they occasionally exude a large amount of serous fluid. The hard fibrous tumors are of slow growth, and are smooth, firm, usually single, generally movable unless having bony attachments, painless and encapsulated. Fibromas, as a rule, have few vessels; but they are occasionally very vascular, and then, as

FIG. 18.



Fibroma of the ovary. × 250. (SCHMAUS.)

the fibrous surroundings of the vessels prevent retraction and contraction, severe hemorrhage may follow their removal. Fibrous tumors originate from the fibrous tissue of the skin, connective tissue, subcutaneous and submucous tissue, periosteum, fascias, nerve-sheaths, and other structures; and are found in many situations. They constitute one form of epulis, a variety of naso-pharyngeal polypus, and the so-called false neuroma. The last is a fibroma developed from the connective tissue in the nerve and having nerve fibers spread over its surface. Such tumors are often multiple, and are painless. The painful subcutaneous tubercle is considered by some a fibroma which has no demonstrated connection with nerve fibers; others think it is a true neuroma, or nerve tumor. Uterine fibroid tumors are usually myomas. Keloid growths are fibromas. Fibrous tumors may undergo softening, calcification, ulceration and cystic degeneration.

FIG. 19.

Keloid tumors of back. (Author's case.)

Microscopically, fibroid tumors consist of fibrous tissue more or less compactly interlaced, associated with a few fusiform or star-like cells which are often indistinct. Rapidly developed fibromas usually present a greater proportional abundance of cells and are soft in consistence. Some fibromas closely approach the sarcomas in their microscopical and clinical features. The treatment of fibrous tumors consists in removal. They are non-malignant.

Lipomas or Fatty Tumors.

A circumscribed accumulation of adipose tissue is called a fatty tumor. They occur anywhere, though especially about the back and shoulders. Such tumors are of slow growth, though they may reach a very large size; and are soft, doughy, and sometimes slightly fluctuating. Often they are distinctly lobulated and frequently cause a dimpling of the integument at the situation of the fibrous septa attaching the skin to the deep fascia; they may become pendulous, and even change their position under the skin by the action of gravity; they are painless and seldom undergo degeneration, softening, or ulceration.

FIG. 20.

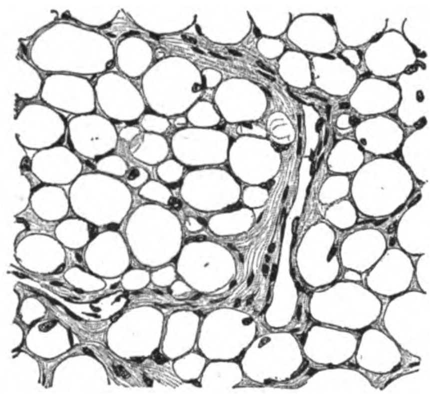
Multiple fibroid tumors of back. (Authors' case.)

They consist of indistinctly nucleated cells distended with fluid fat and connected by a variable amount of connective tissue. As these cells increase in number by proliferation they are filled with fat, and thus the growth acquires bulk. The mass is usually surrounded by a capsule of condensed connective tissue. It is their localization that distinguishes fatty tumors from ordinary obesity. If lipomas require treatment they are to be removed by means of a free incision through the skin, which enables the surgeon to turn them out of the capsule with great ease. No portion of the tumor should be left behind to reproduce the growth.

Chondromas or Cartilaginous Tumors.

These growths are found especially among young patients, and are frequently connected with the bones of the fingers. They are rarely developed from preëxisting cartilage. They occur also in glands, such as the parotid, testicle and mamma, and occasionally in the lungs. When connected with the phalanges of the hands or feet they are usually multiple, otherwise they are single. Cartilaginous tumors are smooth, hard and elastic, and often lobulated masses; of slow development, usually surrounded by a capsule, and non-malignant.

FIG. 21.



Lipoma from the shoulder region, with relatively small fat cells. × 300. (ZIEGLER.)

Occasionally, however, they are much softer than usual, grow rapidly, have no capsule, recur after removal, infect distant tissues by cell transference, and present decidedly malignant characteristics. These tumors usually show, especially at their circumference, sarcomatous structure infiltrating adjacent tissues; hence they are not to be considered true chondromas.

There is a form of tumor called osteo-chondroma, which consists of bone associated with cartilage and originates under the periosteum near the articular extremities of the long bones. It may become transformed into true osseous tissue.

Chondromas, or enchondromas, as they are also called, are in structure almost identical with the varieties of cartilage, and yet they rarely originate from cartilage. They exhibit cells with nuclear aud granular contents enclosed in a matrix which varies from a hyaline to a fibrous or mucoid character. They are usually developed from bone or from connective tissue, and not from cartilage; very occasionally they originate from costal, laryngeal, and other cartilages in the same manner as exostoses grow from bone. It has been proposed to call these overgrowths enchondroses.

FIG. 22.

Multiple enchondroma of fingers.

Changes of a calcareous or ossific character quite often affect cartilaginous tumors. Sometimes portions soften in the interior of the growth and cause an appearance resembling cystic degeneration. Chondromas are to be treated by excision. Prompt operation is demanded in those of a sarcomatous character.

Osteomas or Bony Tumors.

These growths, which must be distinguished from calcareous degeneration of tissue, are hard, painless, of slow development, and frequently immovable because of their firm attachment to bone. They do not acquire a great bulk, but may be multiple. Falls may cause fracture of such tumors. Inflammation of periosteum and bone will frequently give rise to osseous masses, as is seen in long-standing periostitis and when callus is formed after fractures. These are not usually regarded as true tumors, but the line between them and other bony growths is not very definite. Bony segments are occasionally formed in fibroid and cartilaginous tumors, because of ossific degeneration; and at times sarcomas are associated with bony masses. These last may show signs of malignancy, and hence must be distinguished from true osteomas, which are benign. Irregular masses of spongy bone are often ossified chondromas.

On section osteomas resemble bone, showing lacunæ, Haversian canals and canaliculi. Some consist of cancellated or spongy bone surrounded by a thin layer of compact bony tissue, others are much more compact; while still others are so dense that they show no spongy structure, and are hence called ivory-like osteomas.

Bony tumors may originate from bone or its accessory cartilage and periosteum. Then they are denominated exostoses, except when they project into the medullary cavity and are called enostoses. The projections of bony tissue found associated with diseased joints and inflamed bones, usually called osteophytes, are not tumors, but inflammatory formations. The former are frequent upon the interior or exterior of the skull, and the jaws, great toe, humerus and femur; the latter about diseased joints, muscles, and other structures undergoing inflammatory process. Osteomas occasionally arise from the medulla of bone. Bony tumors are non-malignant, but may require removal because of deformity, interference with motion, pain, or ulceration of the overlying integument. Excision, by bone-cutting forceps or saws, or grinding away with the burr of the surgical engine is the proper method of accomplishing removal. Subcutaneous sawing or drilling followed by fracture may be valuable by affording relief of symptoms without entire excision.

Tumors composed of dental structures and hence called odontomas, may be mistaken for osteoma, myleoid sarcoma, or necrosis of the jaw. They are of epithelial origin and do not belong in any way to the same class as osteoma. The growths are often of a cystic character. They are non-malignant and require simple excision. The liability of mistaking them for sarcoma and performing a too extensive operation should be remembered.

Myxomas or Mucous Tissue Tumors.

The most familiar growth of this class is the mucous tumor or polypus found in the nasal cavities. Myxomas are soft, often fluctuating, smooth or somewhat lobulated, painless tumors, of slow growth, and surrounded by a thin capsule. On section they are yellowish-white or pinkish in color, and exude an abundant glairy fluid, which examination shows to be mucoid. The gelatinous consistence and intercellular mucous fluid are the physical characteristics of the growth, which consists of mucous tissue, such as is found in the vitreous body of the eye and in the umbilical cord. Mucous tissue, which must not be confounded with mucous membrane, is a form of connective tissue which is translucent and possesses between its cells a fluid containing mucin. This resembles very much the connective tissue of the embryo, and, therefore, some authorities class myxomas with sarcomas.

Mucous tumors are always developed from some connective tissue, such as adipose tissue, bone marrow, or the connective tissue of the nervous structures and other organs. They may exist in combination with fibroid, fatty, cartilaginous, sarcomatous, and other growths, and may undergo cystic change. On the other hand, various neoplasms may present a mucoid degeneration in spots which gives them the semblance of myxoma. Some tumors called colloid carcinomas are myxomas.

The microscopical examination discloses oval, stellate, and spindle-shaped cells, which are generally nucleated and often possess elongated projections which mutually interlace. The intercellular substance is more or less hyaline, and is homogeneous. It is this that gives the mucous tumors their jelly-like nature and furnishes the mucoid fluid, so characteristic of them.

Myxomas, if not associated with sarcoma, are benign; and if entirely removed, seldom, if ever, recur. Where there is a group of pendulous myxomas, as occurs in the nose, the removal of a large one may, by relieving pressure, allow smaller ones to increase, and thus reproduce the old symptoms; but this is not a recurrence of the original growth.

Gliomas or Neuroglia Tumors.

These growths are composed of tissue similar to the connective tissue found in the brain and spinal cord; and are found in the central nervous system. They may be soft or moderately hard, and resemble somewhat in color the gray matter of the brain. At times they are reddish.

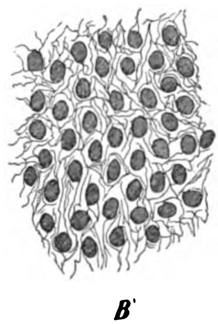
Histologically the tumor consists of a delicate network and cells with comparatively large nuclei and fine branching processes. Gliomas are generally single, do not involve the neighboring lymph nodes, and often are the seat of softening, fatty degeneration, and interstitial hemorrhages. They are benign; but may be found as a mixed tu mor with sarcoma. A gliosarcoma has the malignancy of sarcoma.

II. *Tumors whose general structure or type resembles that of one of the higher or more complex tissues than fully developed connective tissue.*

FIG. 23.

Cells from glioma of brain, teased specimen. × 350. (ZIEGLER.)

FIG. 24.



Section of a glioma of the brain. × 350. (ZIEGLER.)

Myomas or Muscular Tumors.

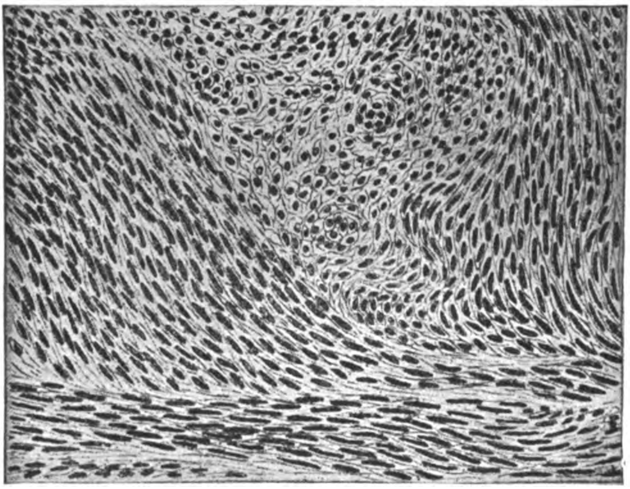
Muscular tumors are growths consisting of non-striated muscular fibers (leio-myomas) usually combined with more or less connective tissue. Very rarely muscular tumors are formed of striated muscular tissue (rhabdo-myomas): these have been usually, if not always, congenital tumors. Myomas are of slow growth and are usually circumscribed by a sort of capsule, though at times they are not distinctly bounded; not infrequently they become pedunculated. They possess considerable firmness and solidity, are often multiple, and are benign. Their most common location is in the uterus, prostate gland, and digestive tube; hence, they show the characteristics of involuntary muscular tissue. From the abundance of connective tissue found associated with the bundles of muscular fibers, especially in long-standing tumors, these growths, when in the uterus, are often termed uterine fibroids or fibro-myomas. Myomas may undergo calcareous or cystic degeneration.

Under the microscope are seen long fusiform cells of involuntary muscle, with their characteristic rod-like nuclei, arranged in bundles or irregularly disseminated through the tumor. There is seen also, except in some recent tumors, a good deal of fibrous tissue. Myomas are innocent, but should be removed if it is possible to do so, when their location or their production of uterine hemorrhage causes annoyance. When such uterine tumors are developed near the lining mucous membrane, especially if pedunculated, they may be removed by forceps or écraseur. They are occasionally expelled by inducing uterine contraction with ergot. It may be necessary and advisable to remove the entire uterus by abdominal incision when such growths cannot be enucleated from the abdominal surface of the womb.

Neuromas or Nervous Tissue Tumors.

All tumors connected with nerve-trunks are not neuromas, for they may be fibromas, myxomas, etc.; nor are nervous tumors necessarily painful tumors, as might be supposed by some readers. A neuroma is a rare form of growth and consists principally of ordinary white or

FIG. 25.



Myoma of the uterus. × 300. (ZIEGLER.)

medullated nerve-fibers. Gray nerve-tissue may be found in neuromas, but this is exceptional.

Such tumors are small, slow of growth, sometimes multiple, perhaps painful, and always develop in the course, or at the end, of a cranial or spinal nerve. A not infrequent situation is the end of a nerve-branch that has been divided in a previous amputation; here they may be compressed in the cicatrix and give rise to much pain. The so-called painful subcutaneous tubercle is a fibroma, not a neuroma.

Under the microscope nerve structure with some connective tissue is seen. Nervous tissue tumors are never malignant, but may require excision when painful.

Angiomas or Vascular Tumors.

Tumors consisting of newly-developed vessels, bound together by cellular tissue, are angiomas; hence dilatations of existing vessels, such as are present in varicose veins and varicose arteries, often called cirsoid aneurisms and aneurisms by anastomosis, are not properly termed angiomas.

Simple angiomas consist of structures resembling normal vessels with unusual tortuosity and may have a predominance of venules or arterioles. The color of the growth varies on this account from pink to dark-red or purple. Such tumors are apt to be congenital and small; and sometimes present no elevation of the skin, being mere stains. They constitute the well-known nævus maternus or mother's mark. Cavernous angiomas are tumors which are made up of erectile tissue. This consists of a series of chambers lined with endothelium and filled with venous blood, which circulates freely through these mutually connected spaces. The walls of the chambers are fibrous septa. The structure is similar to that of the cavernous portion of the penis and gives such tumors an erectile character, which is often accompanied by distinct pulsation. Cavernous angiomas usually give the skin a blue tint; vary in size according to the degree of engorgement, though they are apt to cause a prominence at all times; often grow rapidly, especially in cutaneous and loose areolar tissue; and are not necessarily congenital. Injury to cavernous angioma is followed by profuse hemorrhage.

FIG. 26.

Cavernous angioma of mouth and cheek in a child of two and a-half years.

Lymphatic vessels sometimes communicate with cavernous spaces, similar to those described as occurring in cavernous angiomas. A tumor is then formed, which is called a cavernous lymphangioma. There is also a form of lymphangioma which consists simply of a mass of lymphatic vessels; being, in fact, similar to the simple angioma above described.

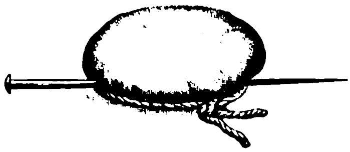
Vascular tumors are non-malignant; but some forms may tend to produce death by hemorrhage, occurring from slight abrasion of their surface or from ulceration. Purely subcutaneous angiomas present themselves as spongy, doughy tumors, from which pressure expels the blood more or less completely, leaving in the grasp a much smaller tumor. If largely composed of arteries, they have a pulsatile character, and a murmur which causes them to resemble aneurisms. The pulsation, however, partakes rather of the character of a thrill than of a beat synchronous with the heart movements. The spongy consistence and the fact that pressure on one artery does not obliterate the thrill and murmur aid in diagnosis. The angioma, moreover, is, probably, not located in the course of an artery. Angiomas in bone resemble malignant tumors. Vascular tumors, which involve both the skin and the subcutaneous tissue, are easily diagnosticated. They may cause great deformity, and even erosion or displacement of the bones.

No treatment is demanded for angiomas which do not increase, nor threaten life from ulceration and hemorrhage, unless the deformity or personal disfigurement is a source of anxiety. Sometimes, though rarely, they atrophy spontaneously. Capillary dilatations situated solely in the skin, causing the pink discolorations often called port-wine marks, may be removed by multiple scarification, puncturing with red-hot or electrolytic needles, or by applying caustics. These marks are often unaccompanied by any increase in the bulk of the part. Under such circumstances they can scarcely be called, with propriety, vascular tumors. Some of these superficial congenital discolorations gradually increase in thickness, and become true angiomas.

The best methods of dealing with these tumors, which are sometimes called thick nævi, are strangulation and excision. The last is the best in nearly all instances.

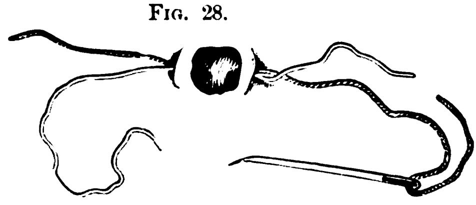
Strangulation may be accomplished in several ways: A needle or pin is thrust through the tissues under the base of the tumor, after which a stout cord is carried once around the mass under the ends of the pin, and is then tightly tied. Sufficient force should be used in making the knot to cut off all access of blood to the tumor, which soon sloughs off, leaving an ulcer to heal. The surgeon may cut away the tumor after ligation, leaving a sufficient stump to hold the pin. It is often well to puncture the constricted tumor with a needle before making the second tie, in order to let the blood and serum imprisoned therein escape. The tumor thus becomes more flaccid and shrunken, and the string can, probably, be tied more tightly. Two pins thrust through at a right angle to each other are better than a single pin, unless the nævus is small. If the string has cut a groove, in which it will lie without slipping over the top of the tumor, the pin or pins may be pulled out after the knot has been tied; otherwise, the pin must be left in position until the parts have sloughed. A second method is to pass a double ligature under the base by means of a large ordinary needle, or one with a handle having an eye in the point. The two halves of the tumor can then be constricted by cutting the string and tying on each side.

FIG. 27.



Strangulation of vascular tumor by a pin and ligature.

FIG. 28.



Ligation of vascular tumor in halves by a double ligature passed under it.

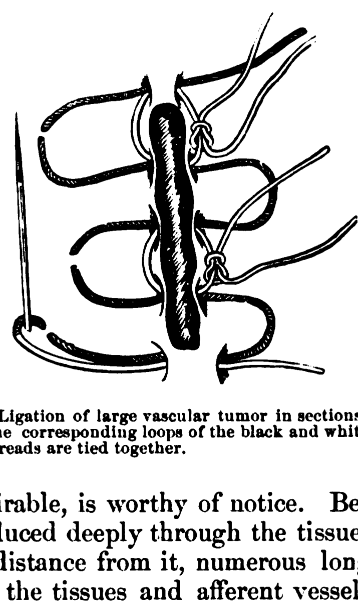
If the tumor has an extensive area, the double ligature, of which one-half should be stained black with ink, may be carried repeatedly through the tissues by a large ordinary needle. Between each puncture of exit and entrance a long loop of the double string must be left. By cutting with the scissors the stained threads on one side, and the white threads on the other, a series of ends are made which can be tied together to strangulate the tumor in sections. The adjacent ends of the separate portions of the ligature may be twisted around each other before the loop's ends are tied, if there is danger of bleeding from the tying pulling the edges of the needle punctures apart.

This plan is well adapted, perhaps, to subcutaneous angioma, which may possibly atrophy without causing ulceration and scarring. The needle must, of course, be reëntered every time at the orifice of exit.

Occasionally constricting a portion of an angioma has set up sufficient inflammation to obliterate the whole. The subcutaneous ligation of the whole or sections of the tumor may be done by carrying a wire around the growth in the same way as described in the treatment of varicose veins. All of these operations must be carried out with aseptic precautions.

Excision of angiomas is, as a rule, the best treatment. The tumor is thoroughly eradicated, the wound, if aseptic, heals more rapidly than the ulcer left after ligation, and there is not the offensive sloughing mass that remains unseparated for many days after ligation. Hemorrhage of a serious character is avoided by making the incision beyond the margins of the growth. When the spongy mass of vessels is removed, sutures are applied and the wound treated as after removal of any other tumor. The method much used by Levis, of Philadelphia, to prevent hemorrhage during the removal of these and other tumors, when even moderate bleeding is undesirable, is worthy of notice. Before making the first incision he introduced deeply through the tissues surrounding the growth and at some distance from it, numerous long acupressure pins, and then constricted the tissues and afferent vessels by strong cords tied around the ends of these pins, as in the pin or harelip suture. If the location was not convenient for using the pins, he carried strong cords through the tissues by means of specially made needles six or eight inches long, and tied the ends of the cords on the surface of the skin. The access of blood to the region of operation is thus more or less completely prevented. After the incisions have removed the tumor, the pins or strings are removed one at a time and the bleeding arteries ligated systematically.

FIG. 29.



Ligation of large vascular tumor in sections. The corresponding loops of the black and white threads are tied together.

Lymphangiomas may be treated by ligation and excision, as described for the removal of arterial and venous tumors, if their extirpation is demanded.

III. *Tumors whose general structure or type is that of the undeveloped tissue of the embryo.*

Sarcomas.

Tumors consisting of connective tissue similar to that found in the human embryo are called sarcomas, and present variations according to the peculiarities of the cells and intercellular substance. The connective tissue of the embryo, before it is developed into the mature connective tissue of the fœtus, consists of numerous small, round cells, with a very small quantity of soft and homogeneous material between them. As the connective tissue becomes more mature, the cells decrease in number and assume an elongated shape, while the intercellular material spoken of becomes fibrous. This maturing connective tissue, finally develops into the perfect connective tissue, fibrous tissue, cartilage, and bone of the fœtus and child.

Sarcomatous growths are formed then of embryonic connective tissue, which, instead of maturing, continues to exist and to reproduce itself, thus causing progressive increase of the tumor. Small portions of the tumor occasionally reach a higher development and become fibrous tissue, cartilage, or bone, thus producing a mixed tumor; but this is not general or usual. The cells of sarcomas may be round, spindle-shape, or very large and irregular. They are closely packed together with very little intercellular substance, which varies from a homogeneous fluid to a somewhat granular or fibrillated material having considerable firmness. This matrix usually intervenes between all the cells, and does not allow them to congregate together in groups. These cells may all occur in one tumor, but the form which predominates gives name to the variety, viz.: round-cell, spindle-cell and giant-cell sarcoma. The round cells are either identical in appearance with white blood-cells or they may have an indistinct nucleus and bright nucleoli. The spindle or fusiform cells are oblong, terminate in fibrils, and have a long elliptical nucleus, with or without a nucleolus. The large irregular or giant cells, called myeloid cells because they resemble the cells of fœtal marrow, are very much larger than the others, and are irregularly spherical with perhaps several prolongations, and contain many oval nuclei with bright nucleoli. They may not actually predominate in the tumor, but their presence is so evident that they give name to the variety in which they are seen. The blood vessels in sarcomas are numerous, and on account of the small amount of matrix are scarcely separated from direct contact with the cells.

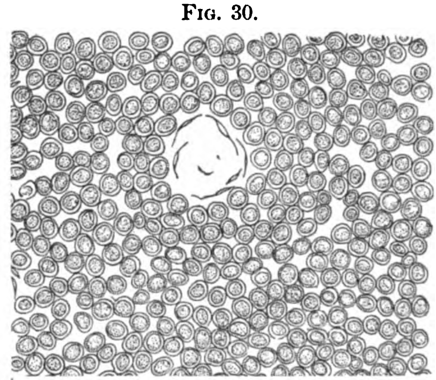
Sarcomas always develop from connective tissue; hence, they have a general distribution and are found originating from muscular fascias, periosteum, lymphatic glands and marrow of bones, as well as from the ordinary connective tissue beneath the skin and the cellular tissue of the viscera. They infiltrate the surrounding structures and thus extend by cellular invasion. There may be a sort of capsule, though the growth is usually diffuse. Fatty, cystic, calcareous and other degenerations are liable to occur in portions of the growth; and someimes sarcoma may be combined with other forms of tumor. This assumption of, or combination with, sarcomatous elements accounts for the malignancy of certain tumors which are usually classed as benign. This has been referred to when speaking of osteomas and chondromas.

Sarcomas are not as common in old age as in the earlier period of life. Many sarcomas are very malignant, infiltrating adjacent parts, recurring after removal, and finally producing secondary growths in the lungs and other regions. The round cell and the large spindle cell growths are much more malignant than the small spindle or the giant cell tumors. Soft and very vascular sarcomas are to be looked upon as being probably highly malignant. Sarcomas do not often affect the lymphatic glands, while the carcinomas do so with great frequency. The fact that the blood vessels in sarcomas are in close relation with the cells accounts for the occasional rapid development of secondary tumors without lymphatic involvement. The cells readily penetrate the thin vessel walls and are carried along with the blood current. In carcinomas, as will be seen later, the blood vessels run in the fibrous network, or stroma, at a distance from the cells, which lie grouped in alveoli or pockets. Hence, dissemination usually proceeds along the lymphatic channels before infection by the blood current takes place.

Round Cell Sarcomas present round cells which are similar to granulation cells, which are larger than leucocytes and have an indistinct nucleus with nucleoli. These round cells are seen lying in a soft homogeneous or granular intercellular substance or matrix. The structure is, in fact, that of the primitive tissue of the embryo.

Round cell sarcomas are soft, and gray or pinkish in color upon section; furnish a juice when scraped; are very vascular, and hence are often stained by rupture of vessels and are liable to contain blood cysts. They rapidly infiltrate neighboring parts, give rise to distant secondary growths, may even involve lymphatic glands, and in many other characteristics resemble clinically the form of carcinoma called encephaloid. The microscopic appearances serve to distinguish them from encephaloid with its stroma and characteristic cellular elements. Round cell sarcomas are, of course, as seen by their above mentioned tendencies, very malignant. There is a round cell sarcoma which shows an excess of intercellular structure in certain portions of the growth, so that there is a resemblance to the stroma of carcinomas. This has been called the alveolar sarcoma. Lymphosarcoma is a round cell sarcoma, of which the matrix has a reticulated form like that seen in lymphoid tissue.

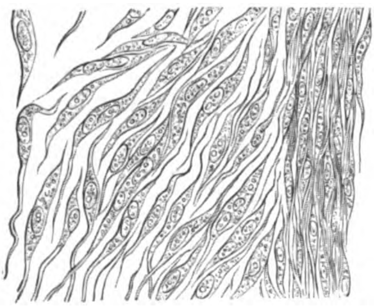
FIG. 30.



Small, round cell sarcoma, showing vessels with mere embryonic wall. × 400.

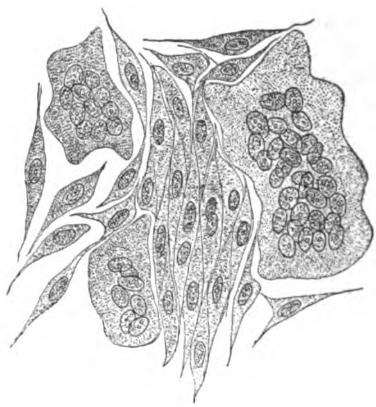
Spindle Cell Sarcomas.—These are the most frequently found of the sarcomas, and consist of elongated cells with distinct oval nuclei and nucleoli. The cells lie close together in parallel rows with little intervening substance, and sometimes give rise to a fibrous appearance until they have been teased apart to show their characteristic shape. If the spindle cells are small the growth is rather hard and probably is surrounded by a capsule. Although it will recur after removal and will spread by infiltration of surrounding tissues, it has little disposition to infect the internal organs and possesses much less malignancy

FIG. 31.



Large spindle cell sarcoma. Some cells teased apart.

FIG. 32.



Cells from a myeloid sarcoma of the tibia. × 400. (ZIEGLER.)

than the large spindle cell variety, which is soft, more vascular, and exceedingly liable to give rise to distant secondary tumors. Sometimes the cells are so broad as to be really oval in form. The small cell-growths are the recurrent fibroid tumors of the older writers.

Angio-sarcomas are tumors in which the vessels determine the arrangement of the cells. The walls of the vessels are increased markedly by a cellular infiltration, and these thick-walled, irregularly placed vessels give the appearance on section of an alveolar structure.

Another form of tumor classed with the sarcomas is the endothelioma. It is derived from the endothelium lining the inner surfaces of serous membranes. These tumors occur in the dura and pia mater, the peritoneum and the pleura; and show histologically endothelioid cells and cuboidal or cylindrical cells. They have a vascular stroma.

Sometimes spindle-cell sarcomas contain pigment granules deposited in the cells. This occurs especially when the tumor arises from a tissue containing pigment, as, for example, the choroid coat of the eye. These melanotic sarcomas are very liable to induce secondary pigmented growths in the internal organs, and are, therefore, very malignant, even if they have less disposition to local extension than some other forms. This tumor a few decades ago was often denominated black cancer.

Calcareous and osseous degeneration occasionally occurs; then the term osteoid sarcoma is used. This is very different from the benign growth called osteoma.

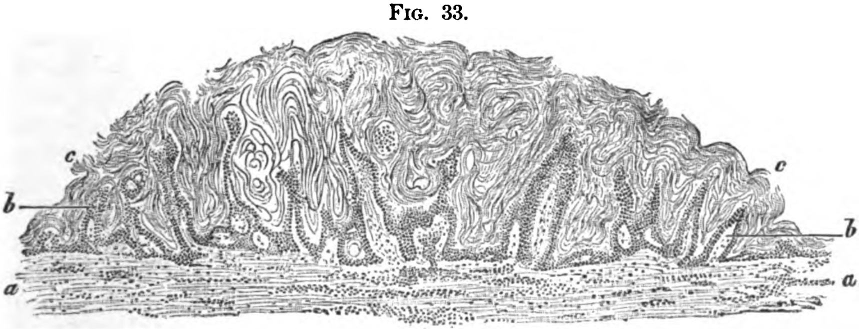
Giant Cell or Myeloid Sarcomas.—These tumors usually arise from bone and especially from the marrow. They contain large multinucleated cells, like those of fœtal marrow, associated with spindle cells, and show little substance between the cells. The nuclei of the myeloid cells contain bright nucleoli. Myeloid sarcomas are usually quite hard, may be vascular, and frequently contain cysts. When they grow from the medullary canal the bone is expanded before them, and therefore manipulation of the tumor may cause a crackling noise. They frequently occur in the extremities of the long bones and in the jaws. They are less malignant than the round and the spindle cell varieties of sarcoma.

IV. *Tumors whose general type is that of epithelial tissue.*

Papillomas or Papillary Tumors.

These growths resemble, and are usually, hypertrophies of the papillæ of the part, and are covered by the variety of epithelium which belongs to the region. They seem to owe their origin to direct inflammatory irritation, and are of slow growth, though they may attain considerable bulk by coalescence of several smaller masses. When the epithelium is abundant enough to cover the numerous papillæ and fill in the crevices between them, the tumor is somewhat smooth; but usually the various papillæ and their branching outgrowths are separate and give the growth a ragged or cauliflower appearance. Papillary tumors occur upon cutaneous, mucous, and serous surfaces, and present characteristics depending upon location. Sometimes they become pedunculated and

FIG. 33.



Section of wart of skin: *a*, corium; *b*, enlarged papillæ; *c*, stratified horny layer. × 40. (ZIEGLER.)

constitute one form of polypoid tumor. Warts, as well as many horny growths and corns, are cutaneous papillomas. These have a hardened epithelium, except when kept moist as soft corns are, and possess limited vascularity. The papillary tumors found about muco-cutaneous junctions and upon mucous membranes are larger, more vascular and softer. They occur especially about the anus and genitals, where irritating discharges cause their appearance. Papillomas are also found in the bladder, larynx, etc. Serous papillomas occur upon the synovial membrane of inflamed joints. The soft variety of papillary tumor may become the seat of ulceration or hemorrhage. Many such excrescences about the anus and genitals were formerly described as syphilitic, but they have no specific origin, except in so far as the irritation of the mucous membrane may in some cases be the result of a venereal discharge. Any other chronic irritating secretion will induce similar growths.

A papilloma consists of a projection of connective tissue, usually quite full of small round cells, surrounding a loop or plexus of capillaries and covered by a layer of epithelium. Papillary tumors are benign, having the epithelium only on the surface, and not distributed through the mass, as in epitheliomas. They may become malignant, however, by transformation into epithelioma. Warts of a pigmented kind occur frequently in the aged. They should not be irritated, as they may thus be excited to assume malignant tendencies.

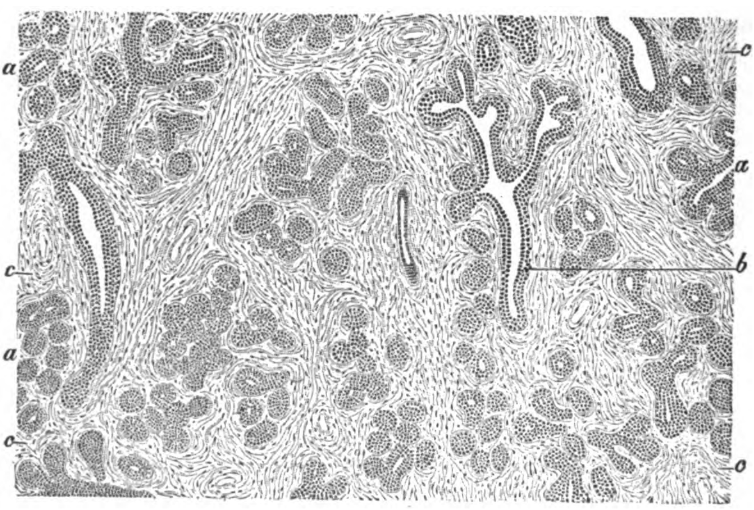
Papillomas on mucous surfaces may give rise to hemorrhages; and in the bladder and urethra may obstruct urinary evacuation.

Papillomas should be treated by removal with caustics, ligatures, or excision. Occasionally the hemorrhage which follows excision will be severe. Powdered tannic acid smeared over the bleeding surface is a good styptic, especially if combined with pressure for an hour or more.

Adenomas or Glandular Tumors.

Glandular tumors consist of such tissue as is found in secreting

FIG. 34.



Adenoma of mamma: *a*, acini; *b*, ducts; *c*, well-marked connective-tissue stroma. × 30. (ZIEGLER.)

glands, such as the simple tubular glands of the mucous membranes and the compound, or racemose, glands, of the mamma and parotid; but the tissue is not capable of performing function as a gland. They must not be confounded with tumors of the lymphatic glands. The tubular adenoma is found originating from mucous membrane, as of the vagina, rectum, stomach, and is often so closely allied to epithelioma that a distinction is well nigh impossible. Racemose adenomas occur in the breast especially, and are often associated with fibrous and sarcomatous tissue, thus forming compound tumors.

Adenomas are of slow growth, may be lobular in form, are quite firm unless undergoing cystic degeneration, are usually surrounded by a capsule, and, when uncomplicated with other morbid growths, are benign. They sometimes undergo, in places, fatty or cheesy transformation. Glandular tumors of mucous membrane sometimes become pendulous and thus constitute a form of polypoid tumor.

Tubular adenomas show under the microscope tubules, resembling the follicles of the intestines, lined with epithelial cells; racemose adenomas exhibit a series of pockets, or acini, lined with one or more rows of epithelium. Between the acini is connective tissue in varying quantity, sometimes containing numerous cells.

True adenoma is benign, but its frequent association with sarcoma, and its tendency at times to become epitheliomatous, render its extirpation usually desirable; especially is this the case because of the liability of error in clinical diagnosis.

An "intra-canalicular" adeno-carcinoma of the breast has recently interested surgeons a good deal, because of the attention given it by Halsted, of Baltimore.

Carcinomas.

The carcinomas consist of a fibroid network or stroma within the meshes or alveoli of which numerous cells of an epithelial type (epithelioid cells) are crowded together without any intermediate substance. A carcinoma may be readily illustrated by a piece of sponge (the stroma) within the cavities (alveoli) of which numerous grains of sand (cells) are grouped. A sarcoma, on the contrary, may be represented by a quantity or mass of sand of which the grains (cells) all lie closely together with no sponge or stroma to form distinct spaces (alveoli) for their reception.

The cells of carcinomas are about five times as large as a red blood corpuscle, have a variety of shapes on account of their mutual pressure, possess large well-marked nuclei and nucleoli, and, though there is no intercellular substance between the cells, have some fluid filling the spaces between them. The cells frequently show molecules of fat within them due to fatty degeneration, and indeed the cells may be entirely destroyed, so that only the free nuclei remain.

It must be borne in mind that similar cells are seen in these morbid growths as in normal tissues. It is the characteristic arrangement of the cells, the variety of their shape and the stroma that distinguish carcinomas. There is no special carcinoma cell.

The fibrous network or stroma of carcinoma is a more or less fibrillated structure so interlaced as to leave numerous communicating irregular spaces called alveoli, within which the cells already described are imprisoned. The amount of stroma varies very much and with its abundance the hardness of the tumor increases. The stroma sometimes, especially if of rapid development, contains in its own structure a few cells. In the stroma, forming as it does the walls of the alveoli, the blood vessels ramify. Hence the cells of carcinoma are separated from the vessels and do not as readily as in sarcoma enter the blood-current and cause rapid dissemination of the growth. The lymphatic vessels, however, which accompany the blood vessels in the stroma, open into the alveoli, and thus readily allow entrance of cells into the lymphatic stream. This accounts for the early involvement of the neighboring lymphatic glands in cases of carcinoma, and its more frequent occurrence than in sarcomas.

Carcinoma cells originate from preëxisting epithelium, and therefore carcinomatous growths occur only where epithelium exists; as in the glands and cutaneous and mucous structures. ' This at least seems to be the opinion with most authority in its favor. After a time the epithelial cells burst through the epithelial basement membrane from which they originated and thrust themselves among other tissues. This has probably given rise to the opinion that they developed from other than epithelial structures. The stroma of carcinoma is partly newly developed tissue and partly the previously existent connective tissue of the part.

The degenerative process occurring most frequently in carcinomas is fatty transformation which is always observable in a greater or less degree. It sometimes converts the tumor into a pulpy mass. Cystic degeneration sometimes occurs. Abscess may, though rarely, occur.

The structure and clinical characteristics of the carcinomas have caused their division into these varieties:

Acinous Carcinoma:

a. Scirrhus, or Chronic Carcinoma.

b. Encephaloid, or Acute Carcinoma.

Epithelial Carcinoma or Epithelioma.

a. Squamous Epithelioma.

b. Columnar Cell Epithelioma.

Any of these may undergo colloid degeneration and become the so-called colloid or gelatiniform carcinoma.

The clinical characteristics of the carcinomas are important. They are exceedingly malignant, though epithelioma is usually less so than encephaloid and scirrhus. They differ from sarcomas in that they generally infect the neighboring lymphatic glands, and do not produce secondary tumors in the internal viscera until after the lymphatic glands in the vicinity of the primary growth have been affected for a considerable time. Sarcomas, on the other hand, rarely involve the lymphatics, but rapidly appear in the viscera, because of their dissemination by means of the blood vessels, which have thin walls and ramify among the cells instead of running in a stroma.

Epithelioma much less rarely reproduces itself in the viscera than the other forms of carcinoma, though it ulcerates earlier. It usually, however, infiltrates the adjacent tissue and involves the neighboring glands. The more rapid and the more vascular a carcinoma is, the greater are its malignant qualities ; hence, encephaloid may be considered as having the greatest degree of malignancy. The secondary growths produced by carcinomas are usually of the same variety as the primary tumor. If a carcinoma is incised, a comparatively abundant whitish juice can be scraped from the cut surface. This consists of the fluid and cellular elements of the growth. Ulceration, sometimes attended by hemorrhage, is of frequent occurrence in carcinomatous disease. Pain of a darting character is a not infrequent symptom.

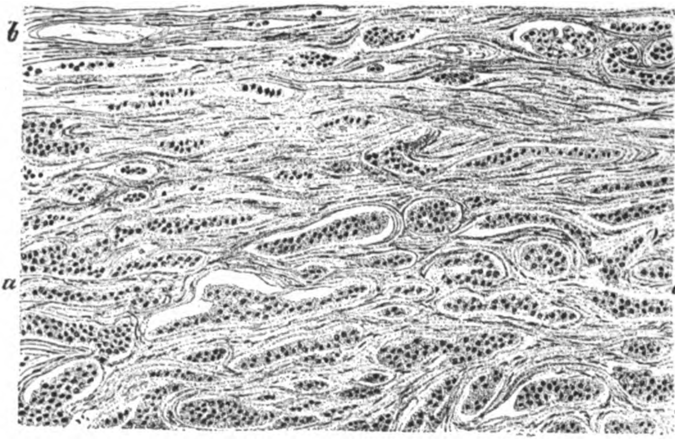
The word "cancer" was formerly much employed to designate malignant growths. This was before the days of accurate pathological and microscopic investigation. Now, some authors attempt to limit the term to the class carcinoma. This produces an unnecessary confusion, for "cancer" has and can have no accepted scientific definition. It has no greater etymological value in the scientific surgery of the present time than has "hives" in dermatology, or "amaurosis" in ophthalmology. The word, therefore, should not be retained in surgical literature.

Scirrhus; or Chronic or Hard Carcinoma grows very slowly, is very hard, is apt to be nodular, seldom attains a large size, and occurs usually in rather advanced adult life. At first it is unconnected with the overlying skin, but soon becomes attached to the integument and causes puckering and retraction thereof. As the disease advances the lymphatic nodes in the vicinity become enlarged ; and ulceration of the skin over the primary growth occurs, producing an ulcer, with ragged and nodulated irregular edges, secreting a foul mixture of pus and blood. The pain in scirrhus, when present, is of a shooting or neuralgic character. Scirrhus is most frequent in the female mammary gland, and in the various parts of the alimentary tract. When the internal organs are involved secondarily, it may assume the form of encephaloid. Section of a scirrhous mass causes creaking as the knife divides the hard fibroid tissue, and shows a whitish shining surface, usually traversed by fibrous lines and often concave on account of contracting influences.

Microscopic examination reveals a very large amount of stroma. This, by contraction and hardening, finally causes atrophy and disappearance of the epithelial cells and almost obliterates the alveoli. Hence, the interior, or older portion of a scirrhoma, approximates in appearance fibrous tissue, while the exterior or newly developed structure shows the alveoli and the groups of epithelioid cells.

Encephaloid; or Acute or Soft Carcinoma.—This morbid growth is soft, having the consistence of brain tissue, and grows rapidly; is very vascular, frequently showing large veins traversing the overlying integument, and when it ulcerates, gives rise to a fungous protrusion which is the seat of hemorrhage. Sometimes pulsation is perceptible, on account of the numerous large arteries in its structure. Encephaloid is not as frequent a growth as scirrhus, and it is found usually in the viscera as a secondary growth following a primary scirrhus of external parts. It does occur, however, primarily at times, especially in the testicle and breast. Many tumors of the eye and of the bones occurring particularly in young adults or children, formerly described as encephaloid disease, are now recognized as sarcomas. On section encephaloid tumors show a brain-like pulpy substance stained by blood extravasations and sometimes quite fluid from fatty degeneration.

FIG. 35.



Scirrhus of mamma. × 100. (ZIEGLER.)

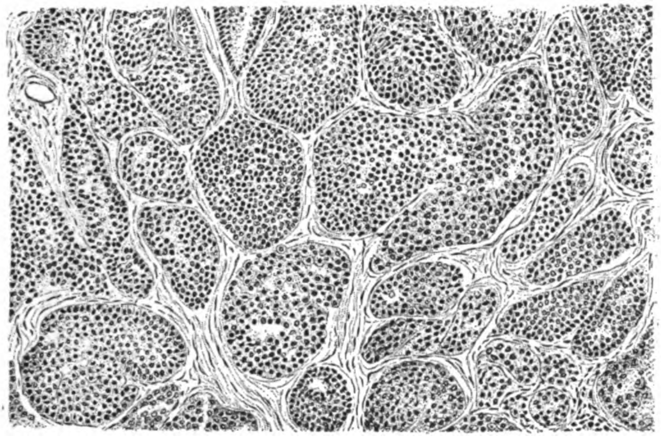
Encephaloid can scarcely be described as an entirely distinct growth from scirrhus; but its softness, its greater rapidity of growth, its less amount of stroma and absence of contractile tendencies, its vascularity, and its abundance of cells rapidly undergoing fatty degeneration warrant its designation by a separate name.

Under the microscope the observer finds large alveoli, surrounded by a limited amount of stroma and containing rather large cells, undergoing fatty change, accompanied by many free nuclei.

Colloid; or Gelatinous Carcinoma.—Colloid carcinoma, or colloma, is a soft, jelly-like tumor, occurring most frequently in connection with the peritoneum, intestines and stomach. It is a colloid or mucoid degeneration of scirrhus, encephaloid or epithelioma. Lipomas, chondromas, myxomas, sarcomas and other growths undergoing change of a colloid or mucoid character may be mistaken clinically for colloid carcinoma.

The neoplasm has still less stroma than encephaloma and the alveoli are large and very distinct, because of their distention with a mucilaginous or glue-like material. This colloid substance is transparent and colorless, or sometimes yellowish, and for the most part structureless, though a few epithelioid cells are seen. These cells are large and distended with the gelatinous material similar to that surrounding them. At times they differ little from ordinary carcinoma cells. Sometimes they have a lamellar surface.

FIG. 36.



Encephaloid cancer. × 100. (ZIEGLER.)

Epithelioma, or Skin Carcinoma. *Squamous Variety.*—This is a more distinct variety of carcinoma than the others, though it does, at times, approach scirrhus in its characteristics. It usually occurs at a muco-cutaneous junction such as the lip, eyelid, ala of the nose, anus, and prepuce; and appears first as a small nodule under the skin or as a scab or an ulcerated abrasion or fissure. It not infrequently arises at the situation of moles or warts. The tumor is quite firm and shows on section a whitish granular surface traversed by fibrous bands, from which a thick, curdy material, like sebum, can be pressed. The epithelial nests, to be described, can often be seen. Epithelioma is rare in young persons; soon exhibits ulcerative action, though of somewhat slow

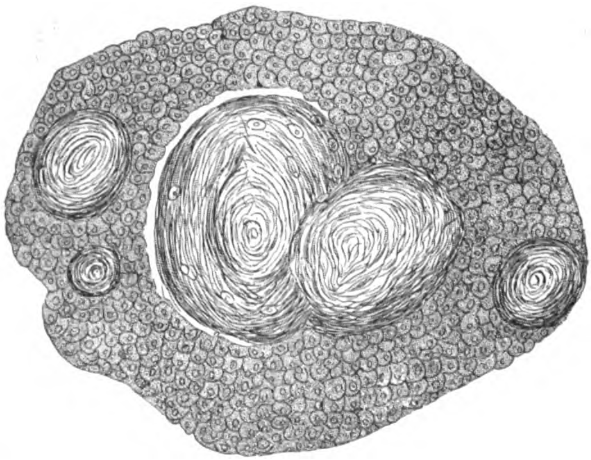
FIG. 37.

Epithelioma. (FOX.)

progress; commonly implicates the lymphatic nodes but does not often infect the viscera; and is traceable to traumatic irritation of the muco-cutaneous tissues more frequently than the other carcinomas.

The cells of ordinary epithelioma resemble the squamous epithelium of skin and mucous membrane, and contain one or more nuclei. They may be flattened by pressure, but have not the varied shape of the

FIG. 38.



A lobulated pavement-cell squamous epithelioma showing pearly bodies. (Drawn by DR. CHARLES B. WILLIAMS.)

other carcinomatous cells, nor do they so readily assume degenerative changes of a fatty kind. They are grouped in the alveoli of the stroma, sometimes as tubular prolongations or plugs, and tend to form nests or "pearls" formed of concentric layers of flattened cells, which resemble the structure of an onion. These epithelial globes or nests are very characteristic of epithelioma, though not essential. They grow down from the surface into the lymph spaces of the connective tissue like nails or plugs. They merely signify that there is a rapid growth of squamous epithelium and may occur in epidermic structures not carcinomatous.

The stroma is rarely so markedly alveolar as in the other members of the carcinoma group, and may be quite limited in amount. It is represented by a fibrous-like tissue or by a tissue filled with small round cells surrounding the epithelial nests. Rodent ulcer is a form of epithelioma.

Columnar Variety, or Cylindroma.—When epithelioma occurs in the intestinal tract the cells are of the columnar or cylindrical variety found in the mucous glands of these parts, appear in more distinct alveoli, and usually do not form concentric nests. The growth closely resembles adenoma.

Epithelioma originates from the epithelium of the skin, mucous membranes, and glands; and then the proliferation of epithelium which occurs causes invasion of the adjacent structures, whether they be connective tissue, muscle, or bone. It is the presence of epithelium in these unusual localities that is the essence of the morbid growth. Rodent ulcer is a form of epithelioma.

V. *Tumors consisting of a sac with contents (cystomas, or cystic tumors), and teratomas.*

Cystic Tumors.—A cavity separated from neighboring tissues by a sac wall and having fluid, semi-solid, or soft contents is called a cyst or cystic tumor. Most cysts, however, are not properly classed as tumors; but it is convenient to consider all of them together.

Such tumors may result from the development of a sac-like cavity in tissues where no sac or cyst previously existed. These are true tumors or morbid growths, and are due to softening of structure, as occurs in fatty and mucoid degeneration; to separation of connective tissue by a secretion or deposition of fluid, as serous and blood cysts; and to the development of a sac around foreign bodies and parasites. In all these cases condensation and irritative development of connective tissue lead to the formation of a circumscribing capsule or sac wall.

Cysts are more frequently developed by slow accumulations within a dilation of a preëxisting cavity or duct. These are not true tumors, but are usually conveniently considered as such in connection with the form just mentioned. The contents are the natural products or secretions of the part, more or less altered by the changed conditions to which they are subjected. Such cysts are developed when the duct of a secretory gland becomes occluded, as is the case in sebaceous, mucous, salivary and other retention cysts; when a ductless cavity secretes more fluid than the absorbents can remove, as in hydrocele, bunion, and bursal tumors; when the blood is poured into a cavity, as in hæmatoceles.

FIG. 39.

Hydrocele of neck.

The wall of a cyst may be thick or thin, tough or friable, slightly or firmly adherent to surrounding tissues, and is developed by condensation and new growth of the circumscribing connective tissue. In the second variety of cystic tumors the wall presents the features of the gland or membrane from which it was developed, and has a similar epithelial lining. Cysts may contain serum, saliva, milk, semen, sebum, blood, and other materials, and often take their name from the contents.

The hydatid cyst is a peculiar tumor due to the presence in the tissues of a parasite. This parasite is the undeveloped tænia echinococcus, which infests animals of the canine family but never progresses to full maturity in the human subject. The ovum having been introduced with food into the human system, develops as far as its cystic stage. The irritation due to the parasite in the tissues causes the formation of a sac or cyst wall from the surrounding parts: within this lies the parasite, which is itself a distended sac without any head, hence called an acephalo-cyst. It contains a transparent, non-albuminous or almost non-albuminous liquid of low specific gravity, in which are floating heads or the hooklets belonging to the heads of this form of worm. These heads are called echinococci. The echinococci may be adherent to the inner wall of the bladder-like parasites. Hydatid tumors occur most frequently in the liver, lungs, muscles, and subcutaneous tissue.

Various changes occur in cystic tumors. Thus, the contents may become inspissated, fatty, or calcareous, and the wall may calcify, ossify, or even undergo cystic or other degenerations. Sometimes inflammation of the tumor supervenes, which leads to suppuration, discharge, or absorption of the contents and cure by granulation. Occasionally, instead of cicatrization occurring, a foul chronic ulcer is left.

A cystic tumor with one cavity is called simple or unilocular; one with several cavities, compound or multilocular. It must be remembered that many of the tumors previously described may undergo cystic degeneration by mucoid or fatty change taking place in their interior.

The treatment of cystomas consists in their removal or their obliteration by evacuation of contents and destruction of cyst walls. True cystomas are benign, but may, as other benign growths, cause death by their situation and size. If they are excised every portion of the cyst wall must be removed, lest the part remaining become the starting point for a similar tumor. Cystic sarcomas and other tumors that have undergone cystic degeneration must be treated as growths of their own class.

Obliteration of cysts may be accomplished by tapping, internal scarification, injection, and incision. If the contained fluid is not viscid it may be withdrawn with a trocar or aspirator; this causes collapse of the sac. Usually the cyst refills, but occasionally the irritation resulting from the puncture is sufficient to cause plastic inflammation of the interior of the cyst and adhesion of the walls. Thus, obliteration of the cavity and cure result. The cure may at times be accomplished by scarifying the internal surface of the cyst wall with a tenotome or long needle thrust into it at one or at several points without evacuating the fluid; which escapes into the surrounding tissues and is absorbed or undergoes absorption during the progress of the resulting inflammation. This method is quite satisfactory in treating hydrocele in infants. Multiple puncture and abrasion of the vaginal tunic with a needle seldom fail to cure such cases. When tapping or scarification fails to induce obliteration of cysts with liquid contents, it becomes necessary to inject into the cavity some irritating fluid to set up inflammation of a plastic grade. The best agent is carbolic acid liquefied by moderate heat or a few drops of water or glycerine. Tincture of iodine, wine, and other irritating and astringent solutions may be employed.

The quantity should vary from twenty minims to a fluidrachm, according to the size of the tumor, and should be left within the cyst cavity.

Cysts with thick cheesy contents, if not excised, should be split open. The surgeon must then scrape out the contents, and, if he does not remove the cyst wall, he must mop the interior of the sac with strong carbolic acid or some strong astringent or cauterizing application, and leave the wound open to granulate. This destroys the secreting surface of the wall and sets up inflammation, which, by means of the granulating process, causes the wound to heal and the cyst to become obliterated.

Teratoma or Congenital Mixed Tumors are due to the inclusion and imperfect development of one fœtus in another or the abnormal development of the single fœtus. All the tissues may be found in these tumors, making mixed tumors of a most complex character. The chief site is in the sacral region and about the head; but they occur elsewhere. They may be small at birth and subsequently enlarge. Dermoid cysts and cystic growths containing structures of an epithelial character, such as skin, teeth and hair belong to the group of teratomas.

CHAPTER VIII.

SHOCK, FAT EMBOLISM AND WOUNDS.

SHOCK.

Definition.—The constitutional symptoms that immediately follow the receipt of a wound or injury, if it be sufficient to induce general disturbance, are grouped under the head of shock or collapse. Subsequently the general symptoms pertaining to inflammation, sepsis or fat embolism may arise. Cases of so-called delayed shock are doubtless instances of fat embolism, sapræmia, septicæmia, or other imperfectly understood conditions.

Symptoms.—Slight shock is shown by pallor of the skin, a sense of giddiness and nausea, and a feeling of approaching unconsciousness. This is but temporary, and reaction or return to the physiological condition quickly occurs. When severe shock is present there is great depression, exhibited by muscular relaxation, pallid and shrunken features, a languid and bewildered expression, clammy sweating, a frequent and perhaps intermittent pulse which sometimes, it is said, may be slow, shallow and gasping respiration, a lowered bodily temperature varying from one-third of a degree to two or three degrees below normal, and nausea and vomiting. Usually the mind is clear or at most only slightly affected by aberrations of the special senses. If grave symptoms of shock continue the patient dies in a few hours from cardiac failure. In sudden death the heart may be spasmodically contracted, but oftener perhaps, the right cavities and venous trunks are engorged with blood.

Recovery from shock takes place by the depression stage being followed by reaction, which is evidenced by increasing power and slowing of the pulse, by a healthier hue of skin, a rise in temperature, and a disposition on the part of the patient to change his posture. Reaction may be inordinate and pass across the health line to the domain of constitutional over-action, when symptoms akin to asthenic inflammatory fever occur. It is usually preferable, however, to have an excess rather than a deficiency of reaction, since it is easier to control force than to create it; but the condition of excitability, coupled with prostration, must not be mistaken for excessive reaction. The time at which reaction occurs depends on the nature of the injury and the recuperative force of the individual, and varies from minutes to hours.

The degree of shock varies with the severity of the injury and the impressibility of the patient. The greater the extent of the injury and the more important the structures involved, the more profound in a given patient will be the shock. On the other hand, however, an impressible person will show great shock upon the receipt of a trivial wound, while a much more serious lesion in another man will be accompanied by little shock. Shock is greater in injuries of the trunk than of the extremities, and in wounds of the abdomen than in those of the chest. In estimating the degree of shock and in diagnosticating the condition itself the surgeon must remember that direct injury to nerve centers, hemorrhage, fat embolism, rapid septicæmia, abstraction of heat from internal viscera and fright are liable to simulate or increase the symptoms of shock. The heart and kidneys should always be examined prior to operations, because chronic disease of these organs increases the severity of the shock of operation.

The pathological condition causing the symptoms termed shock lies in the sympathetic nervous system, and is probably a paralysis of the vaso-motor center in the medulla oblongata, produced by the violent disturbance of the sensory nerves. The perturbation of the vasomotor nerves produces a diminution in the tone of the walls of the blood vessels. This is especially the case in the arteries, hence the speed of the current is deficient, and the blood is unequally distributed and accumulates especially in the veins. The abdominal veins are particularly the seat of unusual blood accumulation. The lowered temperature, the pallor and the concomitant symptoms exhibited in shock are explainable by the pathological condition.

Treatment.—If the symptoms are slight, a drink of water and fanning the face are sufficient treatment. In severe shock perfect quiet of mind and body in the recumbent position and heat to keep up the bodily temperature are the most important requisites. Cardiac stimulants and food are then demanded in the majority of cases. Heat, frictions and artificial respiration will be well calculated to distribute the blood engorging the viscera. Heat is to be maintained by warm rooms, blankets, bottles or rubber bags filled with hot water, hot water enemas, or by the hot bath in which the temperature is raised from 98° to 110° F. Elevation of the foot of the bed so as to increase by gravity the amount of blood in the brain and lessen that in the abdominal veins is a valuable adjunct. If this produces blueness of the face, the patient should be restored to the horizontal posture. Bandages applied to the four extremities from the fingers and toes up to the trunk may have a similar action to that produced by elevating the foot of the bed. Rubbing the surface of the limbs and body, the application of mustard plasters to the abdomen and thighs, and the use of electricity may aid in distributing the blood. A small amount (fʒ ss–fʒ ij) of stimulant in the form of brandy or whisky, may be administered ; but it should be remembered that many injured persons have been given alcoholic stimulants by the bystanders before the surgeon's arrival, or have taken it as a beverage before the accident. Overdosing with such remedies produces depression. Small amounts of coffee, beef-tea or milk should also be given at intervals, but here, as in the case of alcohol, large amounts lying unabsorbed in the stomach do harm and may induce vomiting. Hot coffee administered by the rectum is valuable.

The pulse is the indication to guide the attendant. If it increases in force and diminishes in rapidity reaction has begun. Time is then required; reaction from severe shock may extend over six, twelve, or twenty-four hours. The drugs employed in the management of shock are strychnia (gr. $\frac{1}{30}$) morphia (gr. $\frac{1}{4}$–$\frac{1}{2}$), tincture of digitalis (♏ xx–f℥ss), carbonate of ammonium (gr. v–xx), atropia (gr. $\frac{1}{60}$–$\frac{1}{30}$) nitroglycerine (gr. $\frac{1}{100}$–gr. $\frac{1}{50}$) any of which may be given hypodermically; and quinia (gr. v–xx), best given by the mouth or rectum. Ether in half-drachm doses may be given subcutaneously. Amyl nitrite may be of service by inhalation.

Transfusion of a pint or a quart of warm sterile salt solution (about gr. iij to f℥j) into a vein of the arm or thigh, or its injection into the subcutaneous tissue of the chest or thigh may aid in reëstablishing the circulation and take the place of blood lost by the wound. The temperature of the salt solution should be 100° to 105° F.

When operations are necessary after injuries inducing severe shock, the surgeon should wait, as a rule, until reaction has begun, since there is then less danger of causing dangerous depression from the anæsthesia and incidental bleeding. There may be exceptions to this rule. They are rare. The damaged tissue should be dressed with antiseptic solutions, after attention has been given to the traumatic hemorrhage; and the surgeon should then wait for reaction to at least begin.

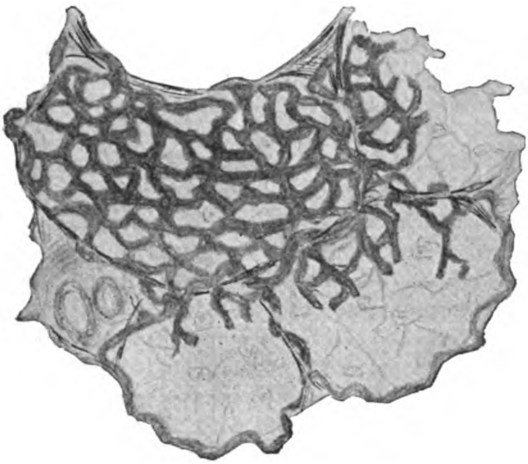
The shock after operations is often excessive because the surgeon has been too slow in his operative work, has exposed the patient to cold air, has reduced the patient's temperature by wet dressings and irrigation, or has depressed him by prolonged anæsthesia.

FAT EMBOLISM.

Plugging of the capillaries of lungs, brain, kidneys or other organs with minute drops of fat, set free by injuries, causes symptoms somewhat like shock. It is quite a common occurrence after open fractures, lacerations of fatty tissue, acute osteomyelitis and rupture of the liver. The fat droplets are absorbed or pressed into the veins and are carried to the heart. Thence they go to the lungs where they may produce fatty infarcts. If they get through the lung capillaries they may plug the vessels in the brain or kidneys and appear as fat floating on the surface of the urine. The chief danger, for death may follow fat embolism, is asphyxia from choking of the pulmonary capillaries. The symptoms are pallor, followed by cyanosis, rapid breathing, and weak, frequent and irregular pulse, without special temperature disturbance. These symptoms occur from one to three days subsequent to the causative lesion and disappear in about two days, if death does not occur.

The occurrence at a later date than shock, the cyanosis, the interference with respiration and the fat in the urine serve to distinguish the condition from shock. Treatment consists in giving the heart power to pump the fat through the lungs, by alcohol, strychnia and

FIG. 40.



Pulmonary capillaries filled with fat in fat-embolism. (PARK.)

digitalis, and keeping the injured parts quiet that no more fat be absorbed. Inhalations of oxygen may do good.

WOUNDS.

Definition.—A wound is a sudden and recent solution of continuity of the soft parts caused by mechanical violence. A solution of continuity of such tissues produced slowly by mechanical pressure or violence, or by inflammation idiopathically is an ulcer; a solution of continuity of bone is called a fracture; hence, the term wound gives the idea of sudden violence to the soft tissues of the body. The mechanical violence is usually directed from without, but it may arise from within, as is the case when wounds are produced by muscular efforts or by the projection of fragments of bone in fractures.

Varieties.—Wounds are either freely exposed to the external air, when they are called open wounds; or are protected from such exposure by the more or less perfect integrity of the skin, when the term subcutaneous, or closed, is applied. A wound communicating with the air by a small cutaneous opening may still be considered a subcutaneous wound; as are also wounds beneath the mucous membranes, though the term, in this instance, is a misnomer.

Wounds may be classified under four heads: 1. Contused, or those in which the injury consists in a crushing or bruising of the parts, with or without rupture of the integument. 2. Incised, or those in which the tissues are divided cleanly or cut, as by a sharp knife, and in which the length of the wound greatly exceeds its depth. 3. Punctured, or those in which a wound is made by a pointed instrument and in which the depth exceeds the length. 4. Lacerated, or those in which the structures are torn apart giving therefore irregular edges to the wound. All wounds are referable to one of these groups, though they may possess additional characteristics: thus, any wound infected with a specific poison becomes a poisoned wound; if the vulnerating body enters a cavity, as the chest or a joint, a penetrating wound results; and missiles thrown by the explosive force of gunpowder produce contused or lacerated injuries, called gunshot wounds.

Symptoms.—Contused wounds are produced by blows or by sudden forcible contact with surfaces that have no sharp edges. The typical contused wound is the ordinary bruise or contusion in which there is no laceration of the skin; ordinarily, however, contused wounds are lacerated wounds in which the bruising is a more prominent feature than the laceration. A simple bruise or contusion is really a contused wound, because there is a solution of continuity of the subcutaneous tissues in all such cases. Contused wounds may involve the skin and superficial fascia only, or may extend also to the muscles and deep structures. In persons with a great deal of subcutaneous fat a slight degree of pressure, as from a pinch with the fingers, will cause a distinct bruise, because the vessels are so readily ruptured. The characteristics of this class of wounds are dull pain or numbness, a black and blue color at the seat of injury due to extravasation of blood from the ruptured capillary vessels, some swelling from effused serum, little or no hemorrhage from any accompanying laceration of the skin that may exist, and a tendency, if the contusion be severe, to the production of abscess and gangrene. Abscess and gangrene result because a place of least resistance is produced in the injured tissues and because the cellular vitality is impaired, thus giving opportunity for bacterial action.

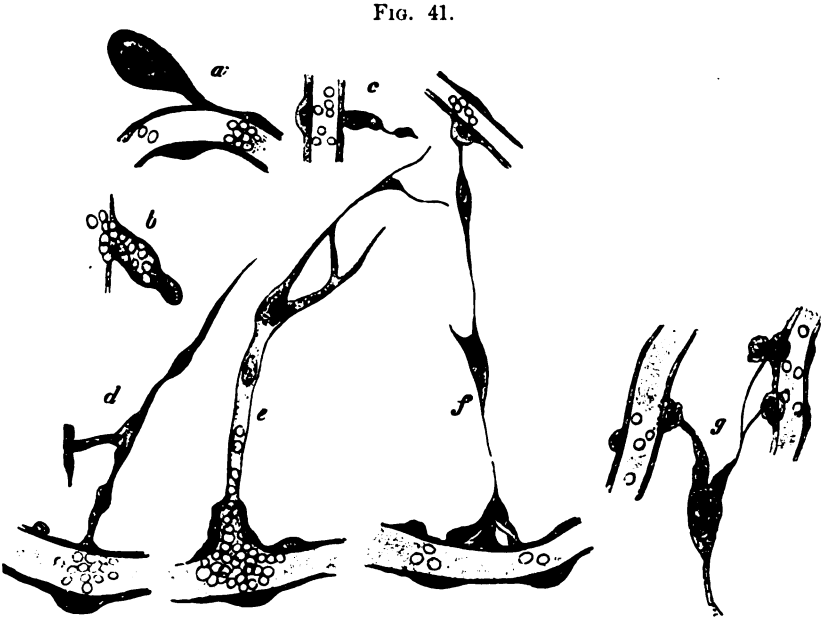
When structures are divided by a keen instrument and the length of the wound is a more conspicuous feature than its depth the term incision or incised wound is employed. Incised wounds are characterized by acute pain and hemorrhage, a tendency to retraction or gaping of the edges, and rapid cicatrization. These features vary, of course, with the locality and extent of the injury. The bleeding washes away bacteria and tends to keep the wound aseptic, hence the rapid healing often seen.

Punctured wounds are those inflicted by a pointed instrument piercing the tissues, and hence they are remarkable for depth rather than for linear extent. A wound one inch long and a half inch deep made by a knife is an incised wound; one of similar extent, but three inches deep, is a punctured wound. Punctured wounds vary according as they are made with dull or sharp pointed instruments; in the former case they resemble lacerations, in the latter incisions. As a rule, however, it may be said that punctures are accompanied by great pain and slight hemorrhage. They are especially liable to be followed by severe inflammation, because they are not likely to be as free from bacteria as those wounds which bleed profusely and which are readily cleansed.

Wounds produced by disruption or tearing asunder of the tissues are termed lacerations or lacerated wounds, and are frequently accompanied by contusion of the parts. In fact, a force which causes crushing of the tissues without much tearing of the integument, gives rise to a contused wound, while the same force so applied as freely to rupture the skin as well as underlying structures is said to cause a laceration. Lacerations are distinguished by irregular jagged edges, moderate pain, slight hemorrhage, little gaping, a tendency to suppuration and sloughing of the edges, and slow cicatrization. These features depend upon the method of injury, for it is the tearing and twisting of the vessels and nerves that prevent bleeding and acute pain, and the devitalization and irregularity of the torn edges that occasion sloughing, favor microbic infection, and prevent rapid healing.

Repair.—All wounds, large or small, open or cutaneous, incised or punctured, contused or lacerated, in soft tissues or hard, heal by reparative processes similar to those which are seen in inflammation; for, after all, that which is termed inflammation is nature's effort to repair damaged tissues or to prevent their further injury.

FIG. 41.



Formation of new vessels by budding: *a*, *b*, *c*, first stages; *d*, *f*, *g*, simple and branching buds; *e*, tubulation of a bud. (TILLMANNS.)

When the wound is of such a character that accurate adjustment of the several tissues can be and is accomplished, a reparative effort merely sufficient to supply a small amount of fibrine or lymph supervenes. This fibrine glues the parts together, and then becomes changed into granulation tissue and finally into connective tissue, or scar, analogous to the original structures. Thus is repaired the breach of continuity. This method of union is union by first intention, or fibrinous repair. It occurs when no foreign body, clotted blood or undue amount of transudation prevents accurate approximation, and when the parts are kept quiet and the patient's tissues are in a healthy condition and free from microbic infection or other irritation. By this mode are repaired subcutaneous and other aseptic wounds.

When there is a loss of substance or an irregularity of the edges of the wound, the space or chasm, due to the injury or to the destruction of the ragged edges by sloughing, is gradually covered and more or less filled up with minute granular bodies of a pink color called granulations. These are formed from lymph, capillary loops and indifferent cells in the same way as the uniting band in cases of union by first intention. If the wound is kept aseptic there will be no suppuration and epithelial formation will occur when the granulation tissue has filled up or nearly filled up the cavity. In the meantime there will be a serous exudate from the surface of the granulations. It is difficult to keep pyogenic organisms away from such wounds when large, and superficial suppuration is not unusual. Absolute asepsis should be attempted always.

The granulations have absorbent power and are gradually converted into a bluish-white connective tissue, called the cicatrix, which occupies the situation of the wound and assumes characteristics similar to, though not identical with, the structures injured. This method is union by second intention or granulation. It is the only means by which healing of wounds can occur if union by first intention fails to take place. It is apt to occur in contused and lacerated wounds, unless they are subcutaneous or have their devitalized edges trimmed off, are rendered aseptic and are accurately approximated. Other varieties of healing have been described, but they are but modifications of the two here considered, which themselves are identical in pathological significance and process.

Healing by first intention is much to be preferred, because it requires much less time, say from two to seven days, and leaves very little cicatrix. Union by granulation, or second intention, requires weeks or months, according to the size of wound or ulcer, and leaves a large scar, which often gives rise to deformity on account of the contractile tendency of cicatricial tissue.

Treatment.—In the management of all wounds, there are four cardinal rules: 1. Arrest hemorrhage. 2. Render the wound aseptic by removing foreign bodies, dirt and germs as far as it is possible to do so without incurring risk. 3. Bring the parts into apposition, if the attempt does not, and will not, cause pressure and tension. 4. Assist the natural reparative process by mechanical rest and the prevention of infection.

These precepts apply to every wound, but their relative importance varies with the character of the injury. Thus, in incised wounds there is often severe bleeding to be arrested, but no foreign body to be removed, while in contused and lacerated injuries there is frequently no hemorrhage, but numerous particles of foreign materials, such as shot, shreds of clothing and dirt, to be extracted. It is much easier to render some wounds aseptic than others.

The arrest of bleeding will be spoken of under Diseases of the Blood Vessels, and the methods of approximating and dressing wounds, and of preventing germ infection under Minor Surgery and Surgical Dressings. In aseptic wounds, union usually occurs steadily and expeditiously and nothing is required but patience on the part of the attendant, who has dressed the wound with germ-free applications. At other times, because of the contaminated nature of the wound or because of the conditions or surroundings of the patient, sloughing, burrowing of pus, abscess, erysipelas, or pyæmia renders the surgeon's duties responsible in the highest degree. If infection occurs through the wound, the constitutional methods discussed under the treatment of inflammation must be employed in addition to local measures. Patients showing a sthenic form of constitutional implication must be depleted and depressed by bloodletting, purging, arterial sedatives and other measures of a kindred nature. The asthenic type, on the other hand, demands supportive treatment, which is effected by tonics, stimulants and a generous nutritious diet.

Wounds must be treated locally according to their special characters, after the general rules given above have been followed; but, in all cases, the most rigid asepsis or antisepsis must be carried out. It is to organisms, either introduced at the time of injury or allowed to come in contact with the wound at a later period, that the constitutional disturbances, slow healing and suppuration are due. It is the surgeon's duty to avoid such microbic infection in operation wounds, and to limit it in accidental wounds when it has taken place before he had control of the patient's destiny. This subject will be further discussed, under Surgical Dressings, in the next section.

Contusions, being subcutaneous wounds, require little treatment. If there is a great deal of subcutaneous extravasation, cold water and pressure with a bandage are indicated to stop the hemorrhage. Absorption of the effused blood takes place very slowly, but gradually the black and blue appearance changes to a greenish and yellowish hue, and the discoloration then disappears. Alcohol, chloride of ammonium solution (gr. x–xx to the fluid ounce), tincture of arnica, hot water, and ichthyol are often used as external applications. If the extravasation is very great in regions where loose connective tissue is abundant, as in the eyelids and scrotum, the swelling will be so great that the surgeon may be tempted to make incisions for its escape. This is usually unnecessary, because large amounts of blood thus effused will be absorbed. When extravasation of blood and rapid inflammatory effusion of serum cause such swelling and tension that the limb becomes cold and there is danger of gangrene from interstitial pressure, long incisions must be made through the tense skin and deep fascia, which retract and relieve the pressure. These incisions must be made with antiseptic precautions, and the whole limb dressed with gauze. When absorption does not occur, but there remains a tumor filled with fluid blood for a long time, the term hæmatoma is employed. This usually requires aspiration or incision. Abscesses and serous cysts occurring subsequent to contusions demand evacuation.

The treatment of open contused wounds and of lacerations may be considered together, because the same principles govern their surgical management. Such wounds are nearly always infected with germs, from contact with the vulnerating body or from their surroundings at the time of their infliction. Before the wounds are dressed, it is very necessary to render them aseptic. This is done by the removal of all particles of dirt with aseptic forceps or fingers, and by cleaning and disinfecting the wounds by means of irrigation with antiseptic solutions. Corrosive sublimate solution (1:500 or 1:5000), poured upon and into the wound from a pitcher or a syringe or squeezed from a sponge, is one of the most effective of such agents. Solution of carbolic acid (1:40) or formaldehyde (1:300) and other substances may be employed. All accidental wounds must be thoroughly sterilized in this manner in order to avoid the occurrence of suppuration. In large wounds where such a procedure would give pain, it is requisite to give ether in order that this important procedure may not be omitted. It is good surgery, after having etherized the patient, to scrape, and scrub such wounds thoroughly with a nail-brush and soap-suds before using the antiseptic solution. This double proceeding removes or destroys all germs that may exist in the wound. Injuries received from machinery almost always need such treatment, because of the dirt and grease ground into the tissues at the time of the accident, or upon the patient's skin before the receipt of injury. Prolonged soaking in hot water and soap will render some of these wounds relatively clean. Acetanilid in powder sprinkled over the partially disinfected wounds before the gauze dressing is put on seems to be effectual in preventing septic consequences. If the wound is large there may be danger of acetanilid poisoning. Iodoform is used for this purpose. It is offensive in smell and may lead to toxic effects from absorption. Acetanilid poisoning is shown by cyanosis of the skin, drowsiness and cardiac depression. Iodoform poisoning causes headache, delirium and fever. After such wounds have been made germ-free, they should be sutured as operative wounds, and provision made by catgut strands or drainage-tubes for the escape of serous and other fluids which may exude. The conversion of such accidental wounds into aseptic wounds by these measures is an essential first step in treatment. Wounds subjected thoroughly to this treatment unite by first intention. If this is not the case the granulation process goes on so rapidly that the patient's convalescence is comparatively short.

After thorough cleansing, the bruised and lacerated parts should be adjusted and kept in place by sutures, if this can be done without causing tension or interfering with the escape of the fluids to be subsequently secreted. Much damage is often done by making nice approximation of such wounds and providing no escape by drainage tubes and counter openings for the serum which may exude in a few hours and cause tension and pain. If the fluids thus secreted find no free avenue of escape, burrowing of pus and septic conditions are liable to occur. Suppuration and sepsis cannot occur without organisms; but, on the other hand, a limited number of germs or germs of moderate virulence may be present and do little harm, if the wound is kept dry by free drainage. Parts that cannot readily be brought together should be allowed to gape.

Union by granulation is the method of healing in these wounds. Contused and lacerated wounds are usually followed by sloughing of their ragged borders; but it is improper to cut away anything more than the edges at the first dressing, since it is not possible to determine what parts are actually devitalized. The ordinary gauze dressing should be used. Thorough drainage of deep and irregular wounds by tubes, strings of rubber, or horsehair is important. When the sloughing stage has given place to the granulation stage the resulting ulcerated surface is treated as an ulcer. If abscesses are liable to form, provision must be made for draining the deep parts by drainage tubes, incisions, and washing out with syringes or by hydrostatic pressure.

When the injury has caused complete devitalization, amputation must be done as soon as reaction from shock has occurred. If the soft parts are completely stripped from the bones amputation may be demanded, even when the osseous tissues are intact, because of the danger of acute traumatic gangrene. If attempts have been made to preserve crushed limbs and rapidly spreading gangrene supervenes, amputation is usually to be done promptly at a high point of the limb.

In incised wounds an attempt should always be made to secure union by first intention, because thus time is saved, the scar is less disfiguring, and there is less chance for septic complications. If the effort fails union occurs by granulation, as in lacerated wounds. In lacerated and contused wounds union by first intention is, from the nature of the injury, almost impossible. After arrest of hemorrhage, removal of foreign matters, and the production of an aseptic condition in incised wounds, accurate adjustment is to be obtained by sutures of catgut, silk, silkworm gut, or wire; or in small wounds by a layer of gauze or absorbent cotton glued to the skin by collodion. About the face the latter dressing is sometimes preferable because a scar is left by sutures. The transparent gauze allows the surgeon to see that the wound is evenly apposed, and any unexpected serous or purulent discharge soon leaks through the meshes of the gauze and is not shut in by the dressing. Deep wounds should be closed layer by layer with buried catgut or other absorbable sutures. This suturing in layers, muscle to muscle, fascia to fascia, tendon to tendon, nerve to nerve, prevents spaces for accumulation of blood and serum and affords the best functional result. The application of sutures and of the collodion dressing will be described in the chapter on Minor Surgery.

Punctured wounds when made with a sharp instrument require treatment like incised wounds; when made with dull instruments, such as carpenter's nails, they are practically lacerations. If they are penetrating wounds there will probably arise inflammation of the lining membrane or viscera of the cavity opened. This will demand treatment directed to the special lesion. The removal of the foreign body is often difficult in the case of punctures. If withdrawal with forceps is impossible a free incision will be required, especially if the vulnerating body is buried in the tissues and invisible. This should usually be done at once, and particularly when the foreign body was probably covered with dirt and is especially liable to cause septic infection. The incision adds little or nothing to the gravity of the injury, may result in detection of the foreign body, and even if unavailing gives free drainage and lessens the dangers of erysipelas and other septic complications frequent in punctured wounds. A simple or an electro-magnet has been found serviceable at times in removing chips of iron after lacerations or punctures of the eyeball. It is almost impossible to render a punctured wound aseptic without enlarging it; hence it is often good policy to increase it in order to sterilize it and prevent the occurrence of cellulitis or gangrene. Skiagraphy will often locate the foreign body and indicate the position of the incision for its removal.

Poisoned Wounds

Are usually punctures, since stings of insects, fangs of reptiles, and points of knives are usually the vulnerating instruments. Any form of abrasion or wound of the skin may be inoculated, however, and at times simple maceration of the skin with poisonous fluids is sufficient in locations where the integument is thin.

The wounds made by insects are comparatively unimportant in this country. It need only be said that if the sting remains in the wound it should be extracted, and lead water, sublimate solution (1 : 1000), water of ammonia, or spirit of camphor applied. Bites from insects with poisonous saliva should be managed in the same way. Any subsequent inflammation should be treated on general principles.

Bites of venomous snakes are usually accompanied by rapid and multiple interstitial hemorrhage, caused by an interference with the coagulability of the blood and disintegration of the vessel walls, due to the poison; paralysis of respiration and the spinal centers; and locally great swelling and vesication. The profound prostration or collapse is accompanied, however, with unimpaired intellection. Death occurs in an hour or so if the amount of poison is large, but in other cases may be delayed several days and occur through the depressing influences of gangrene and suppuration. Many constitutional remedies have been vaunted, but there is no positive evidence in favor of any except alcohol, which should be given freely, but not indiscriminately. The intravenous injection of ammonia has been recommended, but its value is not yet established. The local treatment is important, and consists in immediate free excision of the wound and surrounding tissues, the application of a tight ligature to the limb above the wound to prevent venous and lymphatic absorption, sucking or cupping the wound left by the knife to extract the poison, and cauterization with equal parts of carbolic acid and alcohol. Permanganate of potash freely injected into the wound and surrounding tissues is serviceable in destroying the poison and should always be used if obtainable. Nitrate of silver is valueless as a caustic, as, indeed, it always is when a tissue-destroyer is desired. The so-called intermittent ligature is a rational measure. It is merely a tightly constricting band, applied at the cardiac side of the wound and relaxed momentarily at intervals in order to allow the poison to enter the general circulation slowly and in divided amounts. This gives the surgeon a better opportunity to counteract the effects of the poison and obtain its elimination than when the venomous material is suddenly absorbed in full amount. The poison is a chemical, not a microbic, one. It contains, according to Mitchell and Reichert, two albuminous poisons, called by them venom peptone and venom globulin. With the venom, there are introduced into the wound many bacteria, which are the agents and causes of the putrefaction which so rapidly occurs after snake-bites.

Dissection Wounds.

The term dissection wound is applied to injuries received during operations on dead, and sometimes on living, bodies. They occur also in butchers, fish-dealers, and others whose occupation causes them to handle dead animals. Many wounds so received act merely as similar injuries inflicted under other circumstances; sometimes there is an additional amount of inflammation, as if the animal fluid irritated the part; but occasionally a most virulent form of local inflammation occurs, and is accompanied by grave constitutional symptoms of blood infection. Persons whose previous health is poor suffer more frequently from such wounds than do other persons whose tissues have more resistance to infectious influences. These disastrous symptoms are due to infection by pathogenic germs in the cadaver before death; these are usually destroyed by the advent of marked decomposition. Cases of death from peritonitis, erysipelas and pyæmia are more likely than others to cause such dissection wounds. These wounds owe their virulence to micro-organisms or the chemical products of such organisms. They are, in fact, septic wounds.

There is a complete, or almost complete, protection afforded by preserving cadavers with zinc chloride, as is done in our Philadelphia dissecting-rooms. It is important to recollect that the poison appears at times to infect the pathologist, who is making an autopsy, through the hair-follicles and unbroken skin of the hands, especially if they are immersed in the fluids of pyæmic pleuritis or peritonitis. The warty tumors occurring on the hands of those making many autopsies are tubercular lesions due to a local infection by the bacillus tuberculosis.

The symptoms of a dissection wound, if of the ordinary variety, are those of an acute inflammation about a wound—viz., pain, swelling, inflamed lymphatic glands, fever, etc. Quite frequently suppuration occurs. In the more serious form a vesicle appears, after the lapse of a couple of days, at the point of puncture, and is followed by erysipelatous inflammation, lymphangitis, rapid involvement of the cellular tissue, suppuration, sloughing, and septic symptoms, as shown by rigors, fever, colliquative sweating, and rapid prostration of the vital powers. Those cases seem to be worse in which inflammation of the lymphatic nodes occurs before active inflammation of the wound.

The treatment consists in ligation above the wound to prevent absorption, excision and cupping to get rid of the virus, and cauterization, probably best effected by zinc chloride, corrosive sublimate, of carbolic acid. Operation punctures on surgeons' hands showing irritation may often be cured by an incision, followed by soaking in a strong solution of corrosive sublimate (1:250). The use of rubber gloves while operating is a protection against operation infection. If, however, septic symptoms occur in spite of these precautions, quinia, alcoholic stimulus, anodynes, nutritious food, and supportive agents must be given and the wound treated by incisions and antiseptic washes. It is said that the spreading inflammation may at times be arrested by a blister applied around the limb, above the wound, as soon as the red lines indicating inflammation of the lymphatic vessels appear. Smearing the surface freely with mercurial ointment is often beneficial in these and other cases of lymphangitis and phlebitis. Ichthyol and wool lard in equal parts make a good application; or this may be combined with mercurial ointment and resorcin.

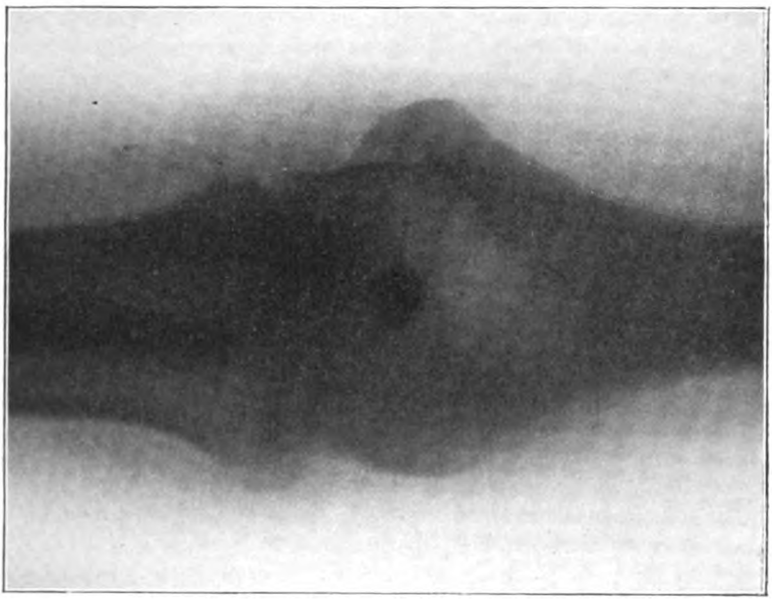
Gunshot Wounds.

Gunshot wounds are injuries produced by the explosive force of gunpowder confined in firearms. They may, therefore, be caused by the powder alone, by the projectiles discharged, by pieces of clothing or splinters of wood given motion by such missiles, and by portions of weapons shattered by explosion. Gunshot wounds partake of the nature of contused and lacerated wounds, and hence are often followed by sloughing. When fractures are produced they are almost invariably open, or compound, and comminuted. Cannon balls crush and pulpefy the parts struck. The wind caused by a passing ball does not and cannot produce a contusion, as was formerly supposed. In injuries so attributed the elastic skin has escaped injury, though actually struck.

The wound made as the missile enters the tissues is called the wound of entrance; that made as it leaves the part, after traversing it, is termed the wound of exit. The wounds of entrance and exit, especially if made by a projectile travelling with a comparatively moderate velocity, differ in appearance. The former is small and has depressed and regular edges, stained, perhaps, with grease and powder. The wound of exit has everted, ragged margins, not stained, and is much larger than that of entrance, because the skin has no external support when it receives the impact from within. Conical bullets discharged by rifled arms travel with such velocity that these distinctions are not often present.

A bullet may traverse the tissues in a direct line, be deflected by bones or fascias, or be split against a bone and make several openings of exit. Instances are recorded where the bullet has taken a circular course and been found imbedded near the wound of entrance. Portions of clothing or wadding carried into the wound act as complications. Small shot fired at short range, say a foot or two, will make a single wound of entrance because there has been no scattering.

FIG. 42.



Skiagraph of bullet wound of elbow-joint. Removal by incision with restoration of function. [Author's Case.]

Powder alone may, if discharged near the skin, produce a serious injury. In any event, if unburnt powder enters the skin there will be permanent discoloration like tattooing, unless the grains are discharged by suppuration or removed by the surgeon. The shock, hemorrhage, and the other symptoms of gunshot wounds correspond with injuries of similar gravity produced by other vulnerating agents.

The treatment consists in removing the foreign body as soon as reaction is established, provided it can be done without seriously increasing the danger. Skiagraphy has been of great service in locating bullets in the tissues. The injury has been produced by the entrance of the projectile, and its passive residence in the tissues does not do sufficient harm to permit great risks to be taken for its removal. Bullets, especially if smooth, often become encysted and may remain without causing trouble. Still, the extraction of the ball, fragments of wadding or clothing and splinters of bone hastens the cure by lessening the danger of septic inflammation and suppuration; and at the same time gets rid of the possibility of remote inconvenience from encysted bodies. Hence, the bullet should be extracted, if it can be done either through the opening of entrance, which seldom is possible, or by a counter-incision. If the wound of exit proves the escape of the entire bullet and no foreign material lies in the wound, these measures are unnecessary. The wound should be made aseptic by cleansing, irrigation with sublimate or other solution, counter-openings and drainage, and should be dressed with antiseptic gauze.

Gunshot wounds, in which nothing except the bullet has entered the tissues, are often aseptic, probably because the missile has been sterilized by the hot grease with which the cartridge was coated. Much harm is often done by infecting such aseptic wounds by means of probes and fingers. Unless the examination is aseptically performed, it had better be omitted, and the wound dressed with antiseptic gauze until a proper examination in skilled hands is obtained. Soldiers in the field carry an antiseptic dressing for this purpose.

To determine the course and position of the ball, careful probing with an aseptic finger or metal probe is proper. When the opening involves the abdominal, cranial or thoracic cavity, it is usually justifiable to make a free incision under rigid asepsis and explore the contained organs. This important topic will be discussed under injuries of the brain and viscera. In abdominal wounds immediate exploratory operation is usually demanded. In cranial and thoracic wounds delay in, or abstinence from, operation may be proper.

It is always well to examine the surface of the body on the opposite side, for the projectile may have passed across and be lodged under the skin, whence an incision will liberate it. For probing or examining the wound the patient should be placed in the position occupied when shot, to get the muscles and bones in the same mutual relation. The probe should be slightly bent at the tip to enable it to follow tortuous passages more readily as it is delicately inserted and turned about in the hand of the surgeon. The probe of Nélaton, which has a roughened porcelain tip, may be serviceable, because it becomes marked by contact with the leaden ball and thus shows that the hard mass touched is not bone. Electrical apparatuses for determining the location of bullets are made, so that the two wires in the probe are connected electrically when the end touches the metallic missile buried in the tissues. This completion of the circuit causes a bell connected with the "telephonic probe" to ring. Skiagraphs are very useful in showing the position of bullets. The X-rays should be used so as to obtain two skiagraphs taken in planes at right angles to each other. This enables the surgeon to locate the ball with sufficient accuracy, and his incisions for removal can be placed effectively. When the ball has been found, attempts at extraction are to be made with the various forms of bullet-forceps and extractors. The incision may be freely enlarged if necessary.

Unburnt powder about the face and hands is to be removed by patient picking with a small knife, or by cutting out little disks of skin with an instrument like a punch. Another method is to prick the skin with a needle dipped in croton oil or other irritant, which causes suppuration and leaves only minute white scars instead of the blue powder marks. The galvano-caustic needle may be thrust into the tissues to burn up the particles of carbon.

When extraction has been accomplished or the attempt found fruitless, the wound is to be managed on the general antiseptic principles previously discussed. Thorough drainage by tubes or counter-incisions is employed according to indications. Immobilization with gypsum bandages over the antiseptic dressings will aid in protecting the injured bones from undue motion, if gunshot fracture exists. Amputation may be required for gunshot injury if the bones are greatly shattered, large vessels or nerve-trunks destroyed, joints freely exposed with comminution of bones or rapidly spreading mortification threatened. Primary amputations are usually preferable in such cases to secondary operations.

Excision may at times be available in joint injuries or in gunshot fractures of the shafts of long bones.

CHAPTER IX.

ANÆSTHESIA.

FOR trivial operations, such as opening abscesses and removing small tumors, local anæsthesia is sufficient. It is induced in one or two minutes by applying a lump of ice or a mixture of ice and salt to the skin; by blowing ether, rhigolene, ethyl chloride, or other refrigerating vapor upon the surface with an atomizer; or by employing cocaine hydrochlorate on the surface or hypodermatically.

Local anæsthesia obtained by the use of aqueous solution of hydrochlorate of cocaine is eminently satisfactory. A twenty-grain solution of this salt in water painted upon a mucous membrane with a camel's-hair pencil or dropped upon it from a medicine dropper, will produce local anæsthesia in about three minutes and will permit the performance of any minor operation without giving the patient any pain. If the application first made does not produce insensibility to pain in the part to which it is applied, repeated applications may be made in a similar manner. The anæsthesia thus produced lasts a number of minutes.

For cutaneous operations of a superficial character it is necessary to inject the cocaine into or under the skin by a hypodermic syringe. The infiltration method of using cocaine, advocated by Schleich, is the best means of anæsthetizing the skin. The hypodermic needle is thrust into the skin, not through it; and the solution is forced into the interstices of the corium. Numerous punctures are thus made, and the line of incision becomes œdematous by reason of the fluid. The white wheals, made by the pressure of fluid displacing the blood, are evidence that the anæsthetic solution has been properly distributed. The first puncture may be made at a point made insensible by a drop of carbolic acid applied to the surface, or by freezing. Subsequent punctures are made in tissue already anæsthetized. Various strengths of solution are employed by Schleich, but they are all weak. A good formula is: Cocaine hydrochlorate, gr. jss; morphine hydrochlorate, gr. $\frac{1}{3}$; sodium chloride, gr. iij; water, ℥iij ʒiij. The solution can often be incarcerated in the part, into which it has been injected, by checking the venous return from the cocainized area by means of a ligature or a rubber ring. If an operation is to be made upon a finger or upon the penis, for example, the anæsthetic will last longer and prove more effective, if it is incarcerated at the seat of operation by tying a piece of tape or placing a rubber band around the base of the member before the hypodermic injection. A mucous surface to be rendered anæsthetic by cocaine applications should not be alkaline, else the anæsthetic power of the drug will not be exerted. The soap used for cleansing should be washed off with sterile water to avert alkalinity due to some remaining soap.

It must be remembered that death has occurred from cocaine poisoning. It is best, therefore, to avoid the toxic effect by using, as a rule, a solution no stronger than twenty grains to the ounce, and it is seldom wise to use more than twenty minims at the most, unless the drug has been incarcerated. Then after operating the surgeon can by intermittent relaxation of the band allow it to enter the system gradually. Solutions of cocaine of the strength 75 to 100 grains to the fluid ounce are, however, used as anæsthetic applications to the vaginal mucous membrane prior to plastic operations. The passage of urethral bougies and instruments of a similar character may be rendered quite painless by injecting the urethra with cocaine. When used upon the eye in large quantity and in too strong solution it occasions opacity, temporary however, of the cornea, and may, therefore, possibly do harm if it is not used with proper caution. Carbolic acid and guaiacol will produce local anæsthesia.

For the production of general anæsthesia in surgery ether is preferable to any other agent at present generally employed. Chloroform is much more dangerous. Its claimed advantages over ether are considerably overrated because of the improper methods in which ether is often given. Chloroform may, perhaps, be a safer anæsthetic than ether, when the patient has chronic nephritis.

Nitrous oxide is not a good anæsthetic for protracted operations, requires bulky apparatus for its administration, and in short operations can readily be substituted by local anæsthesia or the primary anæsthesia of ether.

Rapidly repeated deep inspirations continued for a minute or so will produce insensibility to pain (analgesia) for slight operations, though the sensibility to contact is not obliterated. This effect may be utilized in surgery, but it and anæsthesia from nitrous oxide are used very little outside of dentistry.

Before etherizing a patient the surgeon should examine the kidneys, heart and lungs. The presence of disease in one or all of these organs should not deter him from the administration of ether when necessary for a painful operation; but the knowledge of its existence will render him exceedingly cautious. Anæsthesia should be avoided if possible, during an attack of bronchitis, and when the kidneys are not secreting a normal amount of urine. A few days' delay will permit these conditions to be remedied by treatment. Anæsthesia is always a dangerous condition, and requires the undivided attention of an experienced assistant. Death has occurred not infrequently from etherization and often from chloroform anæsthesia.

The patient's stomach should be empty, lest vomiting occur during or after anæsthesia. Hence, he should fast for four or six hours prior to etherization, and it is even better if no solid food has been taken since the previous day. A hypodermic injection of morphia (gr. $\frac{1}{8}$ to gr. $\frac{1}{4}$) and atropia (gr. $\frac{1}{120}$ to gr. $\frac{1}{100}$) should be administered about 15 minutes before inhalation is begun. This renders anæsthesia quieter, more rapid and more safe. It is not an absolute essential but is very judicious. All clothing restricting deep inspiration must be removed or loosened. It is important to insist upon women unfastening their corsets and the skirts tied about the waist. False teeth and pieces of tobacco must be removed from the mouth, because of the danger of their falling backward into the fauces and obstructing respiration. The patient is usually placed in the recumbent position. The semi-recumbent or sitting posture is not justifiable during chloroform inhalation. In operations upon the nose and palate it is often better to have the patient lying on his back with the head so bent backward that the palate is lower than the floor of the mouth. Blood is thus kept away from the site of operation and flows down the œsophagus and not into the larynx. Choking and coughing are thus avoided. When these preliminaries have been arranged the patient is shown how to inspire and expire deeply, and is encouraged to do so for a few moments. It is well to teach him to breathe properly by placing the dry towel over the face for a few seconds before adding ether. It is not necessary to anoint the lips and cheeks, nor to spray the nose and throat with cocaine before inhalation. These steps are sometimes advocated.

No inhaling apparatus is required. A cone of paper containing a loosely folded towel is a very satisfactory contrivance; but a small piece of sterile gauze or a clean handkerchief loosely folded and covered by a large towel so that the ether vapor cannot escape is usually preferable. The outer towel should cover the eyes of the patient, and no talking on the part of the bystanders should be allowed until insensibility occurs. The senses of sight and hearing should not be stimulated by any such disturbing influences. The ether vapor must be given in a concentrated form, and from one to two fluid ounces should be poured on the napkin at first, that renewal may not often be required. When inhalation has once fairly begun the ether cloth should never be removed from the face, unless spasm of respiration or actual vomiting necessitates its temporary withdrawal. It should not be removed from the face while additional doses of ether are being poured upon it; but the corner of the outer towel should be raised and the anæsthetic poured on in sufficient quantity.

If the room is kept quiet, the patient previously taught how to breathe deeply, a full amount of ether poured on the towel, the eyes of the patient covered, and no air admitted to the lungs except that which passes through the gauze and towel, complete anæsthesia can be obtained in from three to ten minutes in nearly every instance. *It is not safe to give chloroform in this manner.* After beginning anæsthesia with ether, it is sometimes, in operating upon the head, convenient to continue the anæsthesia with the stronger drug chloroform; because the gauze saturated with the anæsthetic agent can then be held further from the seat of operation and still be efficient.

During the entire period of etherization the administrator must carefully watch the respiration, color of skin, and pulse. The first two points demand especial scrutiny, but the changes in cardiac force, which can be most conveniently investigated at the temporal artery in front of the ear, must not escape examination.

It occasionally happens that after a few inhalations have been taken a spasm of respiration takes place, evinced by absence of inspiratory effort and cyanosis of the face. This calls for the withdrawal of the ether for a moment, when a deep inspiration occurs, and no further symptoms of asphyxia are shown. If in the stage of excitation the patient struggles and cries out, the ether cloth must be kept closely applied, because access of air increases the excitement. Retching as if vomiting was about to occur is an indication to keep up the ether. During complete anæsthesia vomiting does not take place. If, however, the stomach contents are regurgitated upward into the pharynx and mouth, the etherization must be stopped until the fauces are cleared of materials that might pass into the larynx. The suspension of inhalation should be as momentary as possible. Sometimes the ether vapor causes an abundant secretion of bronchial mucus, which collects in the larynx and fauces and causes impeded respiration. This complication is met by clearing the throat with a finger introduced into the mouth, or by turning the patient on his face for a moment with his head hanging down over the edge of the operating-table.

When the conjunctiva is insensible to touch with the finger, the muscular relaxation complete, and a tendency to stertorous breathing noticeable, the time for operating has arrived. The ether may then be withdrawn or only administered in sufficient quantities to keep up the anæsthetic state without inducing a continuance of loud palatal and laryngeal stertor. Stertorous respiration usually means that anæsthesia should not be pushed, since the patient is then insensible to pain. Patients are often given more ether, after insensibility is profound, and are kept more deeply under the influence of the drug than is requisite. This is reprehensible, for it throws more work on the kidneys and lungs, by which the ether is eliminated, than is justified. A full dose at the start and comparatively small doses afterwards fulfil the requirements.

There is a primary anæsthesia lasting about a minute which is associated with muscular relaxation and occurs soon after inhalation has begun. This stage of etherization may be utilized for the performance of such operations as opening abscesses and extracting teeth. The recovery from this anæsthetic condition is very prompt and unattended with the nausea and other after-effects of prolonged etherization. This primary anæsthesia or first insensibility of ether is not sufficient for other than minor surgical operations. It resembles the analgesic effects of rapid respiration, previously mentioned, more than true anæsthesia.

In all administrations of ether it must be remembered that its vapor is inflammable and so dense that it falls toward the floor; therefore all candles or other lights should be placed at a distance from the patient and at a higher level than the operating-table.

When patients regain consciousness after etherization they occasionally become very noisy and hysterical. The shouting can be stopped by pouring a little water into the mouth every time the patient opens it to cry out. This compels him to close his mouth to swallow.

If dangerous symptoms, such as asphyxia or cardiac failure, occur during the administration of an anæsthetic the inhalation must at once be suspended. If mucus or vomited matters produce interference with respiration they must be promptly removed. Tracheotomy might be demanded when ankylosis of the jaws or other causes interfered with proper clearance of the larynx. Imperfect respiration may be due to an effect of the ether on the nerve-centers. Pulling the tip of the tongue forward with forceps or pushing the lower jaw forwards, with the fingers placed behind its angle, often aid the respiratory function; but artificial respiration and electrical stimulus may occasionally be required. In many cases dashing cold water in the face, slapping the cheeks with a towel dipped in water, or pouring a little ether upon the epigastrium is sufficient.

The simultaneous inhalation of ether vapor and oxygen gas seems to lessen the danger of the anæsthetic state. It is easily accomplished by passing oxygen from the iron bottles, in which it is furnished under pressure, through a wash bottle containing ether instead of water. It then passes, mixed with the ether vapor so obtained, through a tube to an inhaler held over the nose and mouth of the patient. The ruddy color of the patient and the quick recovery from the anæsthetic state make this method of inducing anæsthesia seem very satisfactory.

Pneumonia has occasionally been observed after etherization. It is not certain how this complication arises. It has been attributed to infectious material, inhaled from the nose and throat or from the etherizing apparatus, and to improper exposure of the patient to drafts after leaving the warm operating room.

Heart failure producing anæmia of the brain is combated by inversion of the body, perfect muscular quiescence, and inhalations of nitrite of amyl. In addition atropia, digitalis and perhaps ammonia should be given hypodermatically in full doses to combat the toxic effects of ether. Experimental investigation in physiological laboratories seems to prove that alcohol is injudicious in the treatment of ether poisoning. It should, therefore, not be given in such cases. If this experimental evidence is accepted it is improper to administer alcohol before etherization to avert shock. Quinine, atropia, digitalis, and morphia are preferable.

Persons addicted to alcoholic stimulation require more ether to induce profound anæsthesia than temperate ones, because they have become habituated to the effects of similar intoxicating agents. The administration of the anæsthetic must be cautious, because the viscera of drunkards are frequently diseased.

It is unwise to etherize a patient without assistance, because dangerous symptoms might arise from the anæsthetic or the operation, and the surgeon would be unable to give efficient aid alone. A woman should never be etherized by a man unless a third person is present, since a charge of criminal assault might be made because of erotic dreams during the anæsthetic state.

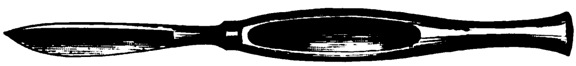
CHAPTER X.

OPERATIVE SURGERY.

INSTRUMENTS AND INCISIONS.

Instruments.—The instruments of the surgeon are innumerable, but those ordinarily required are few in number and simple in construction. Knives, forceps, scissors, hemostatic forceps, saws, needles, probes and grooved directors are indispensable for the performance of surgical operations and undergo many modifications for special purposes. Certain operations demand additional instruments of peculiar character, such as the trocar, catheter, and syringe. A knife with a markedly convex or bellied edge is technically called a scalpel, while one that has very little belly and is nearly straight is termed a bistoury.

FIG. 43.



Scalpel with aseptic hollow metal handle.

Scalpels are usually too convex, and are satisfactory only when a large flap of skin is to be dissected up. A knife nearly straight, partaking therefore of the character of the bistoury, and called a midpoint scalpel, is the best form and answers equally well for incisions, dissections, and opening abscesses by transfixion.

FIG. 44.

Bistoury with aseptic hollow metal handle.

The edge of a knife is tested by drawing it from heel to point across the free border of a finger nail, for by this manœuvre any notches will be apparent. Its keenness is proved by the ease with which it will cut when the edge is gently pressed upon the skin of the finger. The sharpness of the point is tested by the thrusting it through a piece of kid or gold-beater's skin stretched tightly over a ring. This little drum gives out a distinct sound at the time of puncture if the point of the knife is dull.

Hemostatic forceps have a lock and are used to compress wounded vessels during the various steps of an operation, so that the surgeon need not be delayed by ligating bleeding points. In truth this temporary compression is often all that is needed; for small vessels soon become permanently sealed and when the forceps are removed require no ligature. Large vessels should be tied before the hemostats are removed.

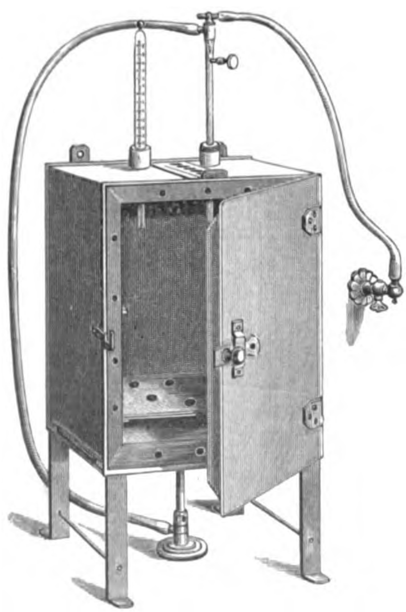
Straight needles with the point ground like a slender trocar on three sides, such as are used by glovers, are nearly always preferable to curved needles. They penetrate the tough skin more readily and enable the surgeon to direct the point more certainly. A needle fixed in a handle and having an eye in the point is often useful.

FIG. 45.

Trocar point needle.

The sharp hook employed for drawing out the ends of divided vessels is called a tenaculum. It has been supplanted to a great extent by the hemostatic forceps. Probes should always be firm, but sufficiently flexible to allow the operator to bend the end slightly before beginning to explore a sinus. The slightly curved extremity will follow more readily the tortuosities of the channel, when the probe is rotated in the fingers.

FIG. 46.

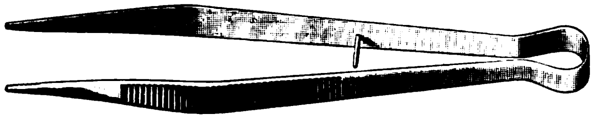


Sterilizing oven with thermo-regulator connected with gas tube to prevent temperature rising too high.

All instruments should be kept scrupulously clean and protected from dust, so as to be free from bacteria. Dried pus and blood are liable to remain in crevices of instruments and infect wounds with which they come in contact. The eyes of catheters and the teeth or joint of forceps are very frequently allowed to contain foul material of this character. Ordinary dust usually contains germs and, if in these fissures, may infect a wound. Moist or dry heat is the only perfect sterilizer of instruments. They should always be washed perfectly clean after operation. Just before use they should be heated to at least 212° F. and kept at that temperature for ten or fifteen minutes. This may be done by boiling in water, by steam, or by baking in an oven.

Boiling instruments in a 1 per cent. solution of sodium carbonate (about ʒjss to Oj) for ten minutes is an efficient method of sterilization and does not tend to rust them. The handles should be smooth and of metal and not cemented, since cemented instruments are damaged by heat. All unnecessary complications and crevices should be avoided. Metal boxes with dust-tight lids are convenient receptacles in which to keep, bake, and transport instruments.

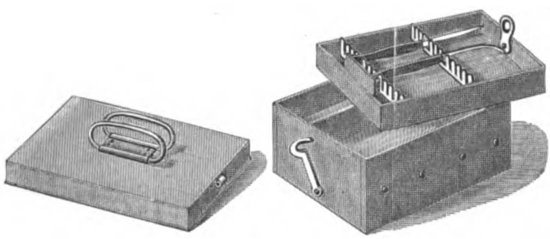
FIG. 47.



Aseptic dissecting forceps, which permit thorough cleansing.

Incisions.—The knife should always be held delicately though firmly. The most common position of the knife for making incisions is that assumed when one uses a pen, though in dissecting up large flaps the surgeon will often hold the knife as if it were a fiddle-bow. Occasionally, as in amputations, the large handle is firmly grasped with

FIG. 48.



Metal boxes for sterilizing instruments by baking.

the entire hand. When an incision is to be made the fingers of the left hand should support the skin at the point where the knife is to be entered, the surgeon then thrusts the point into the tissues perpendicularly and, immediately depressing the handle of the knife, cuts with the edge until the incision is sufficiently long; he should then, in order that the tissues may all be completely divided to the very end of the incision, elevate the handle and bring the knife out perpendicularly.

Incisions should be sufficiently large to expose the parts and should be made with decided strokes of the knife. Nothing discloses the inefficient surgeon so much as small button-hole like incisions, made by picking with the point of the knife. When possible, incisions about the face should follow the cutaneous creases that the scars may be as unnoticeable as possible. Oblique division of the skin causes slight scarring, and curvilinear incisions are less noticeable than straight ones. In making incisions over large vessels or important organs the grooved director may be pushed under the successive layers of tissue before the knife is used to divide them. This does not apply to the skin incision.

PREPARATION OF THE PATIENT AND THE SURGEON AND MODE OF CONDUCTING OPERATIONS.

The preparatory treatment of persons about to undergo operations that do not require immediate execution is important. Debilitated patients should be built up by food and tonic regimen; those of an opposite constitution may require more moderate diet than usual, purgation, and some restriction as to stimulants. Active evacuation of the bowels by salines and an enema should constitute part of the preparatory treatment in practically all cases where the operation is not one of emergency.

Peculiarities of disposition and constitution should be studied by the surgeon, since the existence of the hemorrhagic diathesis, a tendency to delirium or any other marked habit of body might influence the choice of methods of operating. Encouraging words are of great value in sustaining the spirits of timid patients. All patients, if placed in a hospital or removed from their homes, should ordinarily be allowed a day's delay, in order to become accustomed to strange surroundings, nurses and beds. If restraint of a limb in one position is essential to the success of an operation, it is well to keep the limb in that abnormal posture for a day or two that the weariness so caused may pass away. Menstruation if normal does not seem much of a contra-indication to operation, though the time between the periods should ordinarily be selected. Pregnancy is usually a proper cause of delay in operations of expediency. The seat of operation must always be rendered aseptic by shaving, to remove the fine hairs which may retain dust and germs, and by subsequent thorough scrubbing of the skin by soap and water. A second washing with a sublimate solution (1:1000) is then proper. Before serious operations the patient should, if possible, be given in addition a full bath the evening previous. This is to avoid septic contamination from bacteria on the skin. The umbilicus and the folds of the skin about the groins, axillæ and toes are especially apt to be overlooked in these cleansing processes. The secretions, epidermis and dirt retained there are full of bacteria, as are the spaces underneath the nails of the patient as well as of the surgeon. After the tub-bath or sponge-bath and the sterilization of the seat of operation, a wet corrosive sublimate dressing is usually applied over the surface to be operated upon, and allowed to remain until the time of operation.

A good light and a bright, cheerful day are important factors in securing the best conditions for operative surgery. A patient should never be kept waiting by the surgeon after the appointed hour. Anxiety and suspense induce nervousness.

It becomes necessary at this point to enter with more detail into the matter of asepsis and antisepsis. By asepsis is meant absence of all vegetable parasites or micro-organisms. The word, therefore, is employed to signify that the surgeon has used every effort to prevent the presence of any such organisms in the wound; it implies, therefore, the absence of such parasites from the surgeon's hands, from the instruments used, from the dressings applied and from the surroundings. Asepsis or aseptic surgery then means that the procedure is germ-free. By antisepsis is meant that the manipulations are directed toward the destruction of all micro-organisms which may be present. In the one case the endeavor is to obtain perfect freedom from pathogenic organisms; in the other case it is to destroy any pathogenic organisms which may be present in the wound, upon the hands of the surgeon or upon the dressings. If absolute asepsis could always be assured, antisepsis would be unnecessary. It is because there are so many means by which bacteria may get into a wound, even when done under the supervision of the most careful surgeon, that many prefer to use antiseptic precautions in addition to cleansing the skin of the patient, scrubbing the surgeon's hands, and sterilizing the instruments and sponges.

In some cases the use of chemical agents may be deleterious because they act upon the patient's tissues in such a way as to produce irritation; at least, such is the case when they are applied in sufficient strength to render their antiseptic properties valuable. For example, an ordinary solution of carbolic acid or corrosive sublimate can never be put into the peritoneal cavity without danger. It is also possible that frequent washing of recent wounds with such solutions irritates the tissues and leads to greater exudation of serum after the lips of the wound have been approximated than would be the case if the wound was not subjected to such irritation.

As has been said in an earlier chapter, heat is the most perfect destroyer of vegetable fungi; therefore, instruments and dressings, which have been sufficiently heated are free from germs. If the instruments and sponges are kept in boiled water, they can be used with impunity, provided that dust is prevented from falling into the receptacle. Such sterilized, or aseptic, water is far less irritating than water containing chemical antiseptics. Sterile salt solution (0.6 per cent.) is not irritating.

The antiseptic solution most often used for sterilizing the skin of the patient and the surgeon's hands and arms is water containing corrosive sublimate in the proportion of 1 : 1000 or 1 : 2000. This is employed after thorough mechanical sterilization with hot soapsuds and a finger-nail brush. Many surgeons employ, after the soapsuds, a saturated solution of potassium permanganate in which to soak the hands and forearms. The brown discoloration of the skin thus produced is removed by soaking in a saturated solution of oxalic acid. The hands are then dipped in water sterilized by boiling and dried with towels sterilized by dry heat in an oven. As an additional precaution sterilized rubber gloves may be worn.

Solution of chlorinated soda or formaldehyde, and other disinfectant applications are preferred by some operators. The essential is thorough cleansing of the subungual spaces and skin by mechanical means and soap, and subsequent antiseptic washing to make sterility of the hands more certain. A similar technic is applied to the skin of the patient at the seat of operation. The sublimate solution is too strong to be used for irrigating cavities, because if any portion of the fluid should remain, as it often will do, there is great danger of producing corrosive sublimate poisoning. This is evidenced by the occurrence of vomiting and bloody stools. Boiled water, steam which has been condensed in sterile receptacles, or sterile salt solution (sodium chloride 0.6 part and water 100 parts), should be used for abdominal operations.

Sublimate solution should never be used to sterilize instruments, because it tarnishes the steel and dulls the edges of cutting instruments. For such purposes a solution of carbolic acid (1 : 20) is employed. If the surgeon prefers he may boil his instruments in water or one per cent. solution of sodium carbonate for five minutes. The hot water is allowed to cool or the soda solution is poured off and replaced by cold sterile water before using the instruments. They should be covered when not in use so as to avoid contamination from dust. The use of instruments, dried after sterilization, is preferred by some. In this case they are laid on sterile towels or placed in sterile dishes. Sterilization of instruments by dry heat in closed boxes has advantages at times. The method impairs the temper of the steel more than does boiling.

When an operation is to be performed, the skin at the seat of operation, the instruments, sponges, dressings, and hands of surgeons and assistants must be sterile. The operator and his assistants should have the sleeves rolled up to the middle of the upper arm and the clothing covered with recently washed muslin or linen aprons. Aprons sterilized by baking are preferable. The hands and subungual spaces are well cleansed by scrubbing them vigorously with hot water and a mixture of equal parts of ground mustard seeds, cornmeal and Castile soap. The oil in the mustard is said to be a good antiseptic, but the better known antiseptic solutions should perhaps be employed after using the above mentioned mixture for cleansing the hands.

Every assistant should know his duty and attend to it alone. No loud talking or unseemly jesting should be permitted. The assistants whose hands are to touch sponges, instruments and the wound must be as aseptic as the surgeon. No one else should be allowed to handle anything. Nothing, unless it is germ-free, is permitted to come into contact with the incised tissues. An instrument which has dropped upon the floor or touched the bed-clothes must be rejected until again sterilized. The surgeon must touch nothing that is not sterile, unless he sterilizes his hands again with an antiseptic solution or washes them in sterilized water before approaching the wound. He dare not put his hands into his pocket, scratch his head or face, or adjust his eye-glasses without endangering the patient's life by the possible conveyance of bacteria into the wound. It is, therefore, well to surround the seat of operation with sterilized towels laid over the clothing or bed coverings. These may be baked towels or towels soaked in sublimate solution and dried. A table or firm bed is preferable to a reclining chair because more steady, and not so easily disarranged by struggles during etherization. The patient's body and limbs should be covered and not exposed to the chilling influence of the air.

The occurrence of hemorrhage should be precluded by the use of the Esmarch elastic bandage, or by acupressure or digital pressure to the main arterial trunk. Much of the depression formerly attributed to shock was really due to hemorrhage occurring after injury or during operation. The surgeon should not, however, stop in operations to ligate the numerous little branches that bleed; for many of them will cease spontaneously, and others can be controlled by hemostatic forceps, applied by the assistants, until the operation is completed. Then ligatures can be used.

In major operations, as for the removal of tumors for example, the most difficult points should be attacked first. Let the operator get under the mass, if it be a tumor, soon after he has made his cutaneous incision. Then he knows what he has to meet, and having controlled the sources of hemorrhage and mastered the grave complications, he can dextrously and with facility complete the work of removal.

The principles or fundamental laws of operative surgery are:

1. Obtain the services of an etherizer who will not require you to superintend the anæsthetic.
2. Take precautions to prevent hemorrhage, if the locality renders this possible.
3. After proper thought and consultation have the plan of operation clearly outlined in your own mind.
4. Have the patient, the instruments, yourself and your assistants absolutely aseptic.
5. Proceed systematically with the steps of the operation decided upon, and do not be led into a mixed operation by bystanders, unless unexpected developments in diagnosis occur.
6. Attack the greatest difficulties and dangers of the operation first.
7. Do not stop to tie any except large vessels, but let assistants apply hemostatic forceps or make pressure with their fingers until incisions are completed.
8. When the operation is finished, stop hemorrhage and apply dressings.
9. Finally, remember that suppuration in an operation wound is usually, probably always, due to careless asepsis on the part of the surgeon or his assistants, except in those instances where the operation is done on tissues already infected.

CONTROL OF HEMORRHAGE.

The prevention and management of hemorrhage during operations will be considered in the chapter on Diseases and Injuries of Blood Vessels.

SUTURES.

When a wound has a tendency to gape and there is a probability that union by first intention can be secured by correct apposition of the edges, sutures are employed. They should not be used in contused and lacerated wounds, if tension is induced by adjusting the parts, or if the wound is not perfectly aseptic and there is danger of preventing thereby the free escape of serum and pus.

The suturing materials most commonly used at the present time are catgut, silk, wire, silkworm gut and kangaroo tendon. Catgut and tendon are most valuable for buried sutures, because they are absorbed by the tissues; other sutures are encysted and may cause irritation months after the operation. When sutures are on the surface and can be removed after their need is past, there is no essential difference in them. It is asserted that silver wire sutures prevent germ development by an inhibitory action. It goes without saying that these sutures must be rendered aseptic, in order that they may not induce suppuration or other pathological conditions in the tissues into which they are inserted. Wire, silkworm gut and silk sutures are rendered aseptic by boiling or baking, or by soaking in a strong antiseptic solution. Catgut is prepared and then kept in an antiseptic solution until it is used. Antiseptic catgut and silk sutures and wire for suturing can be obtained from the instrument-makers, but it is unwise to trust to the asepticity of materials prepared by commercial houses. The surgeon or a conscientious assistant had better prepare the materials. The methods are now so simplified that this can easily be done. Surgeons often prepare the catgut sutures and ligatures themselves, by purchasing violin strings and rendering them antiseptic by some such formula as the following: Soak the catgut violin strings in oil of juniper wood for forty-eight hours, in order to remove the fat; then wash in alcohol, and store in fresh alcohol until required; then soak in cold sublimate or carbolic acid solution for ten minutes before using. It is best to thread the needles, which should be aseptic, before they and the gut are put in the antiseptic trays used at the operation; because the catgut, when taken from the alcohol, is somewhat stiff and shrunken, but when put in water becomes swollen and cannot, therefore, be threaded through needles with ordinary eyes. The needles should not be put into sublimate solution. Such catgut sutures will become absorbed by the tissues in which they are placed in from five to ten days, varying according to the thickness of the thread. If it is desired to prevent the absorption of the sutures at such an early period—as happens, for example, when tendons or bones have been sutured—it is proper to use chromicized gut. This is catgut rendered less absorbable than ordinary antiseptic gut by the addition of chromic acid to the solution in which it is prepared. To chromicize catgut the following formula is a good one: After having soaked the gut in oil of juniper wood for forty-eight hours, wash it in alcohol and let it soak for forty-eight hours in a solution prepared according to the following formula: Carbolic acid, 1 part; chromic acid, $\frac{1}{200}$ part; water, 20 parts; catgut, 1 part. After standing in this solution forty-eight hours the sutures should be washed in alcohol, and then preserved in fresh alcohol. Sutures or ligatures prepared in this way will be absorbed in from ten to thirty days, according to the thickness of the thread. The thicker the thread the longer the time required for absorption.

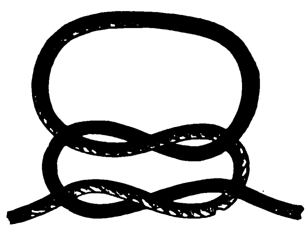
Another method of preparing catgut for sutures or ligatures is to roll it loosely on sterilized glass spools, soak for twenty-four hours in ether, pour off ether and soak for twenty-four hours in a solution of corrosive sublimate 10 parts, absolute alcohol 800 parts, water 200 parts, renew this solution and soak for seventy-two hours. Finally this solution is poured off and a fresh quantity of the same used for storing the catgut. Catgut may be made aseptic and slowly absorbable by the use of formaldehyde.

The forms of sutures usually employed are the interrupted, the continuous, and the twisted or pin suture. The quill suture is deservedly nearly obsolete. The interrupted suture is made by carrying with a needle a catgut, silk, wire or wormgut thread across the wound, cutting it off and fastening the two ends by tying, twisting, or clamping with perforated shot. This is repeated at intervals along the wound. The twisted, or pin suture, is made by thrusting a steel pin through the lips of the wound, which are then held in apposition by a silk or catgut thread wrapped around the ends of the pin and across the surface of the wound. The pin is left in position until union has occurred. The thread may be twisted about the pin in an elliptical or a figure-8 manner, or a rubber band may be employed in its stead.

FIG. 49.

Granny knot, which is never used in surgery. (J. D. BRYANT.)

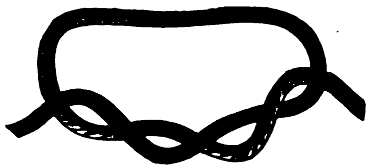
FIG. 50.



Flat or reef knot. (J. D. BRYANT.)

Interrupted sutures are best made with catgut, silk, silkworm gut, or flexible wire and a straight needle. Occasionally a curved needle may be preferable. In linear wounds the first suture should be inserted across the middle; in irregular wounds the projecting points had better be approximated first. The needle should puncture the skin not nearer than about one-eighth to half of an inch from the margin of the wound, and be carried deeply enough to bring the entire depth of the wound surfaces together. The ends of the suture should be fastened at one side of the wound by a flat or reef knot if silk is used, by a surgical knot if gut is employed, by twisting the ends or clamping them with shot if wire is employed.

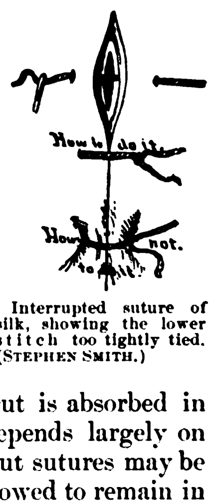
FIG. 51.



First tie of surgeon's or friction knot. The second tie is like that of the flat knot. (J. D. BRYANT.)

Sutures should be placed at intervals of one-fourth or one-half inch and should never be applied tightly, since mere apposition of the edges is all that is required and swelling will probably increase the tension. No sutures would be necessary in wounds, if there were no gaping, or tendency to displacement from muscular movement. A sufficient number of sutures should be inserted to avoid gaping between them. This is better than placing them far apart and using adhesive plaster in the intervals since adhesive can scarcely ever be sterile. It is a useless and dangerous agent in the treatment of wounds. Three to six days is long enough, as a rule, for sutures to remain, though in deep wounds and in positions where strain is liable to occur the sutures, if of wire, may remain almost indefinitely. When stitches are to be removed the wire should be cut close to the knot or twist, the long end bent over to the other puncture and the wire drawn through the tissues in a curved direction by means of a forceps grasping the knot. If this is not done, a little hook of wire is left when the suture is cut, and pain is caused by drawing this through the tissues. Catgut sutures need not be removed, because the portion of the loop buried in the tissues is absorbed and the external portion finally falls away from the skin. Chromicized catgut requires from ten to thirty days to be absorbed; ordinary antiseptic catgut is absorbed in from five to ten days. The time in each instance depends largely on the thickness of the thread of gut. Silk and wormgut sutures may be cut and withdrawn, or, if entirely buried, may be allowed to remain in the tissues; when they become encysted. These processes only occur perfectly when the sutures and wound are free from germs. The twisted, pin, or hare-lip suture is not much employed now.

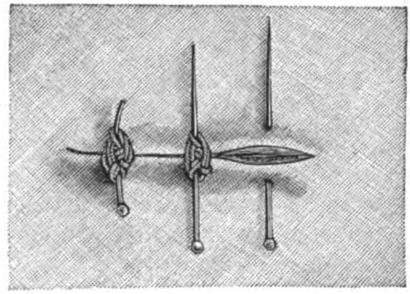
FIG. 52.



Interrupted suture of silk, showing the lower stitch too tightly tied. (STEPHEN SMITH.)

Continuous differ from interrupted sutures in that the first stitch is taken near the end of the wound and the thread carried through the tissues from side to side without being cut off and tied every time it crosses the wound. This form of suturing is used a good deal more now than in the days when suppuration of wounds almost constantly occurred. At that time and under those circumstances the interrupted suture was convenient, because one stitch could be removed for the evacuation of any pus which formed at the bottom of the wound cavity. Now that there is little fear of suppuration occurring the continuous suture is preferable in many instances, because it is much more rapidly applied than the interrupted and because it brings the edges of the wound into neater apposition. When the continuous suture is begun the end of the thread of gut is tied to the main portion of the thread after the needle has drawn it through the second puncture. The needle then carries the thread across the wound and through the tissues in the way shown by the illustration.

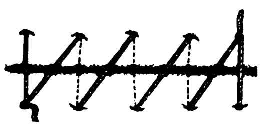
FIG. 53.



The three steps of the twisted or pin suture. (WYETH.)

The suture is ended, at the other extremity of the wound, by tying the end of the thread and the loop made by leaving the thread long in the stitch next to the last. The subcuticular continuous suture is very valuable and is much used. It is made by carrying the thread or wire through the cut edges of the skin without puncturing the epidermis. It is useful because there is little scarring made by the needle and because the occurrence of stitch-hole abscess is unlikely. Stitch-hole abscess is probably often due to the white staphylococcus which is found in the lower layers of the epidermis and which is not removed by sterilization of the surface of the skin. The intracutaneous suture scarcely touches the region inhabited by this organism.

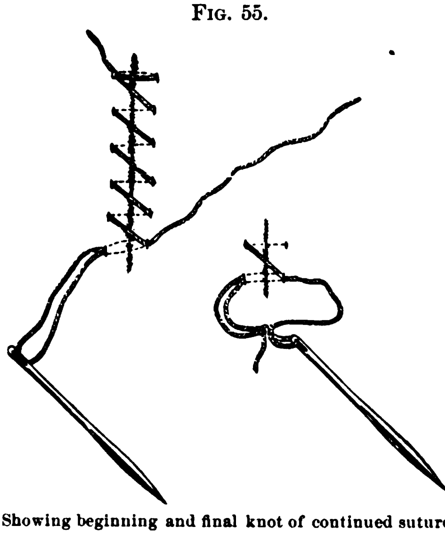
FIG. 54.



Continuous suture. (ESMARCH.)

Buried sutures are stitches which are used to bring together tissues at the bottom of a wound, and which are subsequently entirely covered up by more superficial layers of muscle or fascia, or by skin. In closing large and deep wounds extending through different planes of muscle, the surgeon should suture each layer of muscle and each layer of fascia step by step from the bottom to the surface. This hastens union, pre-

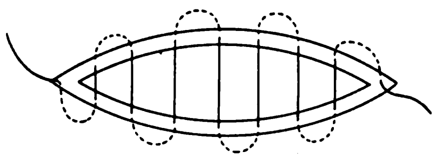
FIG. 55.



Showing beginning and final knot of continued suture.

vents the formation of pockets or cavities, in which blood or wound secretions might collect, and restores most effectually the normal integrity of the parts. Divided nerve-trunks should be united by these buried sutures, severed tendons accurately approximated and muscular masses and fascial sheaths carefully reconstructed. Perfect asepticism is essential for success; catgut is to be employed for these purposes. In suturing tendons chromicized, sublimate or formaldehyde catgut or kangaroo tendon should be used, because ordinary gut is apt to be absorbed before the tendons unite, and because the strain upon the suture is often considerable. In all these instances the sutures are cut off close to the knots and are allowed to become absorbed. The peculiar method of passing the suture shown in the illustration is the best for tendons; other structures may be united by the interrupted or continuous suture as seems best to the operator.

FIG. 56.



Halsted's sub-cuticular suture. (DA COSTA.)

FIG. 57.

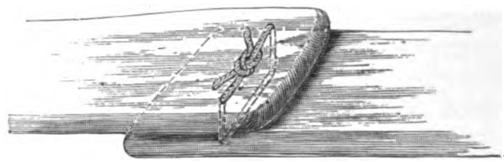


Diagram of suture of tendon. (ESMARCH.)

The peculiar devices used for suturing intestinal wounds will be described under Surgery of the Abdomen.

DRESSINGS AND SPONGES.

The dressing which practically is used for all wounds, whether operative or accidental, is gauze. This gauze is what is technically called in trade circles cheese-cloth or butter-cloth. It is a loose cotton material with open meshes and readily absorbs fluids. It can be bought from dealers in surgical supplies, either plain or impregnated with corrosive sublimate, carbolic acid, iodoform, double cyanide of mercury and zinc or other antiseptic in varying proportions, and is, in the latter case, properly called antiseptic gauze. Plain gauze is supposed to be perfectly free from germs, which, of course, it never is, unless previously subjected to high heat and kept in cans tightly sealed. Cheese-cloth can also be readily bought at dry goods stores, and after it has been washed in hot water containing a little soda and dried, it becomes a very cheap and effective dressing. This the surgeon must make aseptic for himself, by baking it in an oven and keeping it free from the slightest possible contamination with dust; or antiseptic by saturating it with a germicide solution.

When the wounds are open and the gauze dressing comes in actual contact with the wound surface the secretions on drying glue it to the wound. A great deal of pain is therefore given to the patient upon the removal of such a dressing, unless it has been carefully soaked for some time with solution of hydrogen dioxide, or with water, which must be sterilized to prevent infection. It is well, therefore, to cover open wounds with a piece of thin rubber tissue or oiled silk "protective" before applying the gauze dressing. It should be cut full of slits or small holes with a pair of scissors, in order that the secretions from the wound may escape into the gauze and not macerate the tissues lying under the rubber film. Evaporation and percolation are more free through the oiled silk, which goes by the name of "protective," than through rubber tissue, hence the former does not, as a rule, need to be perforated. If a wound has unfortunately become the seat of profuse suppuration the gauze will not adhere even when placed in direct contact with it. In wounds the edges of which are brought into actual contact by sutures there is no occasion for using "protective" under the gauze; the gauze may then be laid directly upon the wound itself. It must be understood, of course, that this rubber film or oiled silk must be thoroughly cleansed and rendered aseptic or antiseptic before being applied to the wound. It is perhaps unnecessary to say that all drainage tubes, whether of rubber or of glass, must in a similar manner be rendered aseptic or antiseptic before use.

When a wound is dressed a large mass of gauze consisting of from four to twenty layers, varying with the degree of serous effusion which the surgeon presumes will escape from the wound, must be firmly and evenly bandaged over the injured surface. It is absolutely necessary that the margin of the dressing should extend a considerable distance beyond the limits of the wound, in order that the wound secretions may not, by travelling between the skin and dressing, get beyond the edge of the latter and become infected with bacteria from the air, clothing or bandages before the surgeon repeats his visit. In such an event the organisms will develop in the bandages or portion of clothing soiled with the discharge and cause putrefaction and suppuration; the infection will continue along the path of serum made under or in the gauze, and finally enter the wound. It is important, therefore, that no such entrance shall be made through or under the dressing by a track of albuminous fluid extending to infected objects outside. The bloody serous transudate, which takes place from the wound, usually occurs within the first few hours. It is, therefore, wise to change the dressing of large wounds and of wounds where there has been a great deal of secretion, within the first twenty-four hours, because of the possibility of such fluids reaching the surface at some part of the dressing not easily examined by the surgeon. This second dressing will cause no annoyance or harm if it is done with the same attention to antiseptic precautions as is given to the first dressing. The hands of the surgeon and all instruments and dressings must be as carefully free from germs as at the time of the operation. After the second dressing no change is required until the fluid soaks through the gauze in the course of several days; or until pain in the wound or a marked rise in the temperature of the patient shows that some complication has arisen and that the wound is not doing well. The drainage tubes may often be removed at the time of the second dressing, unless suppuration has occurred, which condition, however, we do not look for in aseptic wounds. If suppuration from any cause does exist in a wound, tubes will be required to give free vent to the pus.

In small wounds where there is but little effusion a single dressing is often sufficient, and by the fourth or fifth day the wound will frequently be found cicatrized. This sometimes occurs at the second dressing of large wounds when that dressing is not made for a week or ten days.

The gauze should usually be applied dry, because bacteria are much less liable to multiply in dry situations than in wet ones; hence a wet dressing seems to increase the possibility of microbic infection, even when these dressings have been moistened with antiseptic solutions. Gauze which has been sterilized by baking is not very absorbent. A small amount of glycerine sprinkled upon it before it is baked makes it absorb fluids much more efficiently.

When there is no wound and a poultice is desired to relieve pain it should be made of aseptic or antiseptic gauze, covered with oiled silk or rubber cloth to prevent evaporation. Poultices of flaxseed and similar material are seldom used or desirable.

In some small incised wounds a dressing of collodion, collodion and iodoform, or collodion and boric acid may be used instead of a gauze dressing; for example, after the removal of a small tumor of the face a little collodion mixed with iodoform may be painted over the edges of the wound in such a way as to make an impervious varnish, which keeps the wound free from germs. Sometimes this collodion dressing may be made a little firmer by laying a small portion of sterile gauze or aseptic absorbent cotton upon the wound and saturating it with collodion and iodoform or with collodion alone. Boric acid or corrosive sublimate would probably answer as well as iodoform to mix with the collodion and would be less obnoxious in odor. The mixture is painted upon the part after the catgut sutures have been used. If corrosive sublimate is selected, not more than an eighth or a quarter of a grain should be mixed with a fluid ounce of collodion. Applications containing celloidin have been used in a similar manner. Sawdust, moss, cotton jute and other absorbent articles may be sterilized and used for dressings.

FIG. 58.

Mop, a substitute of the sponge.

Natural, or marine, sponges may be employed to absorb blood during operations, or absorbent gauze, cotton, yarn or wool may be made into artificial sponges. Marine sponges are made sterile by being soaked forty-eight hours in a 15 per cent. solution of hydrochloric acid, rinsed in water, placed in solution of potassium permanganate (gr. xxx to Oj), for a half hour; washed and then placed for four hours in a mixture of sodium hypophosphite ℥x, hydrochloric acid f℥v, water f℥xlviij; washed in sterile water and then stored in a five per cent. solution of carbolic acid. Sterile gauze made into flat pads or clipped into pieces and tied in a square piece of gauze makes a pretty satisfactory and cheap substitute for a sea sponge. Cotton, woolen yarn, or zephyr tied up in gauze, answers the same purpose. These substitutes are more easily made sterile. Most of them are inferior to the marine sponge as an absorbent. The zephyr or yarn sponge is probably the best substitute.

COUNTER-IRRITATION.

When a mild form of counter-irritation is wanted, mustard plasters, tincture of iodine, water of ammonia and similar agents, or dry cups, are applied to the skin; if vesication or blistering is desirable, cantharidal collodion, cantharidal cerate or an iron disk heated by im-

FIG. 59.

Paquelin's thermo-cautery.

mersion in hot water is employed. More powerful revulsive agents are setons, caustic potassa and the red-hot iron. The best form of actual cautery is the thermo-cautery of Paquelin, which consists of a double metal tube with a hollow platinum end through which a current of benzole vapor is blown by compressing a rubber bulb. If the platinum portion is first moderately heated in a lamp, it can be raised to, and maintained at, a red or white heat by keeping a constant current of benzole vapor circulating through it.

This is an exceedingly convenient and manageable instrument. Ordinary cautery or soldering irons, heated in a furnace, answer the same purpose. The electro-cautery is usually inconvenient for the surgeon's use. The pain felt from the cauterization after the patient recovers from anæsthesia can be averted by painting the burned surfaces with undiluted carbolic acid before sensibility is regained. The tissues may be rendered anæsthetic by cocaine, if the surgeon think it desirable to do so.

Counter-irritation is sometimes obtained by thrusting needles into the tissues—a method termed acupuncture. The needles may be arranged in a bundle and propelled by a spring, or may be introduced singly by the fingers of the surgeon. Additional irritation is induced, when necessary, by dipping the points in croton oil.

ABSTRACTION OF BLOOD.

Local abstraction of blood by leeches has been superseded, to a great extent, by multiple punctures and scarifications with a sharp knife, and by wet cupping. In both cases the flow of blood is encouraged by affusions of hot water. General bloodletting is accomplished by opening a vein, usually at the bend of the elbow, or, when a sudden and powerful impression is required, by incising the temporal or radial artery.

When venesection from the arm is to be performed, a bandage is tied around the arm above the elbow, sufficiently tight to prevent the venous return but not firm enough to prevent the downward arterial flow. The veins then become distended. The skin must next be made aseptic, after which the operator, selecting the median cephalic vein because it is not in close relation with the brachial artery, steadies it with thumb and forefinger of his left hand and makes an oblique incision into it by transfixing it with the point of a bistoury. The incision must be a free one to allow the blood to escape in a jet. If the median cephalic vein is not large enough to give a good flow, the median basilic or any one that is prominent may be selected. It must be remembered that the brachial artery lies under the median basilic vein; but if the vein is transfixed laterally with the point of a knife and the incision made from within outward, there is no danger of wounding the artery. The old-fashioned spring lancet is much more dangerous, and is inferior to an ordinary bistoury for such an operation. The vein can be nicely steadied for the incision by passing a small acupressure or harelip pin through the skin and underneath the vessel. This is better than attempting to prevent its slipping away from the bistoury by means of the fingers.

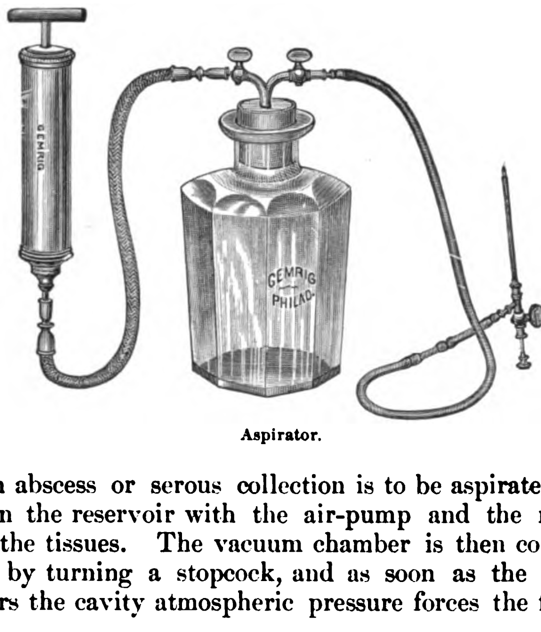
Phlebotomy should be done when the patient is in the semi-recumbent position. Removal of the bandage around the arm will stop the flow of blood, after which an antiseptic pad is placed over the wound and the limb kept comparatively quiet for a day or two.

Arteriotomy is performed by merely cutting down upon the pulsating vessel and making an oblique or transverse incision into its wall. When the amount of bleeding is satisfactory, the vessel should be completely divided and pressure applied; or ligatures may be put upon the ends of the artery.

ASPIRATION AND TAPPING.

Aspiration is the evacuation of fluids by means of a vacuum connected with a hollow needle or a canula, and is advantageous because it prevents the admission of air to the cavity from which the fluid is taken. The aspirator, as perfected by Potain, consists essentially of a reservoir which is connected with an exhausting pump and from which a tube passes to be connected with a hollow needle or a canula and trocar. Stopcocks are provided to prevent the admission of air to the tubes and reservoir and to the cavity to be tapped.

FIG. 60.



Aspirator.

When an abscess or serous collection is to be aspirated, a vacuum is created in the reservoir with the air-pump and the needle introduced into the tissues. The vacuum chamber is then connected with the needle by turning a stopcock, and as soon as the point of the needle enters the cavity atmospheric pressure forces the fluid into the chamber.

When an aspirator is not at hand or when it is desirable to have less pressure than that induced by a vacuum, the principle of the siphon may be utilized by attaching a long tube to a trocar or hollow needle and carrying the end below the level of the patient.

The hypodermatic syringe answers admirably for aspirating small cysts and abscesses, and is also of great value in determining the character of obscure swellings. Motion of the end of the inserted needle will often disclose a cavity, even if the contents are too viscid to escape through the orifice into the glass barrel of the hypodermatic syringe.

When the entrance of air into the cavity to be evacuated is considered unimportant a trocar and canula are employed. In using a trocar the surgeon should make the parts tense by pressure with the fingers of the left hand, select a point free from veins or arteries and plunge the trocar and its surrounding canula through the skin with a sudden rotary thrust. As long as fluid flows freely enough to fill the entire calibre of the canula no air will enter. Such a free flow can be kept up until the sac is nearly empty if pressure is made upon its walls by the surgeon's fingers.

In many instances open aseptic incision is preferable to either aspiration or tapping, which are too often the resources of timid and dilatory surgery. They have, however, a legitimate field, especially in diagnosis.

CHAPTER XI.

PLASTIC OR REPARATIVE SURGERY.

UNDER the term plastic surgery are grouped those operations which have for their object the construction of absent parts, usually from the patient's own tissues, and the reposition or curtailment of parts displaced or deformed by accident or disease.

The suffix plasty is used with a prefix, to indicate the organ formed; thus, rhinoplasty, the reconstruction of a nose; cheiloplasty, the formation of a lip. The term is also employed to show the character of the tissue used; thus, autoplasty, made from the patient's own tissues; osteo-plasty, from bony tissue; heteroplasty, from metal or other foreign bodies.

Plastic surgery is called into play to overcome both congenital and acquired defects and deformities. Its objects, therefore, may be stated to be: To correct deformity due to imperfect fœtal development, as harelip and cleft palate; to replace parts lost or deformed by injury or ulceration, as in closing fistules or clefts, and reconstructing destroyed noses or lips; to relieve or prevent distortion from cicatricial contraction, as after burns and cervical abscesses and the removal of tumors requiring ablation of a large amount of integument; and to curtail organs rendered unseemly by abnormal growth, as in greatly hypertrophied nose or tongue and in large and protruding ears.

The structures used in constructive operations are especially skin and subcutaneous cellular tissue, though mucous membrane, which becomes somewhat like skin when removed to the external surface, muscle, periosteum, and even bone, are at times successfully utilized.

The patient must be in good health, so as to be less likely to have erysipelas or other infections attack the wounds made. When parts destroyed by syphilis are about to be reconstructed, it must be ascertained that no syphilitic manifestations have occurred for several months, since a recurrence of specific ulceration would destroy the success of the plastic operation and perhaps render future measures impossible. The operation should be rigidly aseptic.

The successive steps are: Freshening the edges of the vacuity to be filled and obtaining one or more flaps if such are required; arresting all bleeding, since clots between the raw surfaces may prevent union by first intention; adjusting the parts in proper relation without tension and retaining them in apposition by sutures; closing the gap left by removal of the flaps, if such have been employed; dressing all the wounds antiseptically or aseptically, and preventing motion and frequent handling of the parts.

In complicated reparative procedures it is often necessary to accomplish the desired end by a series of operations, each one of which effects a result which affords a basis for subsequent measures. The time between any two operations may be weeks or months, for the secondary operation should not be undertaken until cicatrization and shrinkage have fully determined the condition gained by the primary one.

In applying the sutures, doubling in of the edges of the flaps can be prevented by introducing the needle obliquely, so that the punctures on the inner surface are further from the margin than the external punctures. This causes the apposed sides to pout out a little at first, but the protrusion disappears with cicatrization; if not, it can be pared away subsequently. A few deeply placed sustaining sutures may be advantageous in maintaining approximation when the plastic operation requires the union of large surfaces extending inward to a considerable depth, or buried sutures may be employed. The strain is thus taken from the superficial sutures, and rapid union of all portions of the wound is encouraged. Silk or gut sutures are sometimes employed between metallic ones to make very accurate apposition of thin edges. Their early removal or absorption, before it is safe to take out the deeper metallic sutures is not disadvantageous.

FIG. 61.

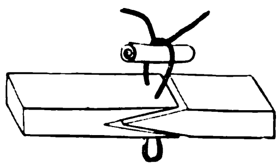


Diagram of tongue-and-groove suture.

The tongue-and-groove suture is often a very excellent method of maintaining apposition in rhinoplasty and operations for exstrophy of the bladder. It consists in slipping the flap margin, which has been bevelled, into a groove made by dissecting up the edge of the skin surrounding the raw surface to be covered. Four raw surfaces are thus apposed. Wire or silk sutures are then applied, as shown in the diagram, and fastened over a perforated disk or a pad. It is easy to adjust the sutures by having both ends armed with needles.

The gap left by the removal of the flap in plastic operations should be closed, if possible, by drawing the integument together; or by inserting a flap taken from the neighboring skin if it can be obtained from a site which will put the cicatricial tension in a less objectionable locality. If neither means is applicable provision should be made for healing by granulation or skin grafting. Often the tissue dissected away to make a raw surface for adhesion of the flap can be utilized for closing the hiatus left by the elevation of that flap.

The various plastic procedures are included in three methods of operating which may be termed respectively the methods by displacement, by interpolation and by retrenchment. Under the displacement method are included operations done by simple approximation and by sliding; under the method of interpolation are classed procedures accomplished by transference and by transplantation.

The relations and characteristics of these modes of operating will be seen by the schedule.

Methods used in Plastic Surgery.

DISPLACEMENT—stretching or sliding of tissues.

I. *Simple approximation after freshening the edges*, as in harelip, vesico-vaginal fistule, and notches caused by tearing out ear-rings.

II. *Sliding into position after transferring tension to adjoining localities*, as in V-shaped incision for ectropium and cicatricial contraction of joints after burns, and in linear incisions to allow stretching of skin to cover large wounds and to relax contracted parts.

INTERPOLATION—borrowing material from adjacent regions, from a limb, or from another person or animal.

I. *Transferring flap with a pedicle.*

[When a flap is borrowed from the arm or hand there is less necessity for rotating and twisting than when it is taken from the neighborhood of the organ to be constructed. The latter is generally the preferred method, however, because less irksome to the patient than the former with its constrained posture.]

A. Putting in place at once.

1. By rotating flap on the pedicle in its own plane through one-fourth or one-half a circle, as in making upper eyelid or nose from forehead.
2. By twisting flap on its pedicle, as in making side of nose from lip.
3. By everting flap entirely so that raw surface is uppermost, as in covering exstrophy of bladder by a scrotal flap.
4. Superimposing one flap on another which has been everted. This is done where a thick wall is desirable, as in closing the front of an exstrophy of the bladder.
5. By jumping, or carrying flap across a bridge of skin, and fixing only its end to the part to be repaired. When the flap has become attached the pedicle is severed.
6. By slipping a flap through a sort of buttonhole ; as in closing an opening in the cheek by a flap turned up from the neck and slipped through a cutaneous incision made along the lower part of the jaw.

B. Putting in place gradually by successive migrations, by same manœuvres as when the flap is placed at once in its permanent position.

This method is not very commonly needed, but may be valuable when there is nothing but cicatricial material in the immediate vicinity of the part to be repaired.

II. *Transplanting without a pedicle.*

a. By carefully suturing or fixing in the gap areas of tissue recently dissected from distant regions, or taken from the lower animals; such as replacing the bone button after trephining, and inserting portions of nerve-trunks in wounded nerves.

b. By skin-grafting with small pieces or large shavings of skin. This is the manœuvre of this class that has been followed by the greatest success. As it lessens cicatricial contraction it may be advantageously used at times in plastic operations that necessarily leave surfaces to heal by granulation. Skin from the frog's abdomen may answer well.

c. By readjusting finger-tips, ears, and noses recently completely severed by injuries.

RETRENCHMENT—removing superfluous material and causing cicatricial contraction.

I. By cutting out elliptical or semi-elliptical pieces of tissue, as in ptosis, cystocele, and prolapse of the rectum.

II. By cutting out triangular or wedge-shaped portions of tissue, as in closing the vaginal aperture, decreasing the size of a lip, ear or nose, and separating webbed fingers.

Retrenchment is often valuable because it decreases the relative size of features ; thus, if a nose has been partially lost the upper lip appears too large, and its diminution will render the deficient nose less noticeable. When material is taken from the prominent feature, and especially if added to the other, the normal proportion is nearly reëstablished and deformity greatly concealed.

To secure success in plastic devices certain precautions should be observed. In the first place, the patient should be in good general health and free from irritation or inflammation about the seat of the proposed operation. In transferring or transplanting it is desirable to select normal integument for the flap, because cicatricial tissue is almost sure to slough if dissected from the subjacent structures. Approximation and sliding operations, however, may be successfully performed with cicatricial tissue, because these methods interfere very little with the vascular supply from beneath.

All flaps should be made large, thick, and with a good vascular supply through a wide pedicle. As soon as the flap is dissected loose, it shrinks and becomes paler and cooler. Hence, it should consist of skin and plenty of subcutaneous tissue, because thick flaps contract less and are more vascular. It should be made about one-third larger in area than the space to be filled and should be allowed to cool as little as possible by being placed in position as quickly as practicable. It is preferable to freshen the edges of the part to be repaired before making the flap. This is especially true in transplanting flaps.

It is sometimes well to cut a diagram of the flap out of paper or cloth, and mark a similar outline upon the skin with ink before beginning the dissection of the flap. It must be remembered that when the flap is formed it contracts very much. At the same time the gap from which it was taken appears larger than is really the fact, because of retraction of the margins of the wound. Nevertheless, it is well to make the flap at least one-third larger and much thicker than the space into which it is to be interpolated would seem to require, since the flap shrinks at once and may undergo contraction and absorption from cicatricial changes for many weeks after union has occurred. Any redundancy can be readily removed when lapse of time proves it actually to exist.

To guard against imperfect nutrition and consequent sloughing of the flap, it is well to make it with its long axis corresponding with the direction of arterial supply, and its base presenting toward the cardiac portion of the arteries. Where there is very free anastomosis, as upon the face, this rule may be disregarded to a considerable extent. The calibre of the supplying vessels must not be interfered with by too much twisting or tension of the pedicle, which must always be wide and thick. Injurious tension on the pedicle can frequently be prevented by cutting a pedicle with curved margins, which will allow increased stretching without occluding the vessels. Skin free from hairs should be selected when possible, unless it is desired to make eyebrows or eyelids with lashes.

A gap to be filled by interpolation and parts to be united by approximation should have their surfaces prepared by such free incisions as will give abundant areas of contact for union by first intention. It is an error to pare away so little tissue that only a thin raw edge is obtained. It is necessary to have broad surfaces of contact to make successful plastic operations, and these must be obtained even at the sacrifice of considerable material. Operations for harelip and torn perineum are often imperfect because of neglect of this rule.

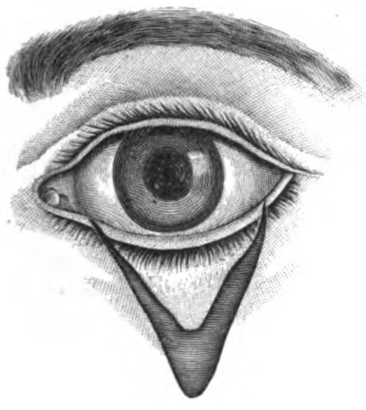
When all hemorrhage from the flaps and freshened edges has been controlled, accurate approximation is to be made by numerous sutures, which should hold the parts merely in contact, allowing them to lie loosely and without tension. It is important in constructing new noses and other features to be satisfied at first with obtaining a bulky semblance of the organ and not to endeavor to trim down the structures to an accurate conformation, because it is impossible to estimate the amount and character of cicatricial shrinkage which will occur.

Exudation and organization of lymph sufficient to hold the parts together with moderate firmness occurs in from two to three days; then some or all of the sutures may usually be removed. Aseptic sutures cause so little local irritation that they may be allowed to remain as long as there is any danger of disruption of the adhering parts. Absolute antisepsis adds greatly to the success of plastic operations, and causes healing with the minimum degree of scarring.

In transplanting without a pedicle, it is of the utmost importance that the tissues be kept absolutely aseptic and warm. Disks of bone, pieces of nerve, skin shavings, and such tissues, when to be thus used, should be kept warm in sterilized salt solution (0.6 per cent.) of about 105° F. If antiseptic solutions are employed, they should be weak and unirritating.

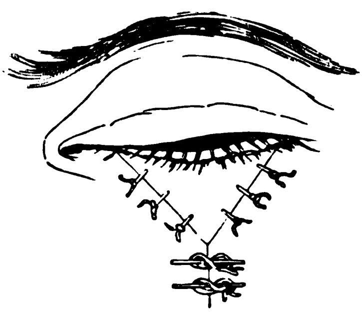
The success following well devised and carefully performed plastic operations is very gratifying. It is especially so in cosmetic opera-

FIG. 62.



Plastic operation by V-shaped flap to correct eversion of lower eyelid.

FIG. 63.

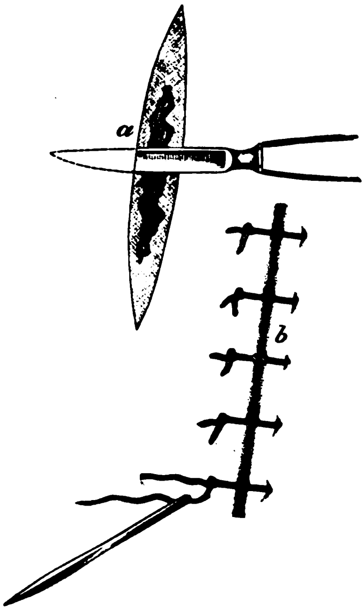


Plastic operation by V-shaped flap. Sutures applied. (STELLWAG.)

tions, since the improved appearance, though not equal to the normal condition, is of great solace to the disfigured patient. It is always a long time before the cicatrices become white and soft; therefore the full result is not apparent until many months have elapsed.

The disabilities due to fistules, ruptured perineum, and many other conditions, can often be entirely removed by plastic surgery. If gangrene of the flap does not occur before the end of the fourth day it is not likely to take place, and the integrity of the operation is pretty well assured. If, however, during the first three or four days the flap becomes grayish and pulpy and shows a loosened cuticle, or, on the other hand, if it assumes a dry and withered appearance, it is evident that destruction by sloughing of more or less tissue is supervening. The surgeon should, nevertheless, leave the parts in position, keep them warm, and disturb the dressings as little as possible, because the gangrene may involve only the edges or the superficial layers of the flaps.

FIG. 64.



Operation for depressed scar. *a* shows lines of incision around depressed scar, and knife separating skin from underlying tissues. *b.* Edges sutured after being drawn to middle line over depressed tissues which have been made raw by scraping.

To illustrate the manner of doing plastic operations a few general methods will be described. As every case has peculiarities of its own, the illustrations are given merely as types which will prove suggestive.

Harelip, as will be shown in another part of this treatise, is usually remedied by paring the edges of the cleft and approximating the freshened surfaces. Ectropium, or eversion of the lower eyelid from cicatricial contraction, is greatly improved by making a V-shaped incision downward, with its base embracing the everted section of the lid, and dissecting the tense structures from the subjacent muscles so that the V-shaped area of the skin can be slid upward until the lid assumes its natural position. The gaping wound left below and laterally can usually be closed by stretching the skin or by interpolating flaps. This principle of relieving tension can be utilized in many regions after deformity from burns. The point of the V must always be in the line of greatest tension.

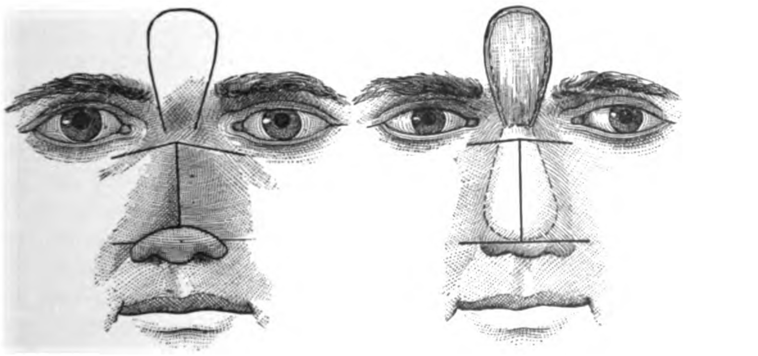
Depressed and irregular cicatrices, such as occur in the neck after chronic suppuration of lymphatic glands, can be rendered more sightly by carrying an elliptical incision around them, freeing the integument laterally, and drawing the under-cut skin over the depression, which has previously been made raw by abrasion. It has been proposed by Mr. Adams to cut loose the deep attachments of such scars with a tenotome, and then to keep the scar tissue raised for a few days by pins inserted beneath. Elevated scars can be excised as tumors, though the redundancy sometimes returns.

Plastic operations for reconstructing the nose may be made by transferring flaps from the forehead, or from the arm as suggested by Taliacotius. The septum, or at least the columna, can be well made out of a piece cut from the entire thickness of the upper lip. Portions of the nose may be restored by flaps from the cheeks or upper lip. It is well to remember that taking portions of the lip away gives a flattened nose a more marked prominence; hence, two indications are fulfilled by using labial flaps for rhinoplastic procedures. The parts may be kept in place by transfixing the organ and the septum with pins, or tubes or plugs may be placed in the nostrils for a few days. When the bridge is very much shrunken, flaps from the forehead and cheeks may be superposed to give thickness. The lower lip can be repaired by flaps from the chin or cheeks; or from the upper lip if the loss of substance is near the angle of the mouth. The plastic operations by which crooked noses

FIG. 65.

Outline of flap taken from upper lip for reconstruction of ala of nose.

FIG. 66.



a

Shows outline of flaps for making the nasal bridge higher. (STIMSON.)

b

Shows the frontal flap turned down under the lateral flaps. The raw surface on forehead is left to granulate or covered with skin shavings. (STIMSON.)

and other deformed features are improved vary with the character of the distortion.[1]

[1] See Author's monograph on the Cure of Crooked and Otherwise Deformed Noses.

PART II.

SPECIAL SURGICAL PATHOLOGY OR PRACTICE OF SURGERY.

CHAPTER XII.

SURGERY OF SPECIAL STRUCTURES.

DISEASES AND INJURIES OF THE SKIN AND ITS APPENDAGES AND OF THE SUBCUTANEOUS TISSUE.

WART OR VERRUCA.

Definition.—A wart is a circumscribed hypertrophy of the cutaneous papillæ.

Pathology.—It is in fact a papilloma, and may have a smooth or rough surface according to the arrangement of epithelium covering the enlarged papillæ. The histology of papilloma is discussed in the chapter on tumors. Warts may be quite hard and horny, as in the common form found on the hands; moderately soft, as seen upon the backs of old persons; or very soft and friable, as the moist verrucous vegetations situated upon the anal and genital muco-cutaneous surfaces. The last are not syphilitic, but depend upon an irritation due to muco-purulent discharges of any kind. The discharge may be venereal, but this has nothing to do with its causing the warts. The growths are very vascular and may be the source of hemorrhages. The fetid oder is due to decomposition of the secretions. The other forms are not very vascular and are usually darker than the adjacent skin. Warts on mucous membranes often bleed freely and in the bladder and urethra may cause obstruction to urination. A warty growth occurs on the hands of those engaged in making post-mortem examinations, as a result of infection, it is believed, with the tubercle bacillus. The horny wart at times disappears spontaneously, hence the reputation of many household applications.

Treatment.—Excision with scissors or curette or repeated cauterization with nitric acid, chromic acid, glacial acetic acid, or ethylate of sodium is the best treatment. A mixture of salicylic acid (gr. xxx), extract of cannabis indica (gr. x), and collodion (℥j) is recommended to be applied daily. After a few days the devitalized tissue should be scraped off. Ligation may be employed if the wart is pedunculated.

The soft warts, often improperly called venereal vegetations, may be treated in the same way, though, when large, provision against hemorrhage must be made by the surgeon being ready to apply pressure or astringents. Powdered tannic acid is a good styptic application. The actual cautery may be used for removing very large masses of these vegetations.

CORN OR CLAVUS.

Definition.—A corn is a small, circumscribed, cone-shaped callosity, due to hypertrophy of the epidermis, usually situated upon the feet or hands, and having its apex pressing upon the papillary layer of the skin.

Pathology.—A corn is originally a papilloma, but as the epidermis thickens it is pressed into the underlying tissues like a nail driven into a board and the papillæ finally atrophy. The cause of corns is pressure, of misfitting shoes or from some instrument used in manual labor, which induces chronic inflammatory hyperplasia. The pain is due to pressure on the delicate papillary layer of the true skin, between which and the callosity a small bursa is sometimes developed. If active inflammation and suppuration occur beneath the corn, the pain is intense, because the pus cannot escape through the thickened epidermis. When moisture is constantly present, as between the toes, the corn is macerated and is called a soft corn. Pathologically hard and soft corns are the same. A hard corn is occasionally found under the toenail.

Treatment.—The treatment consists in removing pressure by wearing broad-sole shoes, straight along the inner border, with low heels. The hardened epidermis may be scraped or cut away. This is best done perhaps after softening the epidermis by soaking in hot water, by poultices, or by applications of alkaline solutions, such as sodium carbonate (gr. x to f℥j). In using strong alkalies care should be exercised not to touch surrounding parts. The corn may be surrounded with a ring of wax. Nitric acid applied to the corn devitalizes it and permits it to be gradually cut away. As the removal of the horny exterior relieves the pressure on the true skin, pain will be mitigated by these measures. A thick pad or plaster with a central perforation to admit the callosity will palliate pain in the same way. The salicylic acid application given for the treatment of warts is often beneficial in cases of corns. Strong applications of nitrate of silver will often relieve the pain of either hard or soft corns. Inflamed corns require elevation of the foot and moist antiseptic dressings. Gauze moistened with an antiseptic solution and covered with rubber tissue, oiled silk or waxed paper is an antiseptic poultice and is valuable. Soft corns are benefited by dusting tannic acid or oxide of zinc upon them. These modes of treatment are only palliative. Excision of the horny cone-shaped mass by careful dissection or by cutting out an elliptical portion of tissue down to the superficial fascia is the radical treatment. If abscess occurs under the corn prompt incision will relieve pain and probably effect a permanent cure. Operations on corns must be aseptic.

It must be remembered that the peripheral circulation in the feet of old and infirm persons is not vigorous; hence, slight operative interference may be followed by gangrene in such patients.

BOIL OR FURUNCLE.

Definition.—A boil is a circumscribed, painful and reddish elevation, due to a localized pyogenic infection of the skin and cellular tissue, usually terminating in central suppuration and sloughing. The infection usually begins in a hair follicle or sebaceous gland.

Pathology.—Furuncles occur singly or scattered over the surface in crops, showing a predilection for the back, axillæ, perineum, buttocks, legs and face. They are at times associated with diabetes and other diathetic conditions. The golden and white staphylococci are the usual cause.

There seem to be two classes of boils: Those primarily superficial, due to local irritation about a hair follicle or sebaceous gland, as when the hands are exposed to irritating fluids in dissecting; and those which begin deeply on account of a localized depressed state of resistance in the cellular elements of the skin and subcutaneous tissue. Boils occur among those of depraved physical condition and in those of robust and vigorous health. Sea air has a tendency to induce their appearance in many people. The cause of furuncle is a mycotic one. The cocci in many instances enter the sebaceous duct or hair follicle from the surface of the skin. In other cases, probably, they are in the blood and become localized at a point where the tissues have least resisting power. This explains the location of boils and their occurrence in the healthy.

Symptoms.—The sharp stinging pain felt upon accidental pressure may first call attention to a small, red pimple, which gradually enlarges, becomes hard and purplish and is surrounded by a red areola. The pain becomes throbbing and constant. About the fifth day a yellowish spot at the apex of the elevation proclaims the occurrence of suppuration and in a day or two longer a cylindrical greenish-yellow core or slough of cellular tissue is discharged by the suppurative process, leaving a deep, punched-out looking cavity. This is gradually filled by granulations, the adjacent exudation of lymph is absorbed so that the tissues around regain their normal softness, and cicatrization is finally accomplished.

The course of a moderate size boil, that is, one which with its areola is say 1½ inches in diameter, is run in eight or ten days. Pain subsides as soon as the slough or core is discharged. Smaller boils or pimples frequently appear in the same locality some days after the disappearance of the primary boil. Lymphatic glandular involvement is common during the height of the inflammation. Occasionally the inflammation terminates by resolution, and as no discharge takes place such furuncles are termed blind boils. Severe boils usually cause some fever.

The diagnosis between furuncle and its congener, carbuncle, is made by the single point of suppuration, the circular and conical shape, the smaller size, the tenderness on pressure, which does not exist in carbuncle, and the usual association with other boils.

Treatment.—It is sometimes possible to abort furuncle by early applications of tincture of iodine, nitrate of silver blisters or undiluted carbolic acid, or by puncture with a red-hot needle. Carbolic acid has been injected into the forming boil with alleged advantage.

Pain is quieted and suppuration probably hastened by wet antiseptic dressings covered with rubber tissue or oiled silk so as to constitute poultices, and by anodyne applications, of which belladonna plaster or ichthyol and extract of belladonna in equal parts are examples; but these are far inferior to early and free incision under local anæsthesia, which relieves tension and pain, depletes the engorged tissues and allows rapid extrusion of the slough. It is the effort of the dead cellular tissue to escape that, in the majority of instances, causes much of the pain.

Scraping the diseased tissue out with the curette or excising it while the patient is etherized may hasten cure. Dry antiseptic dressings should be used after the slough has been removed or discharged.

The treatment of the condition giving rise to a succession of boils (furunculosis) is difficult, because a determination of the underlying causes is often impossible. Impoverished blood demands iron, quinine, mineral acids, cod-liver oil, malt and alcoholic beverages and pure air. Arsenic (gr. $\frac{1}{20}$ to $\frac{1}{15}$), hyposulphite of sodium (ʒss to ʒj), sulphide of calcium (gr. ij to gr. iv), and solution of potassa (♏xv to ♏xxx) have some reputation as antagonists to the furunculous diathesis, and one or other may be administered three or four times daily. Eliminative measures, such as the Turkish bath, should be employed; and any gastric, intestinal or genital derangement corrected. Thorough cleansing of the skin with soap, aided perhaps by turpentine, ether and non-poisonous antiseptics, seems most philosophical. The occasional association of furunculous inflammations with syphilis, septicæmia, nephritis and diabetes must not be forgotten.

CARBUNCLE.

Definition.—Carbuncle is a more or less localized, deeply-seated suppurative inflammation of the skin and cellular tissue, attended by a hard, very painful, flattened swelling and asthenic symptoms. It is a similar infection to the furuncle, but the infection probably occurs at more than one spot. The infection is said by Warren to travel through the columns of fatty tissue in the skin.

Pathology.—This section does not discuss the local lesion of malignant pustule, or anthrax, which is spoken of in an earlier chapter.

Unfortunately the term anthrax is sometimes applied to carbuncle. Carbuncle is due to pyogenic organisms. There is a great clinical similarity between furuncle and the more severe disease, carbuncle.

Symptoms.—Carbuncle is usually single and is most frequent in elderly people and in those of impaired health; it is often associated with diabetes and chronic renal disease. A chill may be the premonition of the carbuncle, which appears as a painful red spot, perhaps surmounted by a vesicle. The posterior part of the trunk and neck is its favorite locality. A firm, flattened, dusky red swelling, evidently involving a considerable depth of tissue and exceedingly painful, though the pain is not much increased by pressure, soon shows that a mere furuncle is not to be expected. The brawny inflammation is localized; though it evinces some tendency to spread, which is quite unlike the sharply-defined furunculous affection.

The feeling of tension and the throbbing pain are very marked, the muscles in the vicinity become stiff from pain, and glandular swelling is quite prominent. After the lapse of ten days or two weeks the skin softens, first perhaps becoming vascular, and is riddled by gangrenous openings through which sloughing cellular tissue and ichorous pus is discharged. Tough fibrous cords or sloughs are extruded and the continuous destruction of the skin goes on until there is left a deep excavated ulcer with irregular indurated margins. The diameter of a carbuncle varies from one to six inches and it may extend down to the underlying muscular tissue, but rarely goes beyond. The duration of the disease is a month or six weeks, though this period may be greatly lengthened by indolent cicatrization of the ulceration. The prognosis is exceedingly unfavorable when the carbuncle is large and situated upon the head or neck, especially if the patient is old or infirm.

The constitutional symptoms are asthenic, and are of course more grave if the sloughing causes profuse hemorrhage.

Treatment.—The internal treatment, therefore, comprises supportive and anodyne measures, for even preliminary depletion would be inadvisable. Quinia (gr. x–xv daily), dried sulphate of iron (gr. iij–vj daily), and milk punch (whiskey, f℥j–v daily) represent the character of agents to be employed in severe cases.

Ice has been recommended as a local application in the early stage to cause the disease to abort. Blisters are sometimes employed with a similar object, and are also sometimes applied around the carbuncle to prevent extension of the inflammation by causing abundant effusion of serum. Circular compression made by plasters with a central hole over the focus of inflammation or by a cupping glass has advocates, who think that the progress of the carbuncle is limited or its severity lessened by this device. When it is evident that arrest cannot be accomplished, moist antiseptic dressings, covered with rubber cloth to prevent evaporation, are the proper applications to hasten suppuration and the discharge of the gangrenous tissue. The treatment by incision, or by curetting or excision is in accord with the pathology of the disease. The earlier the sloughing and suppurating mass is removed the better for the patient. Incision aids in the spontaneous extrusion; curetting or excision is a more radical and quicker method. Judgment is required on the part of the surgeon to determine which is best. Subcutaneous injection of undiluted carbolic acid may be valuable in antagonizing the infecting agent. Thorough cleansing with sublimate solution (1 : 1000) of the cavities under the perforated and sieve-like integument is judicious. Cicatrization of the resulting ulcer is accomplished as in ordinary cases of ulceration after gangrene. Stimulating ointments or lotions and skin-grafting may be required. The cicatricial contraction is usually less than would seem probable from the extent of the ulceration. This is due to the fact that the thickened and indurated edges give the ulcer a factitious depth.

Capillary hemorrhage may be pretty free after operative treatment but will relieve engorgement; it is not likely to do harm, even in the asthenic condition present, unless a vessel of considerable size is wounded. Pressure with compresses and bandages will control the bleeding, if it is sufficient to require treatment. Applications of very hot water have a styptic influence. The diseased structures may be destroyed without hemorrhage by the application of caustic potassa, which cauterizes and causes chemical destruction of the skin and subcutaneous tissue. Cauterization with a hot iron might be employed.

LUPUS.

Definition.—Lupus, or lupus vulgaris, is a chronic cellular infiltration of the skin, exhibiting itself as irregular, nodular, reddish-brown patches of granulation tissue, which may or may not proceed to destructive ulceration but which usually leave disfiguring cicatrices. Lupus, as previously stated, is a form of cutaneous tuberculosis, due to the tubercle bacillus.

Pathology.—The disease has an important surgical bearing, because there is a liability of its being confounded with syphilitic and epitheliomatous ulceration. The superficial form of lupus, erythematous lupus as it is called, is a different affection from ulcerating lupus. It is a skin disease located especially in the sebaceous glands and does not interest the surgeon.

Symptoms.—Lupus begins as a group of small, hardened, reddish-brown points in the skin which increase until they become papules or tubercles. The patch may enlarge or several small patches may coalesce. There is no pain. Cure may occur at this stage by absorption of the nodules, leaving an atrophic kind of scar; or destructive ulceration of the affected skin may take place. Such ulceration is exceedingly chronic and is characterized by accumulation of crusts, slight discharge, slow involvement and destruction of underlying cartilaginous structures, and contracting cicatrices which cause marked deformity. Ulcerating lupus usually attacks the face in the neighborhood of the mouth, nose, and ears, but may appear upon other parts of the body, especially the fingers. There may be slight pain in the later stages of the disease.

The causation of lupus is the tubercle bacillus. The general health may be good. It occurs in children chiefly, and is rare in this country, except among the foreign element of our population.

Lupus must be carefully differentiated from syphilitic ulcers and from epithelioma, which shows a predilection to attack similar regions of the face.

Ulceration from Lupus.	Syphilitic Ulceration.
Comparatively superficial.	Quite deep, often excavated.
Area rather small.	Area may be quite large.
Ulceration usually limited to one region.	Ulcers often disseminated over surface of body.
Increases by coalescing of adjacent patches.	Ulcers remain separate.
Border illy defined.	Border sharply defined.
Discharge slight and not fetid.	Discharge abundant and foul.
Scabs thin and reddish-brown.	Scabs thick, often greenish.
Progress slow, takes months to develop.	Progress more rapid, a large ulcer will develop in a few weeks.
Scars hard, yellowish, and have great tendency to contract.	Scars soft, whitish, have little contractile tendency.
No other lesions.	Lesions of bones, glands, etc.
Not improved by medicinal treatment.	Cured by mercury and potassium iodide in full doses.

Ulceration from Lupus.	Epitheliomatous Ulceration
Usually upon face, may attack other parts.	Situated usually at muco-cutaneous junctions.
Induration not very marked and is diffuse.	Induration well marked and circumscribed.
No pain.	Pain may be quite severe.
Ulceration begins at several points of the patch.	Ulceration begins at one point and spreads.
Destruction of tissue usually not very great.	Destruction and loss of substance great.
No hard and everted border ever present.	Indurated and everted border a characteristic.
Ulcer usually rather superficial, with base of small, red granulations.	Ulcer deep, with uneven base and foul discharge.
Slow in its progress.	More rapid in its progress.
Occurs especially in children.	Occurs especially in adults and aged.

It will be seen that the clinical history of the ulcerative stages of these affections—lupus, syphilis, and epithelioma—is very different.

Treatment.—This intractable affection requires active and prolonged treatment. Good nutritious food, general hygienic measures and constitutional and local remedies are demanded.

Cod-liver oil (f℥ij to f℥ss), iodide of potassium (gr. v–x), and syrup of iodide of iron (f℥ss to f℥j) are probably the most valuable internal remedies, and should be tested before severe local applications are adopted. Arsenic is a constitutional remedy worthy of trial. Caustics are necessary as topical remedies, unless absorption of the infiltration occurs in the early stages of the disease. Absorption may possibly be assisted at this time by painting with tincture of iodine, undiluted or mixed with glycerin, or by applying tar or some mercurial ointment, or using iodoform powder. Later it becomes necessary to use caustics to destroy the diseased tissue. Nitrate of silver is highly recommended by Hebra, but it is not as powerful as other agents, which, however, in some instances destroy the healthy as well as the unhealthy skin. Potassa and lime are painful applications, and have a very destructive tendency; hence, the surrounding parts must be protected by pieces of plaster or cloth, and some weak acid should be at hand to neutralize the alkali if necessary. Arsenious acid (gr. xx–xxx to ℥j of ointment) is painful, but acts only on affected structures. Pyrogallic acid ointment (ʒj to ℥j) is painless, and acts very slightly on the normal tissue. Chromic acid, to which a few drops of water have been added, applied with a brush, is my favorite for such purposes. Solution of ethylate of sodium may be used and is efficacious as a destroyer of abnormal structures. Scraping away the diseased skin with a sharp-edged scoop or curette and applying subsequently caustics, such as zinc chloride or one of those mentioned above, is a proper and often efficient method of treatment. The thermo-cautery or galvanic cautery, is an available method of obtaining a similar object. Excision of the ulcer may sometimes be justifiable when the gap can be closed by a plastic procedure. Multiple incisions are said to be beneficial by arousing traumatic inflammation.

Koch's tuberculin used hypodermically has had some reputation as a remedy.

ARABIAN ELEPHANTIASIS.

Definition.—Arabian elephantiasis, or Barbadoes leg, is a local disease, characterized by chronic hypertrophy of the skin and underlying cellular tissue, giving rise to discoloration, thickening, induration, warty growths and deformity.

FIG. 67.

Arabian elephantiasis.

It is essentially different from Grecian elephantiasis, or leprosy, which is due to a vegetable parasite, the bacillus of leprosy. Leprosy does not belong to the domain of surgery.

Symptoms.—The first step in the disease is a local inflammation of an erysipelatous kind, accompanied by involvement of the lymphatic vessels and glands. This attack subsides, leaving the part, usually a leg or the genitals, somewhat enlarged and œdematous. Recurrence of such inflammatory conditions takes place at intervals, leaving in each instance more thickening and deformity. In the course of a year or two the hypertrophied skin and subcutaneous tissue cause the part to assume enormous proportions. The thickened, hardened skin hangs in irregular folds, and the surface often becomes eczematous. From the accompanying fissures and ulcers bloody serum exudes and causes scabs to form. The surface may be smooth and eczematous, or very rough, from the development of papillary enlargements or warts. The enlarged region is usually darker than natural and greatly misshapen. The decomposing secretions, if abundant, give rise to fetor. The great weight is a source of inconvenience, and pain or itching may at times add to the patient's discomfort. During the active inflammatory periods fever is present, and the local symptoms are more severe.

Arabian elephantiasis is not common in the United States, but is frequently seen in the West Indies, South America and other tropical countries. A condition resembling, if not identical with it, is not infrequently seen associated with chronic leg ulcer. The cause is obscure, but is probably connected with the lymphatic system. The disease is attributed by some investigators to occlusion of the lymphatic vessels by an animal parasite, the filaria. It is found among the poor, especially in adults, and is neither hereditary nor contagious. It is always chronic in its progress, and does not tend to a fatal issue. One of the legs, the scrotum, penis or vulva is the usual situation of the disease.

Pathologically it consists of an hypertrophy of the skin and areolar tissue, with enlarged blood vessels and dilated lymphatics. In very protracted cases muscular atrophy and degeneration, and thickening of the bones take place.

Treatment.—It should be treated in the acute inflammatory stages by rest in the horizontal posture, and by cold water and anodyne applications. When these symptoms have abated inunction with mercurial ointment, painting with tincture of iodine and the application of the elastic bandage are the best methods of inducing absorption and diminution of bulk. Continuous elevation of the limb should always form an important factor of the treatment. The rapid decrease in size under elevation and frequent readjustment of the elastic bandage is often a matter of astonishment, but the hypertrophy is liable to return when the patient regains the erect position. The eczematous complication is often benefited by a paste of salicylic acid (ʒij), carbolic acid (ʒij), zinc oxide (℥ss), mucilage (ʒxx), and glycerin (ʒxx).

Ligation of the main arterial trunk has been followed by apparent amelioration. Amputation may, at times, be justifiable.

BURNS.

Definition.—Burns are injuries produced by the application to the surface of heat sufficient to cause inflammation or destroy the vitality of the tissues. Scalds are burns due to contact with hot fluids.

Pathology.—Sunburn is a dermatitis, or inflammation of the skin, resembling that caused by heat, but due to exposure to the sun's rays. Such inflammation is prevented by protecting the skin with dark veils or clothing, and, when caused, is to be treated as an ordinary burn by cooling and anodyne applications. Injuries due to the chemical action of strong acids and alkalies are improperly called burns, though the effects are similar to those caused by heat.

Injuries from chemicals should be treated locally at first by weak alkaline or acid solutions to neutralize respectively the acid or alkali doing the mischief. The subsequent treatment is identical with that of burns. Lightning and contact with electric light wires sometimes causes burns, in addition to the nervous phenomena due to the electric current. The burns are to be treated as other burns. Prolonged exposure to the X-rays for taking skiagraphs or when working with the apparatus causes a dermatitis which is often called a burn. It is apparently due to electrical irritation of the skin and is prevented, it is said, by interposing an aluminum plate between the Crookes's tube and the skin. The inflammation and sloughing may be severe, and require treatment similar to that used for such conditions from other causes.

The local effects of contact with heat necessarily depend upon the temperature and the time of exposure. There are practically only three classes of burns: 1. Erythematous burns, or those so superficial in their influence that nothing further than hyperæmia and slight serous effusion into the skin occur. 2. Vesicating burns, which do a greater degree of damage, and are followed by vesicles resulting from an effusion of serum between the derma and epidermis. 3. Necrotic burns, which are followed by eschars, because the upper portion of the derma, or, perhaps, the whole thickness of the skin, or the muscles, fasciæ and bones are devitalized.

Symptoms.—In erythematous burns the skin is red, painful, and swollen; but these inflammatory symptoms subside in a few hours or days, and no cicatrix is left, even when desquamation takes place.

Vesicating burns promptly show vesicles or blebs filled with clear or blood-stained serum, and are the seat of active inflammation causing severe pain. The serum escapes by rupture of the vesicle or is absorbed, and a new epidermis is formed in the course of a week. If the old cuticle is early cast off or removed by friction, so that the cutis is exposed to irritation and to pus infection from pyogenic germs, in the air or on the clothing, great pain and superficial suppuration result. No cicatrix follows vesicating burns, though a discolored stain, similar to that seen after blistering with cantharides, may remain for a time.

Necrotic burns destroy the vitality of the tissues; therefore the eschars, when separated, leave ulcerated surfaces to heal by granulation. The pain of such burns is intense, if shock does not prevent its being felt. The dirty brown color of such burns is characteristic, but it is impossible to tell how deep the destruction has been until the sloughs separate. If the parts are kept aseptic there will be no suppuration under the eschars, which will drop off when the parts are healed. Cicatricial contraction and deformity are usually great. The cicatrices may assume a very rough and irregular appearance from abnormal development of fibrous tissue. Keloid and malignant degenerations at times attack such scars.

The constitutional effects of burns vary with the amount of surface involved and the degree of burning. An erythematous burn of a large surface will cause more dangerous symptoms than a deeper burn of limited area. When burns are severe enough to cause constitutional manifestations, these symptoms are exhibited in three stages: 1, that of shock; 2, that of imflammatory fever; 3, that of exhaustion.

The stage of shock is accompanied by feeble, frequent pulse, great depression of the nervous system, lowered temperature, chills, nausea, restlessness and perhaps delirium. Pain is not very prominent if shock is great. Greater shock attends burns of the trunk than of the limbs. Congestion of the brain, of the thoracic and abdominal organs occurs, and the patient often dies in twelve or twenty-four hours without showing any reaction from the collapsed state. The degree of shock caused in children and the aged is greater than in the middle period of life.

The stage of inflammatory fever, which lasts from the second to about the fourteenth day, is characterized by increased bodily temperature, disordered secretions, great thirst, and often by inflammation of the internal organs, such as cerebral meningitis, bronchitis, pleuropneumonia, nephritis and enteritis. It is due largely, if not entirely, to infection of the burned surfaces. Ulceration of the duodenum, sometimes proceeding to perforation, is a remarkable lesion occurring at times during this stage. It is to be suspected if hypogastric pain, vomiting of blood, abdominal tenderness, and bloody stools are observed. Its occurrence has been attributed to the unusual vicarious action thrown upon the duodenal glands, and also to a possible embolic plugging of the vessels of the intestine. Neither of these theories has been proved. Duodenal ulcer, if it occurs, is developed, as a rule, about the seventh or tenth day of the inflammatory stage. In this stage albuminuria varying with the temperature and a small vesicular eruption thickly scattered over the trunk, have been noticed.

The stage of exhaustion is due to the depression, caused by the inflammatory irritation, and by the profuse suppuration often accompanying the detachment of the eschars and the cicatrization of the resulting ulcers. Infection usually occurs before the surgeon reaches the burned patient. There is great debility but no pain unless the ulcers are subjected to pressure or rudely handled in reapplying dressings. Amyloid visceral changes may possibly result from prolonged suppuration. Erysipelas and tetanus occur at times from infection.

Few cases of severe burn, and superficial burns must be considered severe if one-third of the surface be injured, survive until the suppurative stage begins. The majority die of shock within the first thirty-six hours. Many others die during the inflammatory stage from asthenia, sepsis, and lesions of the internal organs. Inflammatory œdema of the glottis from inhalation of steam may be a cause of death; but flame itself is not inhaled, as is supposed by the laity. In most instances where incinerated bodies are found in burned buildings, asphyxia has occurred from the gaseous products of combustion before the tissues have been subjected to the action of fire. Spontaneous combustion of the human body is impossible.

Treatment.—The constitutional treatment of burns should be directed to the relief of shock and pain, the prevention of secondary visceral inflammations and the support of the general powers of the system; while topical remedies should be employed to relieve pain, moderate local inflammation, prevent infection, hasten cicatrization, and prevent contractile deformity.

Reaction from shock should be sought for by the application of heat and the administration of stimulants and concentrated food in small quantities. The hot bath (100° F.) may be available to raise temperature and relieve pain. The addition of sodium bicarbonate to the bath might be beneficial. Pain is to be relieved in severe cases by an immediate hypodermic injection of a quarter or half grain of morphia, or by the inhalation of an anæsthetic. Anæsthesia is often desirable before attempts are made to remove the clothing; small doses of morphia will then be effective in prolonging the freedom from pain. In the later stages of burns laxatives, diuretics, revulsives and other antiphlogistic measures may be demanded to prevent internal inflammation and to substitute the derivative action of the skin. The stage of exhaustion preëminently requires tonics; and on this account actively depressing remedies are to be avoided in the inflammatory stage.

The local treatment varies with the degree of burn. Erythematous burns, if limited in extent, are relieved of pain by solution of sodium bicarbonate, cold water, blotting paper soaked with molasses, lead water and laudanum, and in fact by almost any dressing that excludes air and constringes the dilated capillaries. Menthol might, from its great refrigerant action, be exceedingly soothing. The application of cold to large erythematous burns is ill-advised because of the tendency to depress the surface temperature and congest the internal organs. A household remedy for small burns of this degree is to hold the part near a hot fire and thus apply dry heat. Zinc oxide ointment spread on muslin, zinc oxide powder or wheat flour dusted over the burned surface are recommended highly.

The proper treatment for vesicating burns is to puncture the blebs carefully and allow the serum to escape, so as to prevent the epidermis being rudely rubbed off. This epidermis makes the best possible protection from irritation and septic infection. Antiseptic gauze or cotton or some form of dry sterilized dressing should then be applied.

Salicylic acid cotton does well. Sublimate cotton would be apt to poison the patient if used for extensive burns. The dressing should not be changed oftener than once in two or three days, because detachment of loosened cuticle and exposure to air increase pain, and germ infection is likely to occur. Powders such as zinc oxide, boric acid and perhaps sugar which is an antiseptic, form with the exuded fluids a coating which serves as a good protection from atmospheric influences, and should not be removed until detached spontaneously. Powders are probably better than ointments and prevent septic contamination better. Iodoform powder is liable to give rise to toxic symptoms when used in large quantity. Boric and salicylic acids are harmless, or practically so. Much harm is often done by tearing off the epidermis when removing underclothing. It is better, perhaps, to leave the soiled shirt or drawers upon the body and saturate it with carbolized castor oil (1 : 15) applied upon the outside. Three days later, if the patient live so long, less harm will be occasioned by cutting and removing the garments.

Necrotic burns require the same line of treatment as vesicating burns, with which indeed they are usually associated. Continuous immersion in a hot bath (100° F.) is a very valuable line of treatment. After separation of the sloughs the ulcers are to be treated as previously described. Metallic astringents are often exceedingly valuable to keep down redundant granulations and hasten repair of the breach of continuity. Skin-grafting, in its numerous forms, is often required, and lessens contraction of the cicatrix. Deep burns of extremities may be so destructive to tissue or so threaten life by reason of spreading gangrene, hemorrhage, or violent inflammation that amputation gives the best prospect of recovery.

When possible burned surfaces should at once be rendered aseptic by thorough cleansing and disinfection with antiseptic solutions. To do this etherization and scrubbing the burned surface with soap and a brush may be justifiable if the patient's condition does not contra-indicate. Deaths occurring after the period of reaction are largely due to sepsis.

The greatest ingenuity has to be called into play in the endeavor to prevent cicatricial contraction, which is especially marked when a deep burn has injured the surface of a joint. The irresistible power of the scar contractility everts the margins of mucous orifices, as in ectropium, narrows the outlets of normal canals, flexes or extends joints and renders them immovable, drags features out of position causing horrid deformity, and binds neighboring members together into one mass. During cicatrization this contraction should be prevented as much as possible by keeping joints extended by splints or by weights applied with adhesive plaster or by elastic bands. Adjacent surfaces should be kept separated by similar measures or by interposed dressings or metallic plates. It must be remembered that two apposed granulating surfaces will readily become connected by union by second intention. In this way several fingers may be united throughout their entire length, if not enveloped in separate dressings.

Recent cicatrices may be stretched to a certain extent, but old ones usually require operative treatment. Correction of deformity may at times be accomplished by multiple incision of the scar tissue or by subcutaneous incisions and unfolding of inodular ridges. Plastic operations are often requisite and gain the desired end by transferring the tension to some neighboring region where the cutaneous structures are sufficiently distensible to allow traction without causing distortion.

FROSTBITE AND CHILBLAIN.

Definition.—Frostbite is the injury produced by the application to the surface of cold sufficient to cause inflammation or to destroy the vitality of the tissues.

Chilblain, or pernio, consists in a local paralysis and dilatation of the capillaries of the skin caused by previous frostbite, giving rise to a bluish-red swelling accompanied by great itching and tenderness, and which may terminate in vesication and ulceration.

Symptoms.—When a man is exposed to extreme cold the circulation and respiration become feeble, the limbs stiff and numb, the senses are overcome by drowsiness, and he sinks into a comatose state. If he is not rescued from this condition of apparent death, the fatal issue occurs from congestion of the brain and other organs induced by the contraction of the vessels of the surface. The proper method of restoration is the very gradual application of warmth by means of friction with snow or cold water, followed by removal to a very slightly warmed apartment, and the careful use of stimulants internally and warm embrocations externally. Friction with cloths should also be made in the direction of the venous current. Artificial respiration and other measures should be persisted in for many hours.

It is, however, the local and not the general effects of cold that we are now studying. Frostbites resemble burns, except that their course is slow; and like burns are of three degrees of severity: 1, erythematous; 2, vesicular; 3, necrotic.

Erythematous frostbite follows exposure to a moderate degree of cold, and is due to the capillary congestion and slight inflammatory serous effusion that succeed the primary contraction of the vessels. The skin during the application of the low temperature becomes white from deficient circulation, wrinkled and numb; but as soon as return to warmth occurs a bluish-redness, swelling and tingling pain or itching arise. The equilibrium of circulation is restored gradually and no further pathological changes occur.

When the cold is greater or more prolonged the parts become white, entirely insensible and shrunken, and reaction is accompanied by inflammation, leading to vesication. The vesicles of vesicating frostbite are usually filled with blood-stained serum, and there is danger of gangrene occurring from the violence of the inflammatory process.

Extreme cold devitalizes the tissues at once and they have a mottled appearance from coagulation of blood in the superficial vessels. It is said that the part may be brittle and easily broken, like glass. The necrosed structures are finally separated in the same manner as sloughs produced by heat or chemical agents. In these cases of necrotic frostbite, as well as in vesicating frostbite leading to gangrene because of active inflammation, it is impossible to tell how much of the tissues is capable of having physiological function restored. Amputation, therefore, must not be attempted in the primary condition of the injury.

The extremities and the peripheral points, such as the ears, nose and chin, are most frequently frozen, because normal circulation is less active in these localities. For a similar reason persons with weak hearts, and those enfeebled by disease, dissipation, or old age are most liable to suffer from exposure to low temperatures.

Parts of the body subjected to constriction from tight clothing, such as gloves or shoes, or kept in contact with metal are especially apt to be frozen. Cold combined with moisture or wind is more dangerous than cold and dry weather without wind.

Chilblains are local dilatations of the cutaneous capillaries, due to slight frostbites or to freezing that has been repeated. The congestion which occurs in these paretic vessels is accompanied by œdema, bluish-red swelling, severe itching and burning, and occasionally by the formation of vesicles and intractable ulcers. They are most frequent in women and young persons, and those of feeble cutaneous circulation, and give more trouble when the weather changes from cold to warm than when it is continuously cold. When the limbs become warm after going to bed or when the patient has been indulging in stimulating food or beverages, the itching becomes almost intolerable.

Treatment.—The treatment of all degrees of frostbite should begin by preventing sudden return to normal temperature, because sudden access of blood to the injured capillaries will cause pain and a high degree of inflammation. Hence the parts should never be subjected to heat or put in warm water. The circulation and sensibility are to be restored gradually by friction with articles only a little warmer than the frozen parts. Snow, ice water, and wet cloths are usually employed for this purpose. Afterward slightly stimulating applications, such as alcohol, may be used to complete the reaction. Elevation of the limb and friction toward the trunk may be valuable accessories, because the venous return is thus assisted and congestion in the semi-paralyzed capillaries rendered less intense.

The erythematous, vesicular, and necrotic inflammations that occur after reaction has been established are to be treated very much as burns of similar degrees. Anodyne and cooling lotions or ointments, evacuation of the serum in the vesicles, protection of the skin from atmospheric contact and infection, and perhaps, moist antiseptic dressings, to separate the sloughs are all indicated in the various degrees of injury. The resulting ulcers are managed as such, without regard to their causation. Amputation is frequently required after severe frostbite, but should not be done until the line of demarcation has been definitely formed. Parts that are insensitive when a needle is thrust into them at the time of freezing, will often have the circulation restored, much to the surprise of the surgeon.

The treatment of chilblains is very unsatisfactory. Tincture of iodine; carbolic acid (1 : 10); carbolized ointment of petroleum; nitrate of silver (1 : 40); menthol; tincture of cantharides; tincture of aconite root; mustard foot-baths; nitric acid (1 : 30); ammonia; turpentine or camphor liniment; chloroform; metallic astringents and chloral, as lotions or unguents, and similar applications, are to be tried. Tincture of iodine (♏xx), ether (f℥ij), collodion (f℥j), may be applied with a brush. Perhaps hypodermic injections of fluid extract of ergot (♏x) or of ergotine (gr. iij) near the seat of pain would be beneficial. All pressure from shoes or gloves aggravates the pain, and should, therefore, be avoided. The ulcers that occur demand treatment calculated to cause healing and to alleviate the itching pain.

INJURIES DUE TO ELECTRICAL CURRENTS.

Symptoms.—The passage on its way to the earth of a strong electrical current through the animal body produces the same effects, whether it be lightning or an artificial current from a "live" wire. Alternating currents are more dangerous than continuous currents. The patient may be killed instantly, or, after a period of apparent death, may recover. During the period of unconsciousness the respiration may not be apparent and the pulse may be imperceptible. The symptoms may resemble those of laceration of the brain, namely, insensibility, slow and labored respiration, weak and irregular pulse and dilated pupils. Burns of the surface may be produced, especially where the current entered the body and where it emerged. Laceration of the soft tissues and injury of the bones may occur. The disorganization of the blood and its extravasation from the vessels may cause marks upon the surface having a branching or tree-like form. Money, keys or buttons in or upon the clothes of the patient may be fused by the current and be deposited as a thin metallic film on portions of the skin. When a rapid recovery does not occur, neurasthenia, partial paralysis, blindness or insanity may ensue. The burns may be followed by gangrene and heal very slowly. Exposure for a prolonged period to the X-rays or exposure to these rays when the Crookes tube is too near the skin may cause dermatitis and sloughing, which leads to a very intractable chronic ulceration. This is said to be prevented by interposing a sheet of aluminum connected with the earth.

Treatment.—The bystanders should remove the patient from contact with the "live" wire, if he be still touching it, or shut off the current by the proper method of breaking the conducting wire. Care must be taken that the current does not pass from the injured person who is still in the circuit through the person who attempts to aid him. The rescuer should put on rubber gloves before touching the patient; catch a portion of his clothing without touching his skin; or wrap his own hands up in a dry cloth and break the circuit by then lifting the patient by means of his clothing from the earth or wire. It is sometimes possible to slip a dry cloth between the patient and the ground and thus break the circuit and make it safe to touch him while still in contact with the live wire and earth. Another method of rescue is to push away the wire with a dry stick, or cut it with a pair of scissors with dry wooden handles. Wet clothing greatly increases the danger of conduction. These precautions are unnecessary when the shock has occurred from lightning directly or by the induced current due to an adjacent object being struck by lightning. Persons struck by lightning or shocked from a live wire should be treated for a long time, even if apparently dead, since recovery has taken place after several hours of apparent death. Artificial respiration is very valuable; surface stimulation by frictions or mustard plasters and hot-water bottles may be useful. Hot rectal enemas may do good. It is said that the internal use of alcohol as a stimulant is undesirable. Strychnia may be used. The burns may cause extensive sloughing and the resulting ulcer be very long in healing. The local and general symptoms should be treated on general principles.

ONYCHIA OR ONYCHITIS.

Definition.—Onychia, or onychitis, is an inflammation and ulceration of the matrix of a nail of the fingers or toes, by which the nail is discolored, and usually loosened and finally cast off. Onychia must be distinguished from paronychia, or felon, which is a suppurative affection near the nail, usually a suppurative periostitis or tenosynovitis.

Symptoms.—The condition usually arises from an infected injury, and is most frequently observed in children as a simple inflammation and suppuration about the root of the nail. The new nail that supplies the place of the diseased one is commonly irregularly developed. At times onychitis assumes a much more serious and intractable form. The ulceration exhibits no tendency to heal, the foul discharge and fungous granulations show the finger or toe to be in an unhealthy inflammatory condition, the end of the member becomes bulbous from morbid deposits, and caries or necrosis of the phalanx occurs. This form of onychia, which is chronic in its course, has been called malignant, and frequently is syphilitic in its origin.

Treatment.—The treatment in simple cases consists of antiseptic lotions and dressings and anodyne solutions or ointments. The cases depending upon constitutional states require internal remedies, such as iodide of potassium, mercury and tonics. Locally, cauterization with fused nitrate of silver, or nitrate of lead, or the application of undiluted carbolic acid, iodoform, of nitrate of mercury ointment or arsenious acid ointment (gr. ij to ℥j) is proper. Scraping away the fungous granulations and irregularly developed nail tissue often assists in effecting cure. Entire ablation of the nail, and even amputation of the finger may become necessary.

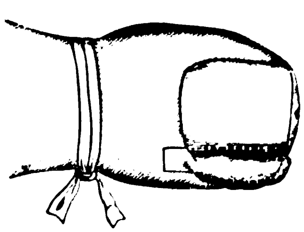
INGROWING TOE-NAIL.

Definition.—Ingrowing toe-nail is a vicious position of the lateral border of the nail in relation to soft parts of the toe, by which the former is buried in, or overlapped by, the latter.

Symptoms.—The malposition of the nail may be due to abnormal curvature of the same, to tight shoes pressing the soft tissues over its border, or to a collection of hardened cuticle under the nail causing it to assume an unnatural relation to the adjacent structures. The affection is usually seen at the outer edge of the great toe, and becomes in time very painful, because the constant pressure gives rise to inflammation and ulceration with foul discharge. The corner of the nail may even perforate the substance of the toe.

Treatment.—Palliative treatment consists in allowing the nail to grow forward, and, after scraping away the thickened cuticle beneath, to keep the square corner elevated by a small piece of cotton carefully pushed under it. By a similar piece of cotton or lint the border of the toe should be kept pressed away from the dorsal aspect of the nail margin. The shoes worn must be wide in the sole, be long, and have toes high enough to make no pressure on the top of the nail. The ulceration, if it exists, should be treated with nitrate of silver or nitrate of lead before the cotton is inserted. Salicylic acid (ʒjss), extract of cannabis Indica (gr. x) and collodion (ʒj) make a good application. At times, however, it is necessary to remove the offending portion of nail. This is done by carrying an incision through the length of the nail, about a quarter of an inch from the edge, beginning far enough up the toe to extend beyond the root of the nail. A transverse cut is then made from the upper end of this incision, and a second longitudinal one carried through the inflamed skin in such a manner as to liberate the buried border of the nail. The lateral portion of the nail is then pulled away. The unhealthy and swollen soft parts near the nail are generally also trimmed off. The raw surface left by the avulsion is soon healed by granulation under the ordinary dressings for exposed and non-approximated wounds. This is a better operation than removing the entire nail; for, even if both margins have to be cut out, the center of the toe still retains its covering of nail tissue. In many cases the surgeon can make his second longitudinal incision run under the skin obliquely and thus free the curved margin of nail without leaving so large a surface for granulation. This is a sort of a subcutaneous excision of the nail border.

FIG. 68.



Operation for ingrowing toe-nail. Tape around root of toe to prevent bleeding, and incarcerate cocaine solution injected hypodermically.

Sometimes the overhanging soft tissues may be drawn away from the nail by excising an elliptical piece from the outer surface of the redundant structures.

The operation is practically bloodless if a piece of tape is tightly tied around the root of the toe before the incisions are made. Cocaine solution may be injected into the tissues so as to produce local anæsthesia. Its incarceration by the tape ligature increases the degree of anæsthesia.

CHAPTER XIII.

DISEASES AND INJURIES OF MUSCLES, TENDONS AND BURSÆ.

WOUNDS AND RUPTURES OF MUSCLES AND TENDONS.

INCISED and lacerated wounds of muscles and tendons, if they involve the entire thickness of the structure, are followed by retraction of the cut ends and loss of motion. The treatment consists in relaxing the muscular belly, by flexion or extension of the joints, and applying sutures to hold the divided muscular or tendinous structures together.

In suturing tendons it is well to pull down the upper end strongly in order to stretch and paralyze the muscles and then to overlap the ends and stitch them together in that position by longitudinal sutures. If the tendon is wide the suture illustrated in Fig. 57 is a good one. After suturing the limb should be kept for several weeks in the position which relaxes the muscles. This can be done by bandages or the plaster-of-Paris dressing. If the torn belly of the muscle protrudes through a small cutaneous wound it must be pushed back, even if the opening in the skin requires to be enlarged to accomplish this object. Excision of the muscular protrusion is usually improper. If the upper portion of the tendon is so retracted in its sheath that it cannot be pulled down by narrow-blade forceps, an incision upward must be made so that it can be found. A muscle or tendon should be attached to a neighboring tendon or muscle when it is impossible to find the two ends of the severed cord. This will prevent entire paralysis of the finger or limb to which the tendon is inserted. Tenosuture and myosuture are often neglected in wounds accompanied by division of the tendons and muscles. In such improperly treated cases the loss of motion may be so detrimental that it is judicious to cut through the cicatrized parts, even after several years have elapsed, and pare the ends of the separated tendon or muscles and suture them to their own or neighboring muscles or tendons. As a rule, tendons divided subcutaneously, as in tenotomy, reunite quickly and satisfactorily as to function; but when their surroundings have been freely divided, as in open wounds, good union does not follow unless sutures have been applied to the cut tendons. This is due to a great retraction of the muscular end which occurs in such wounds.

Subcutaneous rupture of a few muscular fibers is not uncommon in severe strains thrown suddenly upon the muscles, and usually is accompanied by sudden, sharp, localized pain and, perhaps, ecchymosis. Rest, bandaging and massage, supplemented perhaps by friction with some sorbefacient liniment is the treatment requisite. The cure is usually somewhat slow.

Complete rupture of the belly of a muscle or of its tendon, either from the bony insertion or at the musculo-tendinous junction, is rather unusual though not rare. Violence, or a sudden powerful muscular contraction, as in tetanus or in the effort to recover equilibrium when about to fall, is the cause of such lesions. When muscles have undergone fatty or other degenerative changes, rupture is possible from very slight strain; but these tears are unattended by pain, as a rule, and do not concern us surgically. The tendon of the long head of the biceps, that of the calf muscles and that of the four-headed extensor of the leg are the tendons most frequently torn.

The symptoms of rupture of a muscle or tendon are the occurrence during action of sharp pain, accompanied possibly by an audible snap and associated with almost complete loss of motion, a groove or depression in the surface and, in muscular rupture, ecchymosis. The degree of separation of the ends depends upon the amount of laceration of the surrounding tissues and may be as much as an inch. If the tendon is wide some power of motion may remain because the margin is intact.

Rupture of muscles and tendons should be treated by laying open the overlying tissues and suturing the torn structures with chromicized catgut. The limb should then be placed in the posture which tends to keep the extremities of the torn structure near together, and should be so retained by bandages, splints, plaster-of-Paris dressings or by an apparatus of straps adapted to this requirement. Local weakness remains a long time after union of ruptured muscles and tendons.

DISLOCATION OF MUSCLES AND TENDONS.

Dislocation of a tendon occasionally occurs when a sudden strain or twist is brought to bear upon it at a point where its direction is changed by passing around a bony prominence. The long head of the biceps of the arm, the long and short peroneal tendons and the posterior tibial tendon are more frequently displaced than any others. Dislocation of the patella is practically a dislocated tendon containing a sesamoid bone.

Reduction is easily accomplished by relaxation of the muscle and pressure upon the displaced tendon, but as the sheath is torn in such luxations, it is difficult to keep the tendon in place after reduction. Pressure with pads and the elastic bandage will often be effectual, but sudden strain is apt to reproduce the luxation and pain. Incision, followed by suturing neighboring structures, so as to prevent subsequent displacement is the proper treatment.

It is probable that muscles themselves sometimes become displaced from the grooves in which they lie. Such cases should be treated by suturing to the surrounding fascias and muscles. Manipulation may be sufficient.

INFLAMMATION OF TENDONS.

Symptoms.—Tenosynovitis, or inflammation of the tendons and their fibrous and synovial coverings, may be acute or chronic. Thecitis, the term often used, properly refers to inflammation of the theca or sheath alone, but as both structures are involved in the majority of instances, the word tenosynovitis is a preferable designation.

Acute tenosynovitis is produced by punctured and other wounds, or may arise without any traumatism, and is usually found affecting the flexor tendons of the fingers or toes. The pain and other inflammatory symptoms, both local and constitutional, are very severe, and may terminate in diffuse suppuration, sloughing, necrosis of the phalanges, and septicæmia. The rapid spread of the inflammation to the hand and arm, by burrowing of pus along the tendinous sheaths and by gangrenous cellulitis, is sometimes conspicuous. The severe forms of paronychia, often called whitlow or felon, are usually instances of inflammation of tendons, beginning at the end of the finger. Sometimes the term whitlow is used to signify a mere suppurative inflammation of the cellular tissue of the pulp of the finger-tip, a simple abscess in fact; but the destructive paronychia, which is followed by gangrene and necrosis, involves the tendinous structures, periosteum and bone.

Treatment.—Acute inflammation of tendons demands purgatives, sedatives and morphia internally; and hot applications and elevation locally, which must, however, be followed very early by free incision to prevent burrowing of pus along the sheaths. A free, longitudinal incision should be practiced in the middle line of the tendon, going through the structures down to the bone. This should be done as soon as it is seen that resolution of the inflammation will not occur, and without waiting for the formation of pus. The limb should be kept elevated afterward and enclosed in a moist antiseptic dressing. In whitlow supposed to involve only the structures about the tendon, it has been recommended to incise on both sides of the middle line rather than in the center of the finger, in order to avoid opening the sheath and thereby allow the suppurative and sloughing action to involve the tendon. Necrosis, subsequent to acute tenosynovitis, may necessitate resection of a joint or amputation of a portion of the finger or limb. Stiffness or deformity of joints is a frequent sequel of even well-treated cases of acute tenosynovitis.

Constitutional diseases, such as rheumatism, gout and syphilis, are liable to cause inflammation of the fibrous tissue of tendons and aponeuroses, but this is not of the phlegmonous kind, and demands therapeutic management, depending on the cause. Alkalies, salicylic acid, colchicum, iodide of potassium, and mercury are to be administered as indicated.

There is a peculiar form of chronic inflammation of the sheath of tendons accompanied by a characteristic creaking or crackling felt, and sometimes heard, on motion that must be mentioned. This crepitating thecitis usually occurs in the forearm, and seems to be due to roughening of the sheaths by lymph, which causes scraping when the tendons slip in the investing coverings. The inflammation apparently results from long-continued and violent muscular action or from gout or rheumatism, and is associated with a moderate amount of pain and occasionally with tenderness and swelling. The term thecitis is properly applied to this condition.

The crepitation felt when the wrist is firmly grasped by the other hand is characteristic. Its superficial character and occurrence during voluntary motion make it very different from the crepitus of fracture. It should be treated by rest, the elastic bandage, blisters and friction, and stimulating liniments.

Palmar abscess is a suppurative inflammation in the tendon sheaths or other structures in the palm of the hand. The dense palmar fascia prevents spontaneous evacuation of the pus underneath it, and the infectious fluid therefore burrows upwards in the tendon sheaths under the annular ligament at the wrist or perforates the interosseous spaces and points on the back of the hand. The pain is intense and the fingers become flexed to relieve tension. Disastrous results to the integrity of the hand follow delay in opening the abscess by cutting through the palmar fascia. Incision must be free and early. The superficial palmar arch should be avoided. It crosses the palm at the level of the web of the thumb and from it arterial branches run to the webs between the digits. These situations should be avoided in making the one or more incisions required to relieve pain and evacuate pus.

DEFORMITIES FROM MUSCULAR PARALYSIS, CONTRACTION AND RIGIDITY—MYOTOMY AND TENOTOMY.

Pathology.—Any disturbance of the normal equilibrium of the muscular forces gives rise to deformity, hence it is evident that such deformity may be due to increased action of one set of muscles or to impaired power of the opposing group. There are four methods by which muscular distortions occur: 1. Inflammation of muscular tissue (myositis), which is often due to gout, rheumatism and syphilis, may lead to rigidity and contraction of muscles. 2. Long-continued abnormal position or disuse of muscles, such as result from an unreduced dislocation of a bone and from inflammation or anchylosis of a joint, may be, and usually is, followed by spastic contraction. 3. Lesions in the nerve centers may give rise to partial or complete paralysis of a group of muscles, and thus allow the antagonistic muscles to exert unrestrained force; or, on the other hand, the central nervous disease may cause such a tonic contraction of certain muscles that their opponents are unable to resist the displacing tendency. In either event deformity ensues. 4. Irritation of the peripheral nerves may, by a reflex influence, cause contraction or paresis of neighboring or distant muscles. Such instances are seen in connection with diseased teeth and gums and with intestinal and uterine irritation.

Treatment.—The management of deformities arising from abnormal muscular action should differ with the cause of the disturbance of muscular equilibrium. If it be impaired function that causes the distortion, the weakened muscles should be strengthened by systematic exercise, electricity, massage and hypodermic injections of strychnia, and by remedies directed to the promotion of the nervous supply. Brain or spinal cord disease should be sought for and, if possible, removed.

After efforts to strengthen the paretic muscles have proved unavailing, their action may be supplemented by elastic tension or some form of mechanical support. Mechanical appliances tend to do harm if they entirely substitute the action of the weak muscles, because they remove the stimulus to exertion. Hence, the early treatment should be such as will encourage the development of power. If this is found impracticable, mechanical agencies to aid, but not to substitute, are a proper resort. It is sometimes possible to substitute other muscles for the weak ones by operation. For example, paralyzed muscles of the hand and foot may have their tendons cut off and attached to other muscular bellies which still retain power. The new muscles will, after such tendon-grafting, assume the function of the disabled ones to a certain extent.

Muscular contraction from syphilis, gout and rheumatism can often be relieved by iodide of potassium, mercury, colchicum, morphia or atropia hypodermically, alkalies, massage, Turkish baths, baking of the limb in an oven so arranged that the local temperature can be raised to 300°–350° F., and similar measures. Spastic contraction from cerebral or spinal disease is to be treated by the proper remedies for the lesion there existing; and that due to abnormal position or disuse, by restoring the function to the osseous or other structures primarily involved. Passive motion will often be all that is required to give suppleness to the stiffened muscle around an impaired joint.

Repeated stretching by manipulation or continuous stretching by weights, elastic extension or mechanical apparatus adjusted with screws, will often overcome muscular rigidity and deformity. The removal of the source of peripheral irritation has often been promptly followed by relief of the muscular contraction or paresis. Tonic spasm of the masseter muscle has been quickly cured by extracting a wisdom tooth occupying an abnormal position in the alveolus. When the nervous irritation is central and cannot be removed, stretching or excision of a portion of the nerve-trunk supplying the contracted muscle may be useful in curing deformity and relieving the pain which often accompanies the condition of muscular spasm. It is not impossible that cases may occur in which it would be good surgery to trephine the skull and remove the cortical brain center.

When ordinary measures have been unsuccessful in curing deformity due to muscular contraction the patient should be subjected to division of the displacing muscle. This operation is done subcutaneously or by open incision and consists in cutting through the belly or tendon of the muscle with a narrow, short-blade knife called a tenotome.

Division of the muscular fibers is myotomy, division of the tendon, tenotomy; but the latter term is sometimes used to include division of muscles and fascias as well as of tendons. It is usually better to cut the tendon than the muscle, if a choice is possible, since the muscular gap is repaired by fibrous tissue and not by muscle, while the two ends of the divided tendon are united by tissue almost, if not quite, identical with tendinous structure. The operation practically inserts a piece of new tendon in the gap and thus lengthens the muscle. If the tendon is so short as to be inaccessible, the muscular belly may be divided.

Tenotomy should usually not be performed if the deformity depends upon palsy of the opposing muscles, nor if the deformity can be overcome by moderate mechanical power applied by apparatus or by manual force. In ophthalmic surgery tenotomy of a strong muscle is sometimes performed when double vision is due to a strong muscle overbalancing a paretic one.

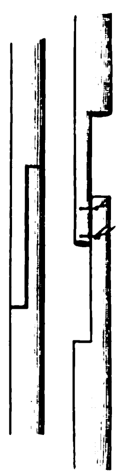
FIG. 69.

Tenotome with round end and aseptic metal handle.

The tenotome should have a short cutting edge and a rounded end somewhat keen in order to divide the skin, but it should not be pointed. There is then no need of a preparatory incision of the skin with another instrument and no danger of the point injuring vessels. It is usually preferable to divide the tendon by inserting the tenotome under it and cutting toward the surface.

The operation is seldom followed by any untoward results. After the edge of the tendon or muscle has been determined by the thumbnail of the left hand and while the parts are kept stretched and tense by an assistant, the operator slips the tenotome flatwise through the skin and under the tendon. The edge of the knife is then turned against the rigid cord, which is completely divided by a sawing motion and separates, perhaps, with a snap, so as to leave a distinct gap under the skin. If this springing apart of the ends is not very evident some of the fibers of the tendon have escaped division, or other tendons or some bands of contracted fascia require section. These must be searched for and cut.

FIG. 70.



Lengthening of a tendon. (WHARTON and CURTIS.)

FIG. 71.

Czerny's method of lengthening a tendon.

After tenotomy it is usual to bring the deformed member into good position at once by manipulation and retain it so by appropriate apparatus. Tenotomy may at times be demanded for the relief of other conditions than spastic contractions, club foot and similar deformities. In oblique fractures with great displacement tenotomy may be required to allow proper adjustment of the fragments. The tendon of Achilles is the one that is most likely to be cut for this reason. Recurring painful spasm of muscles about inflamed joints may sometimes justify such a procedure. In performing tenotomy the vicinity of arteries and nerves must be recollected.

The open method of tenotomy and myotomy is often better. An incision exposing the shortened tendons and muscles is made and one or more of these structures divided. If a definite increase in length is desired, a tenoplasty or myoplasty is performed. The tendon or muscle is cut and the ends so placed and sutured as to insure the necessary length. Sutures are then applied to the tendinous or muscular structures.

TRIGGER FINGER AND HAMMER TOE.

Trigger-finger or lock-finger exists when extension or flexion is accompanied by a sudden stop in the motion, followed by a jerking resumption of movement. It is due to one part of the tendon being too big to slide freely in the sheath. This may be due to a chronic inflammatory swelling or a small tumor. Hammer toe is a deformity in which the first phalanx is permanently extended and the other two flexed. Both of these conditions may require operation. Paring the tendon in trigger-finger, and tenotomy, excision or amputation in hammer toe may be needed. Inability to extend the last phalanx of the finger occurs in baseball players and others from rupture of the attachment of the extensor tendons. This is treated by an incision and suturing the little tendon at each side of the base of the phalanx.

CONTRACTION OF THE PALMAR FASCIA AND ITS DIGITAL PROLONGATIONS.

Definition.—A contraction of the palmar fascia and its digital prolongations, not involving the flexor tendons, which is found especially in male patients beyond the middle period of life and which seems to be associated with and caused by the gouty diathesis, has been called Dupuytren's contraction.

Symptoms.—The little, the ring and the middle fingers are most frequently involved, though the other fingers and even the thumb may be similarly affected. The patient notices that during several years a finger becomes more and more flexed upon the palm, until even forcible extension is impossible and the first and second phalanges are so bent that the last phalanx and nail are, perhaps, pressed against the surface of the palm. The gradually increasing deformity and disability are painless. The neighboring fingers and even one or two fingers of the other hand may subsequently present the same distortion.

Examination of the palm shows one or more tense cords or ridges under the skin extending to the sides or middle of the affected fingers. The disease shows a markedly hereditary tendency and according to recent investigations is evidently of a gouty etiology. Traumatism has been thought to be a cause, but it is probably not.

The diagnosis of this affection from stiffness of the fingers due to arthritis or to inflammation about the tendons is readily made. Chronic changes in the skin and joints, preventing perfect extension of all the fingers, is seen in the hardened hand of the sailor and laborer. These conditions are very different in appearance from contraction of the palmar fascia. The rigid cord or cords extending from the middle of the palm forward upon the sides or middle of the fingers and producing flexion of the first and second phalanges especially, the elevation of the skin over these bands and the involvement in the great majority of cases of one or more of the fingers of the ulnar side of the hand point unmistakably to contraction being in the palmar fascia. A similar contraction of the plantar fascia may occur, but it is very much more unusual than the disease in the hand.

Treatment.—In the early stages of the deformity friction, passive motion and retention on a straight splint for a long time may prevent the increasing distortion, and, perhaps, restore the function of the finger. When the cases usually present themselves for treatment, operation and prolonged treatment by splints and passive motion are nec-

FIG. 72.

Contraction of palmar fascia before operation. (Author's case.)

FIG. 73.

The same hand after treatment by multiple subcutaneous incision.

essary. The contracted fascia and its digital prolongations should be freely divided by a small tenotome introduced between the skin and fascia at various points. The finger should be at once fully extended and kept in that position by a splint, which should be worn constantly for several weeks. Even after the splint is dispensed with during the day it should be applied and worn at night. It has been recommended to dissect up a triangular flap of skin in order to cut away the tense fascia piecemeal, but the subcutaneous method described is usually efficient. If the open method is adopted the apex of the flap should be in the palm over the prominent band of contracted fascia, while the base should be made far enough forward on the finger to give access to the median and lateral digital bands, which may extend as far as the second phalanx. After these fibrous ridges have all been clipped away the cutaneous flap is sutured in its former position.

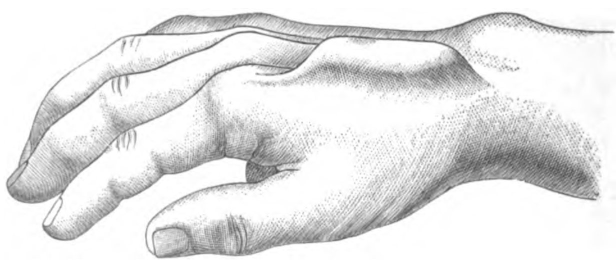
THECAL CYST OR GANGLION.

Definition.—The term ganglion is frequently, though ill-advisedly, applied to cystic tumors connected with the sheaths of tendons. This name should be discarded, because it has, in another sense, become so intimately associated with the anatomy of the nervous system.

Symptoms.—This form of cystoma, or cystic tumor, is seldom found except in connection with the tendons about the wrist and ankle. In symptoms and treatment the disease much resembles chronic inflammation of the normally existing bursæ, which will be described hereafter. The cause of these cysts is unknown, though they may be due to strain or some other form of traumatism.

The simple cyst, which is most frequently seen on the radial side of the back of the wrist, occurs as a globular swelling situated over the carpus, smooth, elastic, quite tense, somewhat movable and unaccompanied by discoloration of the surface. An elongated cyst extending along the sheath of an extensor tendon, such as is shown in the figure or a simple cyst connected with a flexor tendon is rare.

FIG. 74.



Cystic tumor of tendon sheath. (Author's case.)

There is no pain unless nerve pressure exists, but the tumor causes a feeling of weakness at the wrist. Authorities differ as to whether such cysts are developed upon the sheath of the tendon or are localized dilatations of the sheath cavity containing the synovial fluid of the sheath more or less altered in character. If formed in the latter way, the orifice of communication probably becomes occluded during the progress of the tumor, for, as a rule, the cyst does not seem to connect with the interior of the sheath.

The compound ganglion, as the other variety is called, is more frequently found connected with the flexor tendons and is a general dilatation of the sheath cavity, which may involve several tendons. This tumor, though a cystoma and though called a compound ganglion, has not, as a rule, the multilocular character of compound cysts. The disease is probably often a tubercular affection. It is an irregular, fluctuating tumor, often giving on manipulation a creaking sound and a peculiar crepitant sensation to the finger of the examiner. It contains synovial fluid, which may be dark or bloody, and in which are frequently found floating many small bodies, resembling rice-grains. It is these seed-like bodies which give rise to the crepitation. They are little masses of lymph, probably derived from the cyst wall, which may present a roughened internal surface. The tumor is not painful, but when located in the palm of the hand, its most common situation, causes flexion and impaired motion of the fingers. The tumor is not tensely filled, and it is easy to press the fluid from the palmar portion of the tumor upward, under the annular ligament, until the distention is exhibited at the wrist.

Both forms of cystic tumor of the tendons may be found in the foot and other localities. In this connection must be mentioned the fact that in the knee, hand, elbow and other regions there are occasionally met hernia-like protrusions of the synovial membrane of the joint cavity through the ligaments. These become distended with fluid and cause some stiffness, though there need be no effusion into the joint proper. Surgical interference with such tumors is very apt to be followed by general synovitis, unless asepsis is rigidly observed.

Treatment.—The localized thecal cyst is treated by sudden pressure causing subcutaneous rupture, or by subcutaneous puncture and internal scarification with a tenotome. The fluid thus distributed through the cellular tissue becomes absorbed. Firm pressure made by the surgeon's thumbs or a blow with a book or mallet will rupture the sac unless the wall is quite thick. If this manœuvre does not succeed, it is proper to introduce a tenotome through the skin, puncture the sac and cut the wall in various directions by means of the single cutaneous opening. The fluid is thus liberated into the cellular tissue or pressed out through the cutaneous opening, and, as the sac is freely divided, there is little liability of its reforming. The limb should be kept at rest after the operation, and firm pressure made by an elastic bandage or by an ordinary bandage and compress for several days. The external application of blisters and iodine to such tumors is generally of no service.

If rupture or subcutaneous incision does not cure these simple thecal cysts, it is proper to lay them open freely and paint the interior with undiluted carbolic acid, or to excise them.

Compound thecal cysts cause considerable interference with the use of fingers or toes, and, therefore, constitute a greater disability than the simple cysts. They are also more serious to treat, because of their free communication with the general synovial cavity of the sheath.

Free incision, occasionally in more than one place, with complete evacuation of the seed-like bodies and absolute rest of the part, is the best treatment. Clipping away the sac or mopping out the cavity with a strong carbolic acid or sublimate solution may be of value. The operation must be done with antiseptic precautions.

INFLAMMATION OF A BURSA, OR BURSITIS, AND BURSAL TUMORS.

Pathology.—In connection with affections of the tendons, diseases of the vesicular synovial sacs called bursæ must be considered. Bursæ normally exist, as a rule, where a tendon or the integument slides over a bony prominence; but they may become advantageously developed wherever constant pressure and friction call for protection of the underlying structures. The normal bursæ number, it is said, about one hundred and fifty and are found principally in the extremities. The most important surgically are those found over the patella, olecranon, great trochanter, tuberosity of the ischium and heads of the first and fifth metatarsal bones. The bursal sacs in the popliteal space, under the ligament of the patella, under the psoas and iliac tendons as they cross the pelvic brim, over the acromion, between the angle of the scapula and broad dorsal muscle, beneath the deltoid and under the four-headed extensor muscle of the leg should be remembered. Inflammatory affections of these bursæ, though somewhat unusual, are liable to occur and may prove confusing to the surgeon. Occasionally a transmitted arterial impulse causes bursal tumors in some of these localities to bear a slight resemblance to aneurism.

Adventitious bursæ are often developed at the points of pressure in clubfoot and other distortions, and, indeed, wherever the occupation of the man or woman causes more or less constant pressure.

Bursitis, or inflammation of the bursal sac, may arise from injury or from constitutional conditions, such as gout, rheumatism and syphilis. The inflammation may be acute or chronic, and may be followed by suppuration or by distention with dropsical effusions.

Symptoms.—Acute is not as common as chronic bursitis. The symptoms are those of acute inflammation limited to the known situation of a bursal sac, with some distention of the sac by increased effusion of fluid. A slight crepitation may at times be felt with the first symptoms of pain before swelling occurs. The immediately adjacent structures are œdematous and there is often considerable constitutional disturbance. The sac when distended with serum forms a fluctuating tumor. The pus may make its exit from the bursa, or suppurative inflammation in the neighboring cellular tissue may occur without actual rupture of the sac until the skin and deep fascia covering the knee, for example, are completely undermined by the burrowing matter. In time neglected cases will point externally, leaving perhaps fistulous tracts or ulcerated openings. Sloughing of the tissues overlying a bursa may happen.

Chronic bursitis is more usual, and is characterized by much less pain, perhaps a mere feeling of stiffness or weakness of a limb, and by marked distention and thickening of the sac until a smooth, fluctuating, more or less globular tumor is developed. The serous fluid contained in the cystic tumor, for such it practically is, may be quite dark from disorganized blood-cells. It frequently contains rice-like or melon-seed bodies identical with those described in the section on thecal cysts. The amount of fluid may exceed a half-dozen fluid ounces. Sometimes the walls of a bursa undergo a chronic inflammatory change which, by thickening and deposit of lymph, converts the sac into a hard, fibrous-like tumor, with perhaps a small central cavity.

The most frequent location of bursitis is the bursa lying over the patella. The bursa over the olecranon is apt to be inflamed in coal miners.

Bursitis is to be distinguished from arthritis of the adjacent joint by the localized nature of the swelling and fluctuation, the less interference with motion, the absence of the characteristic semi-flexed position due to synovial effusion in joints and the comparative ease with which the normal articular prominences can be seen. Synovitis of the knee-joint causes the patella to float upon the effused fluid so that it is raised from the surface of the condyles of the femur. This serves to differentiate prepatellar bursitis from synovitis.

Slight inflammation of the joint occasionally takes place as an accompaniment of bursitis because of the proximity of tissues. If the bursa ruptures and allows pus to enter the joint, acute arthritis may readily result.

Treatment.—The treatment of acute bursitis should be rest of the limb, assisted by elevation and splints and the application of anodyne or refrigerant lotions. Leeches may be of service. In sub-acute cases or in the earliest stage of acute inflammation a blister may be applied. If suppuration is suspected, an early and free incision, followed by curetting, is proper, because the danger of burrowing of pus and protracted convalescence is great. It is probably preferable in prepatellar bursitis to make the incision a little to one side of the median line, in order that the cicatrix may not be so subject to pressure after cure has been obtained. Sloughing of soft parts and caries of the patella must be treated on general principles.

If spontaneous evacuation of pus and burrowing have taken place before the case comes to the attendant, the sinuses must be laid open and all pouches must be washed out with sublimate solution or carbolized water and emptied by counter-openings or drainage.

Chronic inflammation or dropsy of a bursa is to be treated by counter-irritation and elastic pressure. If this fails, laying open the sac and keeping it stuffed with antiseptic gauze, thus causing granulation and obliteration to occur, is an available method. After laying open the sac the interior may be mopped with some strong caustic, as carbolic or nitric acid. Excision of the bursa is another very satisfactory method. Solid bursal tumors must be dissected out. Care is required to avoid injuring the adjacent synovial lining of the joint.

BUNION.

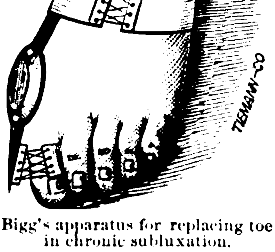
When a normal or an adventitious bursa upon the toes becomes inflamed the condition called bunion is said to exist. Bunions are usually secondary to displacement of and pressure upon the toes, arising from muscular and osseous derangement and the wearing of ill-fitting shoes.

The metacarpo-phalangeal joint of the great toe is the most frequent seat of bunion. This toe is very liable to a chronic subluxation at this joint, and thus becomes bent toward the middle line of the foot. Upon the prominence made at the distorted joint by the head of the metacarpal bone a bursa is developed by the pressure of the shoe. When this bursa, or the normal one situated nearer the plantar surface of the joint, becomes irritated and inflamed, a bunion exists.

It is said that this deformity of the great toe is due to wearing narrow and short shoes, but this is probably untrue, since marked subluxation is exceedingly common in the lower classes, who do not take pride in exhibiting small feet. A more probable explanation is that it is due to excessive standing, which, when the arch of the foot is weak, causes distortion because of the obliquity of the pressure upon the inner side of the sole. Tight shoes cause the development and the inflammation of the bursa, and thus lead to the bunion, but probably do not act as the primary cause of the deformity.

The skin over a bunion may have a corn developed upon it, which, of course, increases the painfulness of the affection. A bunion may suppurate, leaving a foul ulcer or fistulous opening; may open into the joint cavity, causing arthritis and disorganization of the articulation; or may, in some patients, be the starting-point of erysipelas or gangrene. The preventive treatment of bunion consists in maintaining the correct axis of the toe and restoring it when deflection first occurs. The first is to be done by avoiding continuous standing during youth and wearing shoes with flat heels and broad soles, and almost straight along the inner edge. The true Waukenphast pattern fulfils these indications. Perhaps a metal support worn inside the shoe so as to maintain the tarsal arch on the inner side of the sole, may be beneficial in those with a tendency to flat foot and in young or weak persons compelled to stand a great deal. Restoration of a distorted toe may be accomplished by steel springs and elastic traction, so arranged as to be worn constantly. Tenotomy of muscles which act as displacing causes, division of the ligaments, excision of the joint or amputation of the toe may be justifiable if the deformity and the resulting inflammation and

FIG. 75.



Bigg's apparatus for replacing toe in chronic subluxation.

necrosis cause great disability. The bursitis must be managed by rest, elevation of the foot, anodyne lotions, painting with nitrate of silver or tincture of iodine and the local and general measures required in inflammation. The formation of pus requires an incision, but in all operations in this region in old and debilitated patients it must be remembered that the circulation here is feeble and sepsis dangerous. The treatment of bunion, then, is identical with that of inflamed bursæ elsewhere.

A radical cure can sometimes be effected by introducing a tenotome at a distance and cutting up the bursal sac, as is occasionally done in thecal cysts. Laying open the sac by a free incision or excising it may at times be justifiable.

CHAPTER XIV.

DISEASES AND INJURIES OF THE NERVOUS CENTERS AND NERVES.

DISEASES AND INJURIES OF THE BRAIN.

Meningocele, Encephalocele and Hydrencephalocele.

THESE are congenital tumors due to the protrusion of a portion of the meninges in the one case and of a part of the encephalon and its coverings in the other case, through an opening in the cranial bones. The protrusion may occur at a suture, a fontanelle or an abnormal orifice in the skull. The most common seats for such unusual tumors are the occipital and frontal regions. In pathology these tumors resemble hydrorachis or bifid spine.

A meningocele, being a pouch of brain membranes containing subarachnoid fluid, resembles a cystic tumor of ordinary kind.

Encephalocele is often associated with other congenital malformations, and usually is more solid than the tumor just described. When an encephalocele has a cavity in its interior it is termed a hydrencephalocele. The cavity may communicate with the ventricles of the brain.

A fatal issue generally occurs in these congenital hernias of the brain and its membranes, but the surgeon must think of them when diagnosticating tumors of the head. Their partial or complete reducibility, their immobility, the location of the neck of the tumor upon the cranial bones, the variation in distention as the child is quiet or excited, and, in encephalocele, the occasional existence of pulsation will aid in the diagnosis.

FIG. 76.

Cerebral meningocele.

Pressure, aspiration and excision are methods of treatment indicated, but are in many instances valueless.

Hydrocephalus.

Hydrocephalus is a dropsical condition of the brain, consisting of an abundant accumulation of serous fluid in the ventricles or the arachnoid space, or in both. It is a chronic condition, usually occurring as a congenital disease. Acute hydrocephalus, so called, is of different pathology, for the term is variously applied by authors to tubercular meningitis and to cerebral dropsy due to renal disease.

The amount of fluid in chronic hydrocephalus varies from half a pint to several pints, and produces enlargement of the head, especially in the antero-posterior diameter, spreading of the sutures and thinning of the cranial bones. The peculiar squareness of the cranium and relatively small face give the child a characteristic appearance. The intracranial pressure and want of brain development cause lack of intelligence, paralysis, convulsions, retinal changes and other cerebral symptoms. There is apparently little pain felt by the infant.

The most approved remedies are mercury and iodide of potassium, which have at times seemed to yield good results. Early death follows hydrocephalus, as a rule, when the dropsy is great and situated in the ventricles. Dropsy located in the cerebral membranes has a more favorable prognosis.

Tapping the distended skull with the aspirator, whether or not followed by injections of dilute tincture of iodine, has not been very satisfactory. It is better to repeat the tapping than to attempt to evacuate all the serum at once, and the fluid should each time be drawn off slowly. The instrument should not be introduced in the line of the sagittal suture because the superior longitudinal sinus would be punctured. The wide separation of the bones gives opportunity to pierce the cranium at one side of the median line. Aspiration of the spinal membranes through the space between the third and fourth lumbar vertebræ has been performed, and the cerebral fluid thus lessened by the communication between the cerebral and spinal subarachnoid spaces. Trephining and puncture of the subarachnoid space under the cerebellum has also been employed for withdrawing the cerebrospinal fluid. Moderate pressure by an elastic bandage may be employed after tapping, or even as an independent treatment. Intentional puncture of the ventricles themselves has been done.

If convulsions occur during the progress of the disease bromide of potassium is the proper remedy.

INFLAMMATION OF THE BRAIN FROM SURGICAL CAUSES.

Varieties.—Inflammation of the cranial contents is termed encephalitis. The pathological process may be located in the meninges or membranes (meningitis), in the nervous tissue composing the various parts of the brain (cerebritis), or may involve both structures (meningo-cerebritis). Inflammation of the dura is called pachymeningitis, of the pia-arachnoid, lepto-meningitis.

These conditions, therefore, are merely varieties of encephalitis or intracranial inflammation. It is rare to find severe meningitis without some involvement of the underlying brain substance; and, unless the cerebritis is limited to the deep parts of the brain, local meningitis, at least, is a usual accompaniment of inflammation of the nerve tissue.

Pathology.—In meningitis inspection of the membranes shows vascular engorgement of the dura mater and pia mater, cloudiness or opacity of the arachnoid, and greenish or yellowish lymph deposited upon and between the membranes. The arachnoid membrane and its cavity show with most frequency the existence of pathological changes; but puriform lymph and pus will be found smeared upon the dura mater or in the meshes of the pia mater, if the inflammation reaches a high grade. The relative position of these morbid deposits, as to the dura and pia mater, depends much upon the starting-point of the encephalitis. Thickening of the membranes occurs with the progress of inflammation. Cerebritis, and the term is used to signify inflammation of the cerebellum and pons as well as of the cerebrum, is exhibited by increased vascularity, a change in color from gray or white to a pinkish or dirty yellow or a leaden hue, turbid serum in the ventricles and softening of the nerve structure. If the disintegration continues pus will be formed, constituting a cerebral abscess, which may contain several fluid ounces of pus.

Causes.—The causes of surgical encephalitis are fracture, caries and necrosis of the skull, involving directly or indirectly by infection the cranial contents; mastoiditis; sinusphlebitis; wounds of the membranes; contusion, lacerations and other wounds of the brain, and pyæmia.

Symptoms.—The symptoms of meningitis and of cerebritis are not, as a rule, sufficiently distinct to make a differential diagnosis possible. Fortunately, their treatment would be identical in the majority of cases, even if such a diagnosis was made. Acute traumatic encephalitis gives rise to headache, pain and elevation of surface temperature at the seat of injury, contracted pupils, intolerance of light and sounds, restlessness, delirium, general fever, full and frequent pulse, constipation and perhaps vomiting. As the disease progresses twitching of the muscles, strabismus, convulsions, stupor increasing to absolute coma, and relaxation of the sphincters of rectum and bladder supervene. Great circulatory depression, as shown by feeble, irregular and very frequent pulse, clammy sweating and dilated pupils proclaim serious involvement of the brain, which will, in all probability, speedily terminate in death. The paralytic symptoms are due usually to the exudation of inflammatory products, which cause a condition similar to compression from extravasation of blood in depressed fracture. Rigors occasionally happen and suggest the formation of an intracranial abscess or of pyæmic infection from inflammation having involved the diploic structure of the cranial bones. Subnormal temperature is thought to be indicative of abscess.

Acute encephalitis occurs in from one to three days after the receipt of injury, and usually leads the surgeon to believe that there has been infection in addition to the evident local lesion.

The condition, occurring after injuries, called irritation of the brain is probably a minor degree of encephalitis affecting special regions of the brain substance. It is characterized by restlessness of the patient, who lies curled up on one side with his limbs flexed and his eyes tightly closed. If aroused from his semi-insensibility he shows a momentary mental irritability and then relapses into a restless sort of sleep.

Chronic encephalitis causes headache, vertigo, hebetude and intellectual dulness, insomnia, epileptiform seizures, choking of the optic disks, or papillitis, paralysis and coma. The symptoms are less violent than in acute inflammation, but are similar, though coming on insidiously and at a period varying from weeks to months. Pain at the seat of injury and a local rise in surface temperature are grave symptoms in old head injuries.

Death occurs in encephalitis from pressure due to morbid deposits or from blood extravasated from diseased vessels; from destruction of nervous centers by softening or abscess; from interference with blood-supply by thrombosis, and from pyæmic injection of the general system.

A diagnosis between meningitis and cerebritis is, as a rule, impossible, because the two conditions are so frequently associated that we are not assured of the symptoms pertaining exclusively to each. If the local pain, the restlessness, nausea and hyperæsthesia of the optic and auditory nerves are especially marked, it is probable that inflammation of the meninges is the prominent pathological change. Cerebritis is to be suspected if convulsions, jerking of the muscles, trembling and sudden disturbances of the special senses are observed. The suspicion is strengthened, if the muscular symptoms are unilateral and if coma and actual paralysis of one side rapidly occur.

Treatment.—Acute inflammation of the brain requires active treatment. The entire scalp should be shaved to permit full examination for fracture, contusion or other injury; the head should be elevated, cold should be applied to the cranium by means of a bladder or rubber bag containing cracked ice or by means of cold water passing through a coil of tubing encircling the head several times, and the patient should be kept in a darkened and quiet room. If the pulse is hard and frequent, the face flushed, and the carotid arteries evidently carrying a large amount of blood to the head, venesection at the bend of the arm is valuable. The bleeding should be supplemented by free purging, large doses of bromide of potassium (ʒiij to ʒv in twenty-four hours) and cardiac depressants, such as tincture of aconite root (♏j to iij every two or three hours) and tincture of veratrum viride (♏j to iij every two or three hours). The best purgatives are calomel and jalap (gr. v to x each) or two or three compound cathartic pills. Many do not require bleeding, but are judiciously treated by the other remedies mentioned, with or without wet cupping at the nape of the neck. Digital or instrumental pressure upon the carotid arteries has been suggested as a means of diminishing the intracranial circulation. When there are great restlessness and brain irritability, morphia in moderate doses is indicated. Chloral (gr. v to xv) or hyoscine hydrobromate may be employed to meet this symptom. The diet should be limited in quantity, and restricted to milk or other non-stimulating food. In the later stages, when exudation has probably occurred, blisters may be used locally, and iodide of potassium (gr. v to x) and mercury (yellow iodide, gr. $\frac{1}{6}$ to $\frac{1}{3}$) given internally several times in the twenty-four hours.

When great depression supervenes some alcoholic stimulant may be employed, but usually this stage presages death, which cannot be, and perhaps could not have been, averted. In all cases the bladder should be watched and catheterized if the urine is not passed. The patient is perhaps unconscious, and the attendants may neglect to call attention to the fact that no urine has been passed, unless the surgeon makes inquiries.

Subacute and chronic encephalitis demand similar though less active treatment. The measures mentioned for the later stages of the acute disease are especially applicable. Mercury, iodide and bromide of potassium, blisters and laxatives are usually employed. If an acute inflammation is engrafted upon a chronic one, it must be met by active and vigorous measures, as though it had been an acute affection primarily.

In all cases of suspected brain disease the condition of the urine should be investigated, since renal changes will induce uræmic symptoms, simulating intracranial inflammation.

Patients who have recovered from encephalitis due to surgical causes, may suffer for many weeks with vertigo, headache, sleeplessness, mental aberration and other sequels pointing to deranged nervous activity. These symptoms are to be treated by the long-continued use of alteratives, such as the preparations of mercury and iodine, and by the temporary administration of bromide of potassium, chloral hydrate and similar medicines.

Chronic encephalitis is a not uncommon symptom of tertiary syphilis, and is frequently associated with syphilitic inflammation of the spinal cord. Mercury (yellow iodide, gr. j to gr. ij, during twenty-four hours) with iodide of potassium (gr. lxxv to gr. c in twenty-four hours), is especially indicated in such cases. All chronic cases should be subjected to antisyphilitic treatment, as should all cases of supposed brain tumor.

Operative Treatment.—When it is possible to locate the exact seat of the intracranial inflammation, operative interference may sometimes be undertaken with the hope of removing the spicule of bone or the foreign body which has caused and is keeping up the morbid process, or with the expectation of evacuating the collection of blood or pus which is threatening the life of the patient.

Opening the skull with trephine, chisel or circular saw, incising the membranes and puncturing the brain tissues are the modes of operation that may be adopted. Such procedures are much more frequently justifiable in chronic than in acute encephalitis, because the former is more likely to be local in its causation and in its lesions, and, therefore, more accessible by operation. Trephining and incision of membranes in acute encephalitis to permit escape of non-purulent inflammatory exudate is probably at times demanded to relieve pressure and avert disorganization. It is probably a measure of as much importance as incision of periosteum and other dense structures in inflammation accompanied by pressure from exudate. Irrigation through more than one trephine opening may be beneficial.

Operation may be done to give exit to an extravasation of blood or a purulent collection within the cranial cavity; to remove a foreign body, such as a bullet, supposed to be buried in the brain or membranes; and to endeavor to find and get rid of the cause of an inflammation which is suspected to be due to a splintered condition of the inner table or to localized bone disease.

Collections of pus or blood may lie between the bones and membranes (subcranial), in natural or abnormal cavities formed between layers of membranes (intermeningeal), or in the substance and ventricles of the brain (cerebral). Subcranial and cerebral extravasations and abscesses are usually circumscribed, and therefore more amenable to operative treatment than intermeningeal collections, which are, as a rule, diffused.

Localization of Brain Lesions.—The recent study of cerebral localization has made it possible to determine the site of many lesions of the cerebral cortex or surface, by the character of the paralytic and other nervous symptoms. The special symptoms belonging to irritative and destructive lesions of the various parts of the interior of the brain have not yet been established with much accuracy; and, in-

FIG. 77.

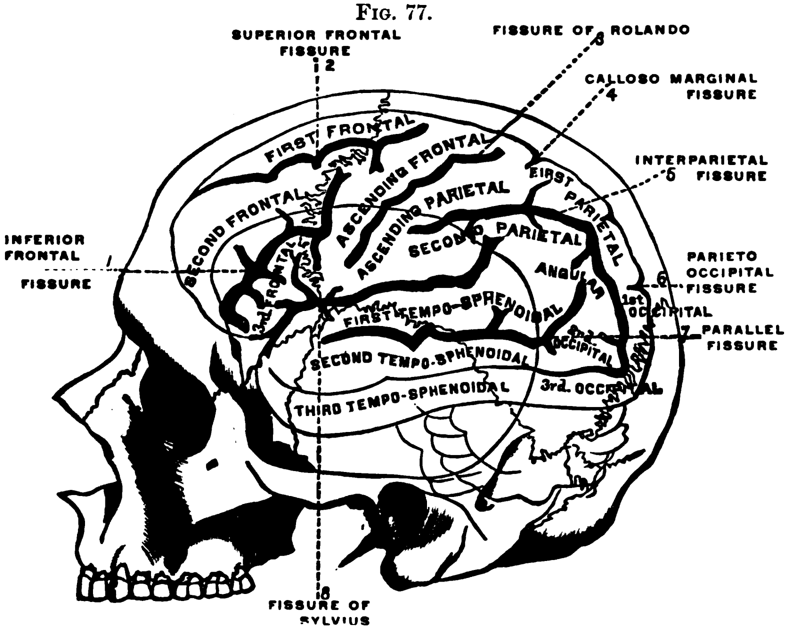


Diagram of skull showing relation of convolutions to bones.

deed, the exact locality of many of the nervous centers upon the surface is still doubtful. Nevertheless, enough has been done in this direction to aid the surgeon very much in determining, from the symptoms, where to apply the trephine in suspected abscess, extravasation, or impacted splinters of bone.

It is important to distinguish lesions of the surface of the cerebral hemispheres from those of the interior of the brain, because the former, unless at the base, are more easily reached by operation. (Plate III.) Cortical lesions cause usually not a loss of motion of an entire side (hemiplegia), but a paralysis of only a special group of muscles, as of the hand, forearm or leg (monoplegia), and there is quite frequently early rigidity of the same muscles. Jacksonian epilepsy, or convulsive action of a single group of muscles, as of a thumb, occurring alone or as a prelude to a general epileptiform convulsion, gives indication that there is a lesion of that particular cortical center and points to the advisability of an exploratory operation in that region. Local pain, which may be felt only when the head is percussed over the lesion, is also a symptom of cortical disease, and, finally, unconsciousness is not so often associated with the paralysis from cortical lesions, as is the case in paralysis from lesions of the central portion of the brain.

The portions of the cortex in which the nervous centers of motion are located are the bases of the three frontal convolutions, the convolutions along the fissure of Rolando and the paracentral lobule; while

FIG. 78.

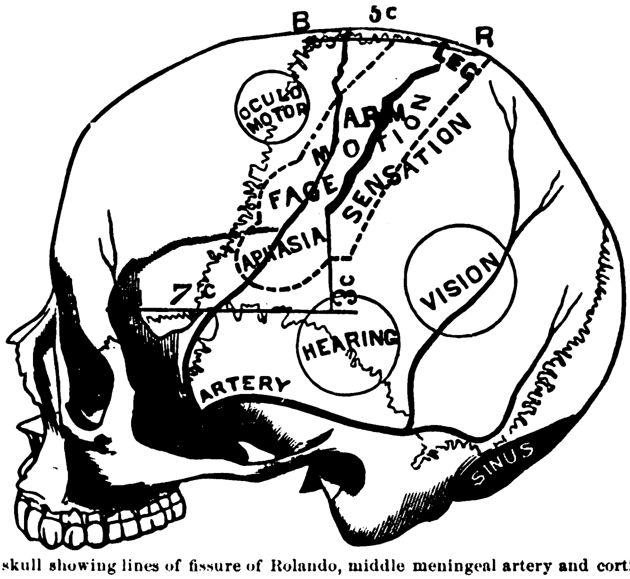
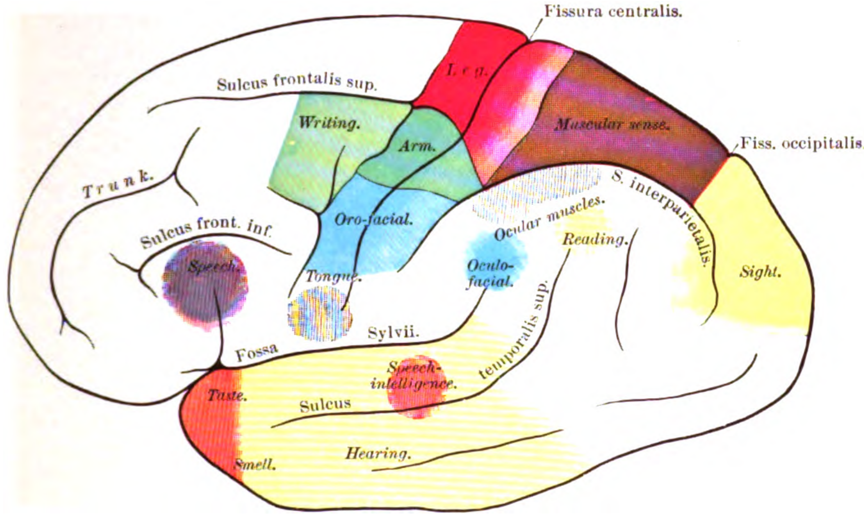


Diagram of skull showing lines of fissure of Rolando, middle meningeal artery and cortical centers.

the centers of sensation seem to be in the parietal, temporal and occipital lobes of the cerebrum. Recent investigations go, however, much further than this and locate with considerable certainty centers governing many special motions. From this knowledge it is possible to diagnosticate with a great degree of certainty the location of the inflammatory process which is producing the symptoms in a given case.

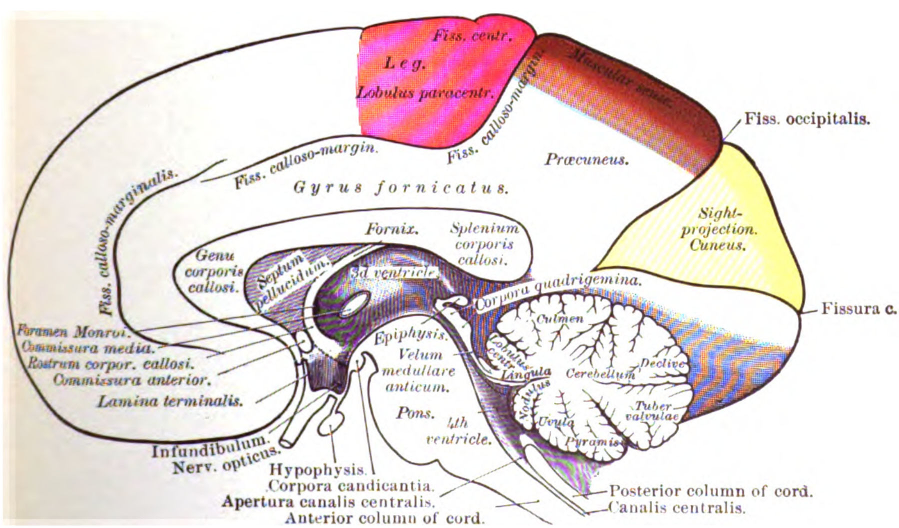
PLATE III.

FIG. 1.



Topographical Anatomy of Cortex. Localization of Functions. (Ziehen.)

FIG. 2

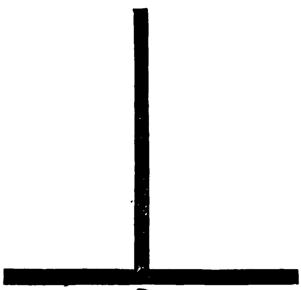


Topographical Anatomy of Inner Surface of Right Hemisphere. Localization of Functions. (Ziehen.)

The symptoms pertaining to lesions of limited areas still require further differentiation, but the value of cerebral localization to surgical treatment has so rapidly increased that even now it is incumbent upon all surgeons to recognize its utility. For example, paralysis of an arm alone (brachial monoplegia) indicates disease of the upper part of the ascending frontal convolutions of the opposite side. Here then would be the place to trephine, if the other symptoms rendered the occurrence of abscess or intra-cranial bleeding probable.

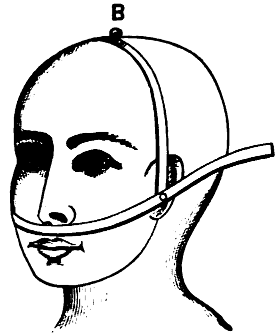
It is always important to determine upon the shaved head the location of the fissure of Rolando, or central fissure, before undertaking

FIG. 79.



Broca's square.

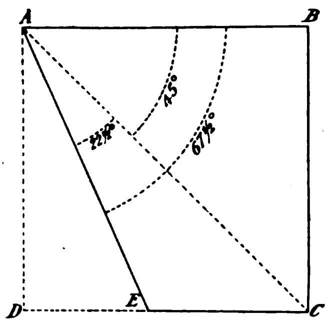
FIG. 80.



Broca's square applied.

any operative procedure based on cerebral localization. This may not be necessary if any external injury or scar indicates the probable seat of lesion. This fissure has its upper end 50 or 55 millimeters behind the bregma or junction of the inter-parietal and coroneal sutures, but does not quite reach the middle line of the skull. The bregma is found by drawing a vertical plane through the two external auditory openings. The lower end of the Rolandic fissure is about six centimeters above and a little behind the external auditory canal. It makes an angle of 67 degrees with the median line drawn from the glabella, or smooth spot at the root of the nose, to the external occipital protuberance, or inion; and has its upper end beginning on a line with a spot situated $55\frac{7}{10}$ per cent. of the total distance from the glabella to the inion. The illustrations show two methods of determining the location of the Rolandic sulcus: that by Broca's square and that by Wilson's cyrtometer.

FIG. 81.



Chiene's method of obtaining an angle of 67½ degrees for fixing position of Rolandic fissure. (KEEN and WHITE.)

A convenient method of outlining the location of the central fissure is to mark the bregma, which lies vertically above the auditory meatus; and to go 50 or 55 mm. below it and draw a line downwards and forwards at an angle of 67 degrees. Chiene has devised a simple method of obtaining an angle of 67½ degrees; this is sufficiently near to 67 degrees. He takes a square of paper and folds it into two right-angle triangles, the smaller angles of these triangles must measure 45 degrees, and half of one of these angles is 22½ degrees, which added to 45 degrees equals 67½ degrees.

FIG. 82.

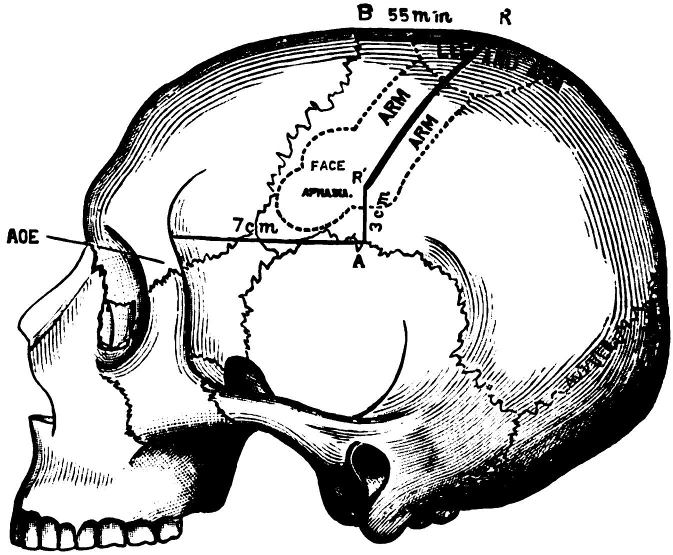


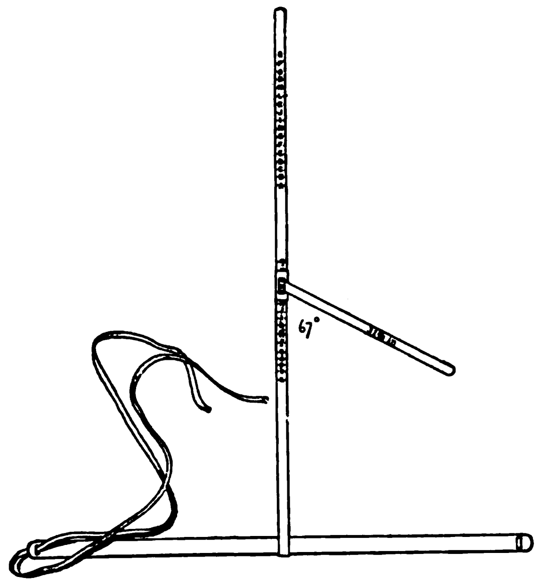
Diagram showing one method of locating the fissure of Rolando. (NANCREDE.)

Some general rules may be formulated that are well worth attention.

In injury or disease in the neighborhood of the central fissure, which is the motor region, operation is indicated when monoplegia is present, except when anæsthesia accompanies the paralysis of motion; then it may be contra-indicated, because the lesion is evidently so extensive that sensory as well as motor centers are involved. When paralysis or convulsive movements occur in connection with disease of the sensory region, operative interference may be improper, since the pathological change is not limited to the sensory centers but involves the motor region. An exploratory trephining, if properly carried out with antiseptic precautions, is so devoid of danger that many surgeons would operate notwithstanding the coexistence of motor and sensory symptoms.

Paralysis on the same side as the injury of the head should be considered an indication against operation at the point of injury, because there is probably a lesion at the opposite side of the brain, due to counter-stroke. Again very profound loss of motion points to non-interference, because it is likely that the injury involves deeper tissues than the cortical centers of motion. Paralysis of the cranial nerves, Cheyne-Stokes respiration, choked disk and symptoms referable to injury of the base of the brain usually contra-indicate surgical procedures.

FIG. 83.

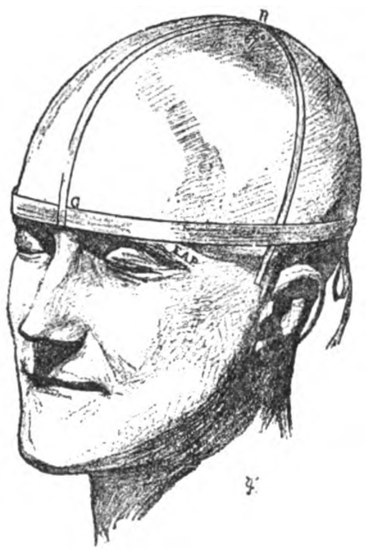


Wilson's cyrtometer, consisting of a steel tape to encircle the cranium and sliding upon it another tape making with it an angle of 67°. Both tapes are marked with a scale. (PARK.)

The occurrence of aphasia betokens an abscess, pressure from a clot or injury from a spicule of bone, located near the base of the third frontal convolution and the island of Reil, and usually on the left side. Right-sided loss of motion in addition to the aphasia, while showing a more extensive lesion, perhaps, fixes the lesion at the left side of the brain. In such cases trephining gives a reasonable hope of reaching and removing the cause of the threatening symptoms.

When the symptoms and principles just discussed furnish sufficiently clear evidence to satisfy the surgeon as to the probable seat of the lesion, it is proper, if the case present a serious outlook, to trephine without delay. Delay is dangerous if the lesion is chronic encephalitis with abscess; and equally so if there are symptoms of a large extravasation of blood or of a local inflammation due to spicules of bone. After the skull has been bored the pus or blood will be evacuated if it lies between the bone and dura mater. If none is found, and the dura bulges into the opening and does not show pulsation, an incision should be made through this membrane with the object of reaching any collection beneath it. If the symptoms of cerebral abscess have been very characteristic and death is imminent, it is justifiable to puncture the brain in various directions with an aspirator needle or grooved director in order to reach the purulent deposit. In the event of discovering a large hemorrhagic effusion from a meningeal vessel, torsion of the artery may be required. If this fails a trephine may be again applied over the course of the vessel and a ligature applied after removal of the disk of bone. After reaching an abscess of the brain the surgeon must be on the alert to keep the orifice open and not let it become closed by granulations. Injections of carbolized or other antiseptic solutions into the abscess cavity and the use of drainage-tubes or gauze wicks will contribute to the successful treatment of such cases. A trap-door-like opening in the skull made so that the soft parts act as a hinge and which may be subsequently closed, is often preferable to an ordinary trephining. It is made with a chisel or saw.

FIG. 84.



Cyrtometer applied, showing *G*, glabella; *R*, junction of line of Rolandic fissure with median line from glabella to inion. (PARK.)

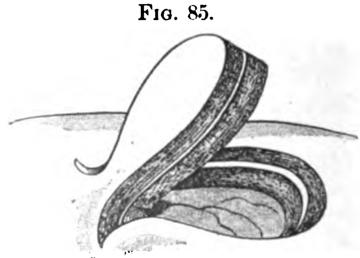
INJURIES OF THE BRAIN.

Under this heading wounds, concussion and compression of the brain will be discussed. Fractures of the skull will be considered in the chapter on Diseases and Injuries of Bone.

Scalp Wounds.

The proximity of the brain to the part wounded and the possibility of the vulnerating force having fractured the skull or caused brain injury, at the time the scalp wound was inflicted, should make the surgeon cautious in watching symptoms and careful in the treatment of scalp wounds; but there is nothing intrinsically special in such injuries. They should be rendered aseptic and closed by sutures, and their complications, such as hemorrhage, abscess and erysipelas, met as in ordinary wounds. It is easy to control hemorrhage by a tight bandage around the head, for the cranium gives a firm surface against which to make pressure.

FIG. 85.



Osteoplastic resection of skull by the Wagner-Wolff method. (ESMARCH and KOWALZIG.)

Wounds of the Brain.

Wounds of the brain are usually accompanied by fracture of the skull. Such is not the case, however, when laceration from sudden jarring occurs or when punctures are received through the fontanelles or other openings in or between the bones. Wounds of the anterior and superior region are less serious than those of the base or posterior part of the encephalon. Very serious wounds result when fragments of a fractured cranial bone are driven into the meninges and brain substance. Gunshot wounds are also very destructive.

The symptoms of brain wounds depend upon the situation of the injury and the amount of nervous tissue involved, as is easily understood from the foregoing remarks on cerebral localization. Shock, paralysis and perhaps unconsciousness, in varying degrees, are the early symptoms of brain wounds and are soon followed by local or general inflammation of the brain. Portions of brain material may be cut off by the surgeon or carried away by extensive injury and recovery be not only possible but even probable if the parts are kept or soon rendered aseptic.

Treatment.—The treatment of brain wounds is embodied in two precepts: Remove the foreign body, if any exists and it can be withdrawn without inflicting grave additional injury; and prevent, or at least limit, the secondary inflammation that is liable to follow the wound by antisepsis and most thorough drainage.

Probing brain wounds to discover the locality of a bullet or any missile should be done only with great care and with aseptic precautions. A large-headed probe of aluminum is the best instrument and should be allowed to follow the bullet-track by its own weight when the patient's head is so placed that gravity will carry the probe in the course of the wound. Trephining to give access to the foreign body is proper, and thorough drainage with gauze or rubber tubes is essential to cure. Measures calculated to combat encephalitis should be employed. Secondary abscess must be diagnosticated and treated as described in the section on cerebral inflammation. The brain can be punctured, incised and excised with a considerable degree of impunity, provided the internal ganglia are undisturbed and these operations are rigidly aseptic.

It occasionally happens that through the opening in the membranes and skull there occurs during the progress of inflammation a fungoid protrusion of brain matter mingled with lymph or pus. This constitutes the condition called hernia, or fungus, of the brain. Fungus of the brain usually demands no special line of treatment; but cleanliness in removing the discharges and the use of antiseptic dressings are proper. Moderate pressure upon the mass may be attempted, but it is liable to do harm by causing retention of the secretions within the cranial cavity if the wound be septic. To cut off the protuberance is not infrequently good surgery.

The possibility of fungus of the brain occurring must be remembered when operations are performed which are liable to divide the dura mater; hence, the dura mater should be carefully sutured after the removal of tumors of the brain. It is understood that provision for drainage must be made through the dural incisions by tubes or strands of catgut or horsehair.

CONTUSION AND LACERATION OF THE BRAIN.

Pathology.—The term concussion has long been used to designate the symptoms which followed vibration of the brain, consequent upon blows received directly upon the skull or transmitted there through the spinal column, which it was supposed produced no physical lesion of the encephalon. The possibility of the vibration causing a molecular change in the nervous cells, the capillaries or the cerebro-spinal fluid, which could not be appreciated by our ordinary methods of investigation and which still might be capable of producing the symptoms found in slight concussion, is admitted; but when death occurs in cases denominated concussion of the brain, distinct lesions, if carefully sought for, will probably always be found in the brain or other organs.

If a vessel containing jelly, of the consistence of the brain and containing similar cavities, was forcibly struck, fissures could easily be produced in the mass by irregular transmission of the vibrations of force. So may lacerations and contusions of the non-homogeneous brain occur. In my opinion, then, the so-called concussion of the brain is not a functional condition, but designates organic changes. The term, therefore, should be discarded for contusion or laceration.

Cases of slight "concussion" very much resemble a similar degree of the condition called shock. It is probable that a sudden force applied to the head, or transmitted through the spinal column to the head, causes pallor, vertigo and confusion of ideas by the same pathological change that occurs when peripheral nerves are injured and shock is induced by paralysis of the vaso-motor center. When greater violence is offered to the brain it is to be expected that, in addition to the condition of shock, symptoms will be presented due to the laceration or contusion of the brain. Surgeons should place under the head of shock those temporary symptoms now called slight concussion, and class all other instances of brain injury of a similar character as contusion or laceration of the brain.

Lacerations and contusions of the brain may be multiple, giving rise to numerous minute extravasations of blood scattered throughout the brain and scarcely distinguishable from the normal vascular points seen on section. On the other hand, hemorrhage from the torn vessels may be so great and so diffused as to produce symptoms of compression of the brain, thus greatly obscuring the diagnosis. The irregularity of the base of the skull causes laceration to occur most frequently in the corresponding region of the encephalon.

Causes.—Direct violence to the head or force applied to the legs or buttocks, and transmitted through the spinal column to the cranial bones, are the causes of contusions and laceration of the brain. A blow on one part of the cranium will often give rise to laceration of the brain at the opposite side without there being any marked injury to the cerebral tissue immediately underlying the bone struck. This is due to the soft consistency of the brain, and is termed contusion by counter-stroke.

Symptoms.—When a slight blow has been received by the brain the patient at once becomes giddy, is confused in his ideas, feels weak, staggers and perhaps would fall if not steadied by grasping some neighboring support. At the same time his face becomes pallid and his heart's action feeble. There is a feeling of nausea, and vomiting sometimes actually occurs. These slight cases do not exhibit actual unconsciousness, but the patient is stunned, and for a moment is not able to collect his thoughts. He in a moment promptly returns to his normal state. This is the condition in which it is possible, perhaps, that no laceration of nervous structure or blood vessel occurs, and such cases are those that resemble surgical shock of slight severity.

The violent shaking of the brain caused by the application of a severe force is followed by symptoms of gravity, which are due to the production of contusion or laceration of the brain or its membranes. The patient is almost, but, as a rule, not completely unconscious; lies motionless with a cold, pallid skin, has a feeble, fluttering pulse and heart, and sometimes passes urine and feces involuntarily. The insensibility is not a complete coma, for usually the patient can be roused by loud questioning to utter a monosyllable or a groan. The pupils vary in different cases as to contraction or dilatation, and the two eyes may not be alike in this respect. Usually the pupils react to the stimulus of light. The breathing is quiet, though it may be feeble and shallow; there is no hemiplegia, and the limbs if pricked with a pin will be withdrawn, though probably in a lazy manner. Vomiting is liable to occur as the patient begins to react from the semi-unconscious condition which has immediately succeeded the injury. Convulsions sometimes take place after such cerebral injuries. The location of the contusion is an important factor in the determination of special symptoms. The symptoms just described may last a few hours or a day, before signs of recovery or of progressive inflammation supervene. When return to health is to ensue, the symptoms of brain contusion slowly subside and the patient's functions assume their normal condition. It often happens, however, that headache, vertigo, impaired memory and other cerebral sequelæ remain. When the issue of the injury is to be an unfavorable one, the patient either sinks into a comatose state, without reacting, or, if he does react, soon presents the characteristic symptoms of encephalitis.

The prognosis is grave in all cases of contusion of the brain, because it is impossible to define accurately the extent of the lesion, and because even slight lacerations and contusions are liable to impair the mental functions and the special senses. All injuries producing vibration or concussion of the brain that are followed by the semi-unconsciousness mentioned are serious, because there is organic lesion of the brain tissue.

Treatment.—As the symptoms are those of shock, combined with those of brain contusion and laceration, the treatment is obviously clear. At first absolute quiet in the supine position, with the feet elevated slightly and the head low, should be enjoined. A darkened room and an opportunity to sleep should be afforded. Stimulants will rarely be needed and should be avoided if possible; because after the shock of injury has passed away, cerebral excitation and plethora will tend to produce hemorrhage from the torn vessels and to set up inflammatory engorgement. Agents, such as ammonia, that stimulate momentarily are preferable to the more lasting alcoholic preparations. External applications of heat or of mustard to the general surface may be available to relieve the depression. When the pulse shows increasing strength or there is evidence in the reddening of the skin that reaction has commenced, the surgeon must adopt measures to prevent the occurrence of cerebral inflammation. The head should be elevated, cold applied locally, and bromide of potassium, purgatives, and other remedies employed in the manner described when speaking of inflammation of the brain from surgical causes. Even bloodletting may be required, though in the early hours after the injury such treatment might prove fatal. It requires the exercise of great judgment to manage such cases. The measures appropriate for the first few hours' treatment of contusion of the brain are diametrically opposed to the line of treatment required after reaction has been induced. It is a nice question to know when the change should be made.

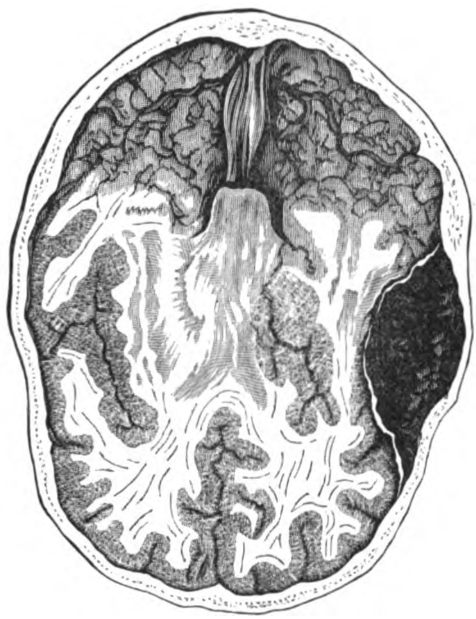
All cases of contusion of the brain, however slight, require surgical supervision for a long time. Indiscretions in mental work, in diet or in physical exercise may be very deleterious.

COMPRESSION OF THE BRAIN.

Pathology.—Compression of the brain is said to exist when pathological lesions or changes exert such pressure upon the organ as to displace the cerebral substance or cause flattening. The symptoms are probably due, to a great extent at least, to the pressure impeding cerebral circulation and causing a local deficiency of blood supply. It is certainly not likely that the amount of force exerted by extravasated blood, which so often gives rise to compression symptoms, is sufficient actually to compress and condense the brain substance. It would require comparatively little pressure, however, to interfere with the calibre of the capillary blood vessels.

Causes.—The causes of the compression of the brain are: 1. Extravasation of blood upon the surface or in the interior of the brain. 2. Fractures of the skull, accompanied by depression of the fragments. 3. Foreign bodies driven through the skull upon the surface of or into the brain. 4. Inflammatory deposits of serum, lymph or pus. 5. Intracranial tumors. In the second and third instances bleeding, due to laceration accompanying the fracture or wound, has frequently much to do with the occurrence of compression. A comparatively sudden pressure seems to be requisite to produce compression symptoms. If blood, for example, be slowly extravasated, the brain seems to accommodate itself to its new relations, unless the amount of blood be great.

Fig. 86.



Compression following hemorrhage from the middle meningeal artery. (Helferich.)

Symptoms.—A patient suffering with compression of the brain is dead to external impressions, but the organic functions of respiration and circulation continue. He lies on his back totally unconscious and immovable, with pupils unaffected by light and one or both of them usually moderately or considerably dilated. The respiration is slow (ten to sixteen per minute), snoring and accompanied by a peculiar whiff or puffing out of the cheek at the corner of the mouth. The stertor is due to paralysis of the palate muscles. It may be greatly diminished by turning the patient on his side, so that the relaxed soft palate will not hang unsupported in the current of air. The puffing out of the cheek is due to loss of power in the buccal muscles. The pulse is slow and rather full, beating perhaps not more than forty or fifty times in a minute. The urine is retained until the paralyzed bladder becomes so distended that there is a dribbling overflow. Constipation, followed by relaxation of the anal sphincter and consequent incontinence of feces, is often found. Hemiplegia of the side opposite the injury is usual. This cannot be determined in cases where reflex sensibility is destroyed, unless it is evident from the distortion of the face. The condition of the pupils and the extent and character of the paralysis depend upon the situation of the compressing lesion. The group of symptoms given are those found in typical cases of compression, and are those of cerebral apoplexy, which is a form of compression. The temperature is apt to be high in acute brain lesions, inducing compression.

Symptoms of compression due to depressed bone or to foreign bodies lodged in the brain arise immediately after the receipt of injury. Extravasation of blood, unless profuse, causes a gradual supervention of symptoms, while compression from inflammatory products appears only at a later period. It is probable that a factor in many cases of compression from depressed fracture is the concomitant occurrence of inflammation, whose symptoms are blended with those due to the pressure which often is too slight to cause in itself serious symptoms. (Plate IV.)

If the pressure is not relieved by treatment and the cerebral mass fails to accommodate itself to the new relation of parts, coma deepens, the organic functions become gradually involved and death occurs. The time occupied in the fatal invasion and destruction of these functions is usually a few days, though it may extend through weeks.

Diagnosis.—Typical cases of compression of the brain are readily distinguished from contusion or laceration of the brain of moderate severity. If a laceration or contusion is sufficient to cause much hemorrhage, however, compression symptoms will coexist and complicate the diagnosis. So, on the other hand, laceration and contusion of the brain substance is liable to result from the same force that produces a depressed fracture and a consequent depression. Hence, it is often impossible to determine accurately the pathological lesion.

The points upon which a differential diagnosis may be founded in uncomplicated cases are given in the following table:

Compression of the Brain.	Contusion or Laceration Without Compression.
1. Symptoms may not be immediate after injury.	Symptoms always immediate.
2. Complete unconsciousness and total insensibility to impressions upon organs of sense.	Partial unconsciousness and only impaired sensibility to impressions upon organs of sense.
3. Respiration slow, stertorous and puffing.	Respiration quiet.
4. Pulse slow and full.	Pulse frequent and feeble.
5. No vomiting.	Sometimes vomiting.
6. Retention of urine and often of feces.	Incontinence of urine and feces.
7. Paralysis, usually hemiplegia, of opposite side.	No paralysis.
8. Pupils insensible to light.	Pupils react somewhat to light.
9. Deglutition impossible.	Deglutition possible.

In the absence of a history of the patient before unconsciousness occurred, it is frequently difficult and sometimes impossible to discriminate between coma due to compression of the brain, alcoholic or narcotic poisoning, uræmia, apoplexy, sunstroke and hysteria. An unconscious man with bruises upon the head, picked up in the streets, may be suffering from brain compression due to injuries received while intoxicated; or may have fallen from an elevation because of an apoplectic seizure or sunstroke, and thus have sustained secondarily a depressed fracture of the skull. In such cases the head should be shaved, and careful examination made for signs of injury to the skull; the urine should be examined for albumin and tube casts, alcohol, opium and other poisons; the temperature should be taken, and tests of electro-muscular sensibility and contractility should be insti-

PLATE IV.

FIG. I.

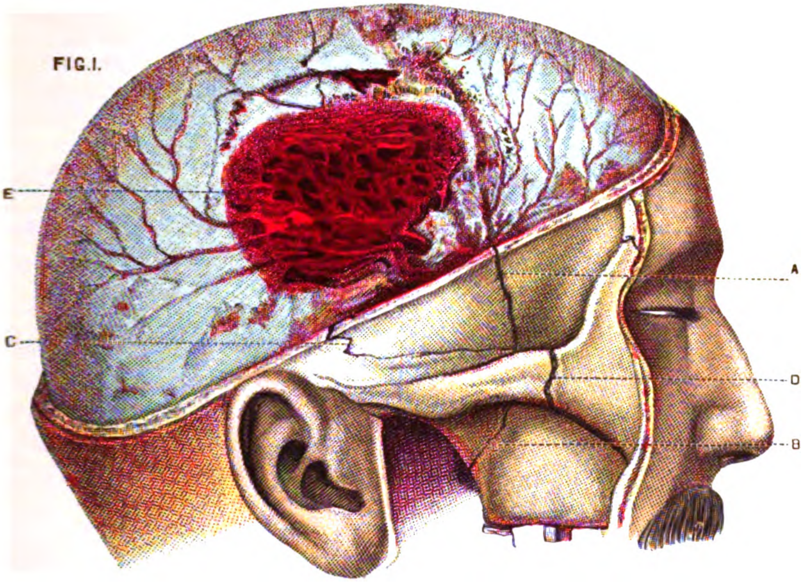


FIG. 2.

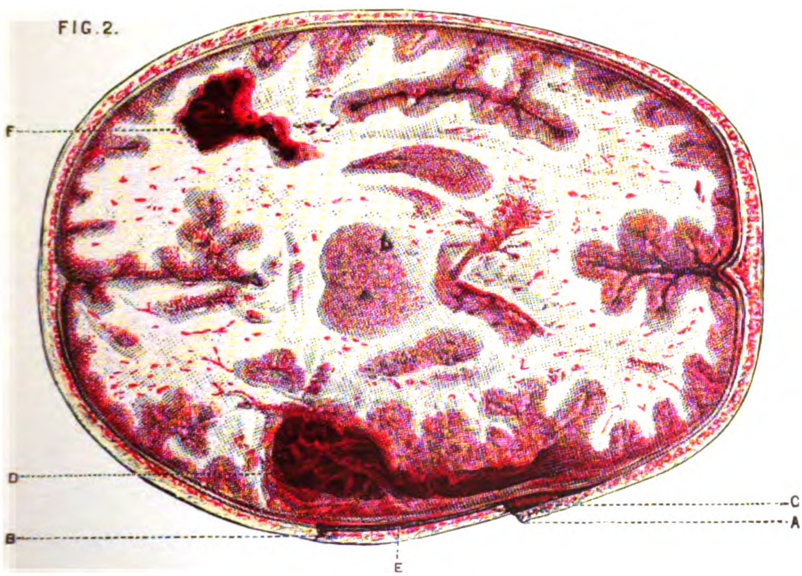


Fig. 1. Compound Fracture of Cranium, with Depression; Fracture of Bones of Face; Extradural Clot from Rupture of Middle Meningeal Artery.

Fig. 2. Horizontal Section of same, showing Depressed Fracture of Bone; C, Extradural Clot; D, Laceration of Brain-substance, with extensive Intracerebral Clot; F, Same condition produced by *Contrecoup*. Punctate Hemorrhages and Minute Lacerations at Numerous Points, characteristic of *Contusion* of the Brain. (Anger.)

tuted. The ophthalmoscope will sometimes be of service in disclosing albuminuric retinitis, choked disk or other changes in the fundus.

The existence of paralysis in compression of the brain usually serves to distinguish it from the conditions named, with the exception of apoplexy. It is the compression produced by the hemorrhage in an apoplectic seizure that induces many of the symptoms; hence, a diagnosis is impossible unless the history and evidences of injury afford direct information. The treatment, however, is identical in such conditions.

The odor of poisons, the contracted pupils of opium narcosis, the œdema of chronic Bright's disease, the high temperature of sunstroke, and the sex in hysteria will aid in the differentiation of some obscure cases. Such evidence is fallible, however, and it may be that the surgeon's opinion must be suspended until the progress of the case clears up the obscurity. The patient may indeed be suffering from two conditions at the same time.

Treatment.—Compression of the brain demands removal of the cause if this can be done without inflicting more serious brain injury. Depressed bone should be elevated; foreign bodies extracted; pus evacuated by trephining; and extravasated blood removed and further bleeding prevented by opening the skull, turning out the clots and tying the vessel. These operative procedures are proper when the existence of compression is clearly established and its cause and location known. When such measures are not deemed wise, the patient should be treated on the general principles laid down for the prevention of encephalitis. Purgatives, bromide of potassium, iodine and its compounds, mercury and bloodletting are the remedies to be employed. If hemorrhage is supposed to be the cause of compression, the head should be elevated. Enemas may be given to empty the lower bowel. The catheter must be introduced twice or thrice daily to withdraw the urine from the paralyzed bladder.

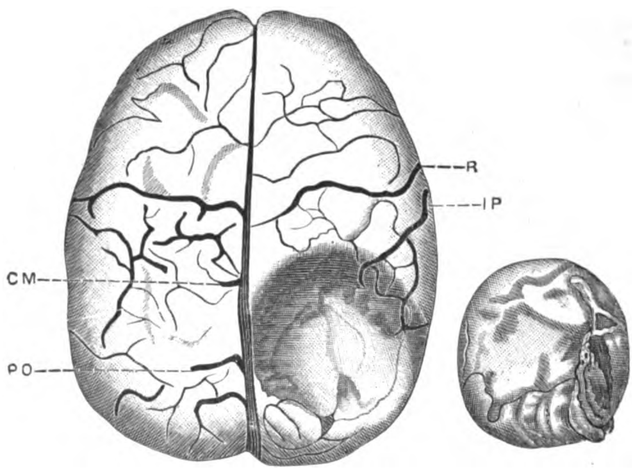
CRANIECTOMY.

Imbecile infants, whose mental deficiency seems to be due to premature ossification of the sutures and fontanelles, or to inflammatory conditions due to injury at birth, may sometimes be benefited by the operation called craniectomy. This consists in removing a long strip of the bone and periosteum, a half inch wide, on each side of the sagittal suture. The theory is that this operation relieves pressure and gives opportunity for the brain to grow and develop. The results in a few instances have apparently been satisfactory. The bony incisions may be varied in position and shape. The procedure does not hold out much hope for most idiots and is accompanied by a rather high mortality.

TUMORS OF THE BRAIN.

Tumors of the brain may be fibromas, sarcomas, gliomas, carcinomas, cystic tumors, etc. They may have their seat between the dura and the cerebral convolutions or they may be more or less deeply imbedded within the brain tissue. The symptoms depend upon the position of the growth and its size. Epileptic convulsions, local paralyses and spasms, choked disks, aphasia and intellectual aberrations all occur. It is the simultaneous or consecutive occurrence of these and other symptoms which enables the neurologist to localize the position of the growth. If such a tumor does not involve the basal ganglia, nor occupy a position so far under the base of the brain as to make access impossible, it is proper to attempt its removal by opening the skull and excising it. Such operations should be done with the strictest antiseptic precautions and by means of a large trephine and gnawing forceps, or osteoplastic resection with chisel or saw. Provision must be made for drainage, even if the opened dura mater is subsequently sutured, as it usually should be, and if the button of bone cut out by the trephine is replaced before the scalp flap is sutured into position.

FIG. 87.



Specimen of cerebral tumor found in the dissecting room. It grew from membranes and could easily have been removed by operation. The concavity in the convolutions, due to pressure, is shown. The chief fissures of the hemispheres are indicated by initials. (Author's case.)

Growths situated at some distance below the surface of the convolutions are not accessible until the surgeon has incised the brain tissue. This procedure is justifiable, if punctures carefully made with a probe or grooved director give evidence of a tumor below the surface. When the clinical history of the patient shows evidence of multiple brain tumors or of a tumor which is evidently a secondary malignant growth, it is scarcely proper to attempt removal. The diagnosis in cases of suspected brain tumor is very difficult and requires the most careful consideration of the skilled neurologist. Hence examination of the eye grounds, of the paralytic symptoms and of the epileptiform seizures should be made by those who are trained to such matters.

When a reasonable diagnosis has been made by such expert observation, it is proper to perform an exploratory operation.

Relief of pain may be given in irremovable tumors by cutting away a considerable portion of bone and splitting the dura, in order to allow the contents of the cranium to bulge through the opening, and thus lessen pressure.

DISEASES AND INJURIES OF THE SPINAL CORD.

Hydrorachis or Bifid Spine.

Hydrorachis is a congenital protrusion of the membranes of the spinal cord and sometimes of a portion of the cord itself or of the spinal nerves through an opening in the posterior part of the vertebral column. The deficiency of the bony wall is due to imperfect development of the laminæ and spinous process of one or more vertebræ; hence, the name bifid spine. The osseous laminæ usually unite about the sixth week of intrauterine life. The protruded membranes are distended by cerebro-spinal fluid forming an elastic and sometimes fluctuating tumor. A more proper name would be spinal meningocele. Those protrusions containing portions of the cord would then be called myeloceles. The deformity occurs most frequently in the lumbo-sacral region. The cord, it should be remembered, ends at about the upper border of the second lumbar vertebra.

The tumor varies in size and in tenseness with the position of the child, and in occasional instances has no cutaneous investment whatever, being a mere sac of thin spinal membranes. It is apt to become more tense or larger when the child cries. The fluid can sometimes be pressed back into the spinal canal so that the edges of the fissure in the bones can be distinctly felt. Hydrocephalus and other deformities are often found in the same infant. Paralysis is not uncommon. Death generally occurs from meningitis, convulsions or paralysis, or from rupture or ulceration of the sac.

Support and moderate pressure by means of elastic bandages or cup-shaped pads afford palliative treatment. If the orifice of communication with the spinal canal is small, injections of diluted tincture of iodine may be employed in the endeavor to cause obliteration of the sac. Excision with rigid aseptic precautions is the preferable treatment. All tumors over the spine in children are not cases of bifid spine; but the possibility of this condition existing should always be in the surgeon's mind before undertaking operation.

A dimple in the skin, a sinus, an abscess or a sac containing sebaceous material and hair is at times found in the coccygeal region. This is simply a vestige of the fœtal opening of the spinal canal, which has imperfectly closed. It has perhaps accumulated sebum, hair and dirt and become inflamed. It has no surgical connection with spina bifida, and should be treated on general principles as similar conditions found elsewhere.

INFLAMMATION OF THE SPINAL CORD FROM SURGICAL CAUSES.

Varieties.—The inflammatory process may be located in the membranes (spinal meningitis) or in the substance of the cord (myelitis). The terms spinal leptomeningitis and spinal pachymeningitis designate inflammation of the pia-arachnoid and dura respectively. It frequently happens that meningitis and myelitis are associated.

Pathology.—In traumatic cases the inflammation is usually local, but the pathological changes may gradually spread along the spinal marrow. Injection of vessels, effusion of serum, exudation of lymph, formation of pus and softening of nervous structure are the results found at the after-death examination. Sclerosis may occur in chronic cases.

Causes.—Intraspinal inflammations of surgical causation arise from contusions or lacerations and other direct wounds of the contents of the vertebral canal; from intra-spinal tumors and syphilis; and from fracture, caries, and necrosis of the vertebræ.

Symptoms.—There are certain differences in the symptomatology of meningitis and myelitis which will be discussed in speaking of diagnosis. Here the symptoms of spinal inflammation in general will be described.

As the cause is local the inflammation is limited; hence, chills, high fever and great constitutional disturbances are unusual. Pain in the spinal region, aggravated by motion or pressure, and often reflected along the nerve trunks is exhibited. Burning and tingling sensations and a feeling of insects creeping over the body, local hyperæsthesia of the surface, more frequently cutaneous anæsthesia, delay in perceiving the contact of points, and a sense of constriction about the body marking the upper limit of the disease are common symptoms of inflammation of the cord and its coverings.

Muscular jerkings and spasms, and subsequently permanent muscular contractions, affecting the muscles supplied from the diseased region are especially associated with meningitis. Motor paralysis below the seat of lesion is usually present, being much more prominent and complete in myelitis.

The palsy, as a rule, involves both sides, and is due to division, compression or disorganization of the nerve fibers of the cord. If paraplegia occurs immediately after the receipt of injury, it indicates that the fibers are divided or have been compressed by displaced bone or extravasated blood. A slowly increasing paralysis suggests inflammatory pressure or disorganization. Injury of one side of the spinal marrow would give rise to unilateral palsy on the same side. It is possible in lesions of the cervico-dorsal area of the cord to have motor paralysis of the arms and not of the legs. As the cord terminates at the level of the upper border of the second lumbar vertebra, injuries below this point are accompanied by no paralysis, or by a slight and temporary form only which depends upon lesions of the loose bundle of nerves called the cauda. The small diameter of the cord immediately above its lower end and the envelopment of this termination in the nerve roots going down the vertebral canal serve to prevent severe involvement of the cord, even at a somewhat higher level than the lumbar vertebra mentioned.

The seat of the cord lesion can often be determined by the limitation of the motor or sensory paralysis. The muscles and regions supplied by branches given off from the spinal marrow below the injury are usually the only ones that lose their innervation. On account of the downward distribution of the nerves as they leave the cord, the lesion is generally somewhat higher than the horizontal line marking the upper limit of the palsy. An exception to this may occur when the terminal nerve filaments are distributed upward. This occurs especially in the skin.

The paralyzed parts are exceedingly liable to severe bedsores. These are due to the impaired innervation and circulation and to the unrecognized irritations which the insensible and immovable parts receive. The local temperature of the palsied limbs is often high. Atrophy soon occurs. Bedsores and atrophic changes are more marked the longer the patient survives. Hence, in injuries low down in the cord these nutritional changes are exceedingly conspicuous.

Retention of urine occurs nearly always. When the paralyzed bladder has become fully distended, there is a dribbling overflow, which is an indication for an immediate catheterization, lest rupture of the bladder or other harm result. After a few days' incontinence of urine relaxation of the sphincter supervenes. The bladder is thus kept nearly empty. At the same time the urine exhibits chemical changes, becoming alkaline, turbid, ammoniacal and filled with mucus and phosphates. Inflammation of the bladder is usually found at this period, due either to the distention and catheterization or the alkaline urine, or perhaps to both. Other changes, such as the presence of sugar, are occasionally witnessed. Priapism, either spontaneously exhibited or following catheterization and handling of the genitals, occurs in many instances where motor palsy is a symptom. It has no connection with sexual feelings and only exists when loss of motion is present. Incontinence of feces is seen when the sphincter is paralyzed by injury to the lowest region of the cord. If the damage is effected higher up, constipation is the condition exhibited. This may subsequently be followed by looseness of the bowels.

Dyspnœa and hurried respiration result when the spinal inflammation is located in the upper dorsal and cervical regions because of paralysis of the intercostal and serratus muscles. If the injury disorganizes the cord above the region of the phrenic nerve or if inflammatory destruction ascends thus far (to the third or fourth cervical vertebra), death occurs instantly from paralysis of the diaphragm. Difficulty of respiration is experienced in intraspinal troubles in the lower dorsal region; first, because there is paralysis of the abdominal muscles which aid expiration, and secondly because the loss of muscular tonicity here allows tympanitic distention of the intestines to occur and interfere with the descent of the diaphragm. When the sympathetic cardiac nerves are interfered with by lesions in the cervico-dorsal region, the pneumogastric nerve can then exert its inhibitory function unrestrained and the heart's action is slowed. Otherwise the pulse is influenced merely by the general state of the patient.

There are many other symptoms of intraspinal inflammation which depend upon the location of the lesion and the nervous center consequently involved. From these the location of spinal lesions is established with considerable certainty. It must be remembered, however, that in some cases brain injury has been associated with the spinal hurt. It is occasionally difficult to differentiate the spinal from the cerebral symptoms. Unconsciousness, when present, renders the diagnosis of cerebral involvement clear.

Diagnosis.—Meningitis and myelitis are often combined, but the predominant affection can, at times, be diagnosticated by the character of the symptoms. In meningitis there is more pain on motion, more cutaneous hyperæsthesia, more twitching and permanent contraction of muscles, less impairment of motility and less involvement of the bladder and rectum. Effusion occurring in meningitis may cause paraplegia by pressure on the cord, but the paralysis is not as complete as in myelitis and varies in its degree.

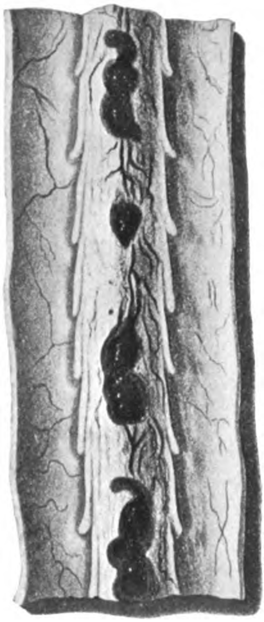
In myelitis the loss of power occurs earlier and is more marked, electric contractility and reflex movements are soon impaired and the sense of constriction about the trunk is conspicuous. Priapism, urinary complications, bedsores and nutritive changes are usual.

Prognosis.—The higher the seat of inflammation the graver the prognosis as to prolongation of life, because more of the vital functions are impaired. Myelitis is a much more serious affection than meningitis and is seldom followed by restoration of the paralyzed limbs. If the injury is low down in the spine or if, when higher, it implicates a limited area of the cord, recovery of a fair amount of health occasionally takes place. Contractures and paralysis, however, usually remain. Sensation is usually regained sooner than motion. Intraspinal inflammation in young adults, if not traumatic or tubercular, is usually syphilitic; and therefore is of favorable prognosis, if active treatment is carried out.

Treatment.—Intraspinal inflammation requires a line of treatment similar to that recommended in encephalitis. Rest, preferably in the prone position, the ice-bag, leeches or wet cups locally; hydragogues, iodide of potassium (gr. x to ʒj), or mercury to slight ptyalism, and fluid extract of ergot (fʒss to fʒj), given internally several times daily, are the proper measures in acute cases. Morphia and bromide of potassium may be employed to relieve pain and induce functional rest. Atropia is an appropriate remedy in meningeal congestion. When the condition is subacute, blisters or the actual cautery may be applied to the spine and the induced current to the paralytic muscles with advantage. Strychnia is to be avoided in spinal meningitis.

PLATE V.

1



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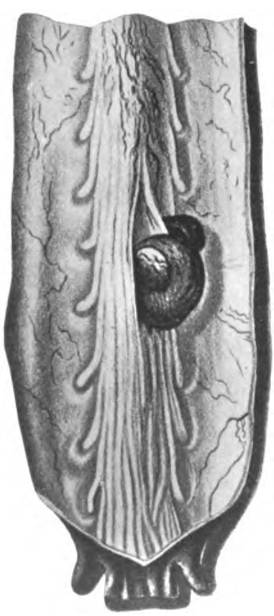

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4

Fig. 1. Hemorrhage on the Surface of the Spinal Cord of Trumatic Origin.

Fig. 2. Sarcoma of the Spinal Cord.

Fig. 3. Sarcoma of the Spinal Cord.

Fig. 4. Meningitis and beginning Compression Myelitis from an Extra-Dural Tumor. (Bock.)

The paralyzed muscles of chronic myelitis should be treated by means of electricity, massage, the hot and cold douche and subcutaneous injections of strychnia, in the endeavor to prevent atrophy and restore power. Syphilitic meningitis and myelitis call especially for mercury and iodide of potassium in active doses.

Suspension by the shoulders and head from a tripod, so as to extend the spinal column by the weight of the lower limbs, has been advocated in some forms of chronic disease of the cord.

When retention of urine exists, the catheter must be passed three times daily. The cystitis, that arises later and is accompanied by phosphatic urine, is alleviated at times by carefully washing out the bladder with nitric acid and water (♏ v to f℥j). Even if incontinence has occurred, it is well to pass the catheter once every three or four days to empty any decomposing residual urine.

An attempt at preventing bedsores should be made by seeing that there are no folds in the sheets, by bathing the prominent points of back and limbs with alcohol and by keeping them free from contact with the urine and feces. It is well to place the patient as soon as possible upon an air or water bed. A good water bed can be improvised by partly filling a long tank or tub with water and nailing a rubber blanket over the top, so that it will rest upon the surface of the water.

If a diagnosis of abscess or tumor within the spinal canal is made, it is proper to saw away the laminæ in an effort to evacuate the pus or remove the growth. In localized inflammation due to fracture or other cause, laminectomy followed by separation of the adherent membranes and cord might possibly give relief to the symptoms. Exploratory operations here, as in brain diseases, are justifiable. (Plate V.)

WOUNDS OF THE SPINAL CORD.

Wounds of the spinal marrow may be produced by gunshot injuries, by fractures of the spinal column with displacement and by pointed instruments thrust between the vertebræ. The symptoms will correspond with those detailed in the table of Spinal Localization given under Fractures of the Vertebræ. They will vary with the locality of the wound. Such wounds, involving a limited portion of the diameter of the cord will be followed by a limited paralysis, corresponding with the fibers divided.

The treatment of wounds of the cord is such as is detailed for arresting and treating intraspinal inflammation. When fragments of the vertebra are driven in upon the cord or intraspinal hemorrhage is occurring, exploration is justifiable, but the diagnosis of such compression is often difficult. Exploratory operation may then be demanded.

CONTUSION AND LACERATION OF THE CORD.

Shocks, whether direct or indirect, to the spinal column are not transmitted to the cord as readily as similar blows are to the brain, because the cord hangs loosely in the canal and is surrounded by the spinal fluid. Cases denominated concussion of the spine are probably really instances of contusion or laceration of the cord or its membranes or of extravasation from rupture of the spinal veins. The progressive spinal symptoms described by Erichsen as occurring after the jarring of railway accidents, and attributed by him to so-called spinal concussion, are probably due to slight contusion or laceration of the contents of the spinal canal, to neuroses or to malignering.

Contusion and similar injuries of the cord require treatment adapted to preventing and allaying inflammation of this nervous center.

NEURITIS OR INFLAMMATION OF NERVES.

Causes.—Neuritis, which may be acute or chronic, arises from exposure to cold and wet, wounds, strains causing laceration of the nerves, rheumatism, gout and syphilis. Neuritis may be due to infections and to poisoning, as with arsenic. Acute neuritis is particularly liable to follow laceration of nerve-trunks probably because such wounds are liable to be septic.

Pathology.—An inflamed nerve shows changes in the neurilemma and nerve fibers. Hyperæmia, increased connective tissue, serum, lymph and pus are the inflammatory changes and products associated with the former; while granular and fatty changes followed by softening and atrophy occur in the latter. In acute neuritis the nerve-trunk is swollen from the deposition of inflammatory fluids, and pus may be found within the sheath. In chronic inflammation an increase of the connective tissue, leading to sclerosis and consequent nerve degeneration, is the usual pathological change.

Symptoms.—Inflammation of nerves causes disturbance of physiological function, hence the symptoms vary as the nerve-trunk is motor, sensory or mixed.

The first effect of inflammation is to increase the irritability of nerves, but, as it continues, a diminution of nervous excitability is induced. Hence, in motor neuritis twitching and spasm of the muscles occur at the time of invasion and are followed by paresis or complete loss of power, if the inflammation is not speedily arrested. Sensory neuritis exhibits mainly pain and hyperæsthesia followed by analgesia and anæsthesia. When the inflammatory process resides in a mixed nerve, as it generally does in cases met by surgeons, these classes of symptoms are combined. Reflex influences may at times, however, cause the appearance of symptoms of a motor character, even when a purely sensory nerve is inflamed. For example, neuritis of the trifacial will be accompanied by twitching of some of the muscles of the face. The term causalgia is applied to the peculiar burning pain of some nerve inflammations.

Inflammation as found in neuritis of the sciatic, radial and other mixed nerves, then, is exhibited by pain, of a remittent but not intermittent character, increased by pressure, often worse at night and especially severe when due to traumatism. There will perhaps be reflex symptoms such as pain in other parts of the body. The painful sensations are felt in the peripheral distribution of the nerve and may exist even when the skin has become anæsthetic. Reflex excitability and electric contractility are soon diminished. The local temperature of the parts supplied is increased, and the skin over the course of the trunk is red, and sometimes the seat of a bullous eruption. A hard, painful, cord-like swelling is felt along the course of the trunk, if it is a superficial nerve that is involved. Clonic spasms, loss of power, hyperæsthesia, anæsthesia and trophic changes are supplementary symptoms. Fever and other constitutional symptoms occur, varying in intensity with the acuteness of the neuritis. Chronic neuritis causes much less pain, but the other functional disturbances are those already mentioned.

Neuritis may spread along the trunk to nerves nearer the nervous centers. This is called ascending neuritis. In a similar way changes may occur above and spread downward, constituting descending neuritis. Neuritis may be followed by ulceration, deformity of joints and other secondary pathological conditions, dependent upon interference with the trophic function of nerves.

Diagnosis.—Neuritis is distinguished from neuralgia by the continuous pain, which may remit but does not intermit; and by the fact that the pain is usually less severe than the paroxysmal pain of neuralgia. In neuralgia, moreover, there is not the local elevation of temperature, the muscular spasm, nor the paralysis of motion or sensation that have been mentioned as symptomatic of neuritis.

Treatment.—Acute neuritis demands absolute rest and elevation of the part, hot applications locally, and, perhaps, local abstraction of blood. Deep subcutaneous injections of morphia (grain $\frac{1}{8}$ to $\frac{1}{4}$) with atropia (grain $\frac{1}{60}$) over the painful nerve and the application of the primary galvanic current have been useful. The general disturbance will probably necessitate at the same time the use of diaphoretics and laxatives.

Chronic inflammation of nerves is to be treated by blisters, electricity, the actual cautery and increasing doses of iodide of potassium. Hypodermic injections of chloroform or solutions of osmic acid or cocaine may at times be serviceable.

If the inflammation is due to rheumatism, alkalies and salicylate of sodium are indicated; if to gout, colchicum; if to syphilitic causes, mercury and iodide of potassium. The actual cautery has been used also in acute neuritis with alleged benefit. The atrophied muscles are to be subjected to massage, electricity, douches and hypodermic injections of strychnia (grain $\frac{1}{60}$). Tonics and similar remedies will often be of value in chronic neuritis.

Nerve stretching (neurectasia), neurotomy or neurectomy is sometimes necessary for the relief of pain in neuritis.

INJURIES OF NERVES.

Nerves are liable to be bruised and lacerated, as occurs when the ulnar is compressed against the internal condyle and when the circumflex is torn in dislocation of the head of the humerus. They may be punctured, incised, completely divided or have a portion excised. Dislocation of the ulnar nerve from its bed behind the internal humeral condyle is an occasional injury.

Symptoms.—The symptoms in such injuries, whether open or subcutaneous, vary with the degree of damage done to the nerve-fibrils. Slight contusions cause pain at the point of injury and tingling or numbness along the peripheral branches. Other wounds give rise to pain followed by paresis or paralysis. Sometimes pain is absent. A foreign body impacted in a nerve is apt to cause spasmodic action of the muscles in addition to the pain and other symptoms.

Subsequent to the receipt of injury the symptoms of neuritis occur. Neuralgia is often developed as a sequel to nerve wound. This is especially the case in hysterical subjects. When a nerve is compressed or dragged upon by the cicatrix of a wound in the other tissues, nutritive changes take place in the parts deprived of innervation. These consist in atrophy and contracture of muscles; alterations in the nails; changes in the skin, which may become shining and swollen or eczematous; lowered local temperature; loss of hair, and subacute arthritis.

The ends of a divided nerve retract, become bulbous from the deposition of lymph and, after the lapse of several weeks or months, are reunited by the development of nerve tissue, thus having their function restored. This will at times happen even when a considerable piece of nerve has been cut out. Hence, when it is desirable after neurectomy for neuralgia that union should not occur, it is necessary to excise a long piece of nerve trunk.

Injured nerves undergo secondary, or Wallerian, degeneration when their fibers are cut off from their trophic centers. Subsequently regeneration, or development of new nerve fibers, occurs. The reaction of degeneration is shown when the nerve has undergone degeneration. It is evident by the nerve failing to give response to static, faradic and galvanic currents and by the muscle responding only to the galvanic current and with a peculiar sluggish tetanic contraction, which is marked when closure is made with the positive pole.

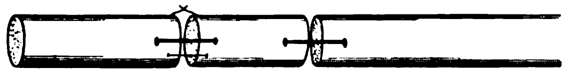
Treatment.—Subcutaneous nerve injuries need only such treatment as will prevent or allay the resulting neuritis. Hypodermic injections of morphia and atropia, cold or perhaps hot applications, and galvanism locally, with quinine or other appropriate remedies internally, are judicious measures. Other local remedies of value are belladonna extract, menthol, chloroform and aconitia, used as lotions or ointment, blisters, leeches, and the actual cautery.

Divided nerves should be sutured, as are other structures, by immediate exposure and the application of absorbable sutures. No special manner of introducing such stitches is required, if only approximation is accurately made. If a portion of the nerve has been lost the remaining portions should be stretched until apposition by sutures can be made; or flaps may be cut from the nerve and turned across the gap and then sutured. Primary nerve-suture is followed by complete, or almost complete, return of function. Massage and electricity are to be employed in the later treatment.

FIG. 88.

Neuroplasty. (WILLARD.)

FIG. 89.



Nerve-suture. (WILLARD.)

If a wound, in which there was a large nerve divided, has healed and permanent paralysis remains, it is proper to expose the nerve, cut off the bulbous or atrophied extremities and apply sutures. Considerable success has been obtained by even this secondary nerve-suture in restoring motion to limbs, the subject of traumatic paralysis from accidental nerve section. Pieces of nerve tissue from the rabbit may be sutured in the gaps left by destruction or excision of nerve trunks.

Neuralgia, due to cicatricial pressure, is treated by excising the inodular tissue, and thus getting rid of the scar and pinched nerve.

Neuralgia.

Definition.—Neuralgia may be defined as pain, usually paroxysmal, situated not in the brain or cord but in the nerves themselves, and due to no noticeable organic lesion. Many cases are probably a neuritis.

Causes.—The chief constitutional cause of neuralgia is debility. Malaria is a very frequent cause of neuralgia, especially of the trifacial nerve. Hysteria, exposure to wet and cold, reflex irritation from uterine disease, syphilis, rheumatism and gout are considered factors in the etiology of neuralgia. Some of these probably cause nerve-pain by inducing neuritis and not true neuralgia. The same fallacy is likely to underlie cases of neuralgia attributed to diseased teeth, necrosis of bone and periostitis. Compression of nerves by tumors and periosteal thickening gives rise to neuralgic pain.

Symptoms.—The most frequent situations for neuralgia are the terminal branches of the three divisions of the trifacial nerve, the sciatic nerve, and the intercostal nerves. Neuralgia may be seated in a number of small nerve twigs, distributed to an organ or a surface of considerable size; thus occurs neuralgia of the breast, of the testicle and of joints.

The pain of typical neuralgia is sudden and paroxysmal. It occurs as a tearing, darting shock, or pang, followed by an interval of more or less complete absence of pain. In many instances there is a dull, aching pain continuously, to which are added at irregular intervals the painful exacerbations. Muscular exertion generally, and pressure sometimes, though not usually, aggravate the pain. Neuralgia shows quite a tendency to be unilateral, and often there is exhibited marked cutaneous hyperæsthesia.

Points of tenderness on pressure can, as a rule, be found along the course of the nerve. These are situated where the nerve passes through a bony foramen, pierces the deep fascia or comes near the surface of the body. Occasionally tenderness is exhibited over the part of the spinal cord from which the nerve takes its origin. Local muscular spasm is found associated with some neuralgias, as are at times a hot, red, swollen skin and increased secretion of the neighboring lachrymal or salivary glands. The peculiar vesicular eruption called herpes zoster is developed over the line of a neuralgic nerve. Patients who have once suffered with neuralgia are liable to similar experience at every exposure to the exciting cause. The location of the neuralgia may vary with each attack. Indeed, the pain is very liable to change from one nerve to another.

Neuralgia, particularly of the trifacial nerve, is often very intractable, but it is not a disease dangerous to life.

Metatarsalgia, or neuralgia at the tarso-metatarsal joints of the third and fourth toes, is supposed to be due to pinching of the branches of the plantar nerve lying near the movable heads of the metatarsal bones. If wearing shoes with flat low heels and so made as to prevent this nerve bruising is not followed by relief the head of the bone should be excised or neurectomy of the little nerve be performed.

Diagnosis.—It is easy to differentiate a typical neuralgia from marked organic disease. There are no alterations in shape or volume, no signs of inflammation and no fever, but paroxysmal pain, cutaneous hyperæsthesia and a history of debility, malaria, or hysteria. Firm pressure frequently relieves neuralgic pain, if it is continued until the hyperæsthetic skin has become accustomed to the contact of the hand. The tendency of neuralgia to be transferred from one nerve to another is a valuable point in diagnosis. In many cases, however, neuralgia can only be presumed to exist, because the pain cannot be attributed to any other affection. Muscular and fascial pains due to rheumatism or syphilis are often mistaken for neuralgia.

Treatment.—As the constitutional condition underlying neuralgia is usually either debility or malaria, quinine and its congeners are the most useful internal remedies that we have. Quinine should be given in full doses even when no malarial history can be obtained. Twenty to thirty grains in the twenty-four hours may be curative when less doses have accomplished nothing. If this drug fails, recourse should be had to arsenic. The solution of arsenite of potassium should be given in doses of five to ten minims three times daily after eating, and be gradually increased. Iron, strychnia and cod-liver oil in large doses frequently repeated, galvanism, good nutritious diet, fresh air, sea bathing and change of scene and climate are valuable agents in combating the tendency to neuralgia. In hysterical subjects, valerian, bromide of potassium and assafœtida may be available; in rheumatic cases, alkalies; in those of gouty diathesis, colchicum; and in syphilitics, iodide of potassium or mercury. Ergot and phosphorus have been recommended by high authority. Uterine or other affections giving rise to neuralgia by reflex influence should be remedied by appropriate measures.

To relieve an attack of neuralgia, when present, morphia, atropia, chloral, hyoscyamus, bromide of potassium, acetanilid, phenacetin, alcohol and the inhalation of anæsthetics have a positive value. The use of such remedies is to be deprecated and their repetition avoided as far as practicable. Neuralgic patients, for this reason, should not be informed of the name of the remedy administered. Aconitia may be given in doses of gr. $\frac{1}{200}$ and gradually and very cautiously increased. The benumbing effect of this powerful drug on the peripheral nerve is well known. Menthol locally gives at times relief.

The local treatment of neuralgia deserves attention. Any suspected local cause, such as diseased teeth or cicatricial pressure, should be removed. In many of these instances, however, the pain is probably due to a neuritis and, hence, is not true neuralgia. Hypodermic injection of morphia (gr. $\frac{1}{6}$–$\frac{1}{4}$) into the nerve trunk or in its immediate neighborhood is a potent remedy and may not only palliate, but by repetition even cure. The needle of the syringe should be thrust deeply into the tissues and, if possible, into the nerve. Atropia (gr. $\frac{1}{60}$–$\frac{1}{40}$) alone or combined with morphia, ether (♏ x–xxx), chloroform or bromide of ethyl, or solution of osmic acid may be employed in a similar manner. These and other sedatives may also be used in the form of liniments and ointments. Aconitia (gr. v to ℥j of ointment), veratria (gr. xx to ℥j of ointment) and menthol are often very efficacious local applications. Heat and cold vary in different cases as to the amount of relief they afford. The primary galvanic current is at times useful. Blisters, strong water of ammonia, the actual cautery and similar counter-irritants have a positive value in some instances. Acupuncture and galvano-puncture have been recommended.

Nerve-stretching (neurectasia), nerve-section (neurotomy), and nerve-excision (neurectomy) are proper surgical expedients when the neuralgia is very severe and intractable.

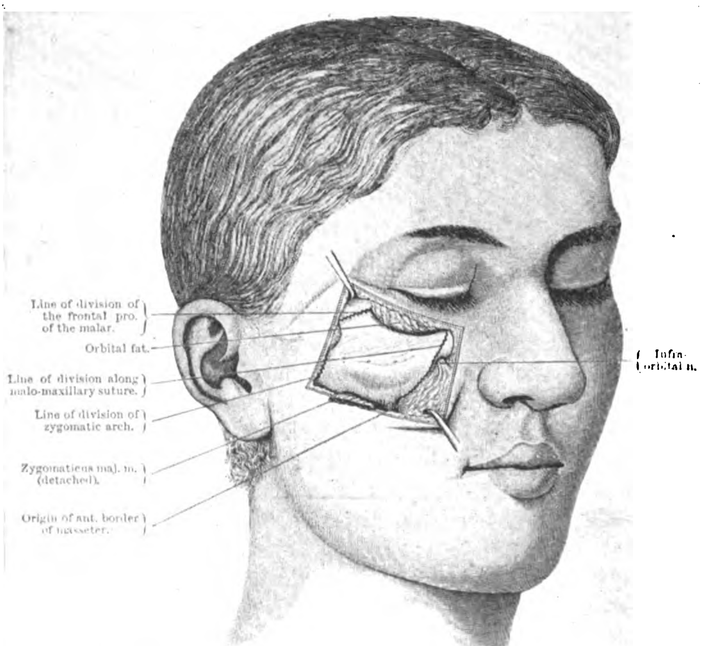
Nerve-stretching is performed by making an incision over the trunk, isolating it and lifting it out of its bed by a hook or the fingers. Strong traction is then made upon it in the direction of the peripheral branches, that is, away from the cerebro-spinal end, until a considerable increase in the length of the loop is apparent. If the operation is done without ether or if only local anæsthesia has been employed, the traction is to be continued until numbness of the periphery is experienced by the patient. The operation is only painful on account of the cutaneous or muscular incisions. The numbness and paresis of the parts to which the nerve is distributed soon pass away. Nerve-stretching has accomplished many cures of neuralgia. It has also been done for spasm of muscles.

Simple section of a nerve is of little value in obstinate neuralgia because union soon takes place ; hence, excision of one or two inches is much more successful. The neurectomy, or excision, should remove a portion of nerve as far as possible behind the seat of pain, for this gives the best chance of getting above the seat of pathological changes. The distal end of the divided nerve may be turned back or a portion of muscle may be interposed between the ends, to prevent union and recurrence of pain. If the neuralgia depends upon peripheral nerve change, these operations are usually permanently beneficial; but if the pain arises from alterations in the nerve centers, nerve-stretching and neurectomy give only temporary comfort. The absence of pain for several months, however, is often a great boon. The palsy after neurectomy is generally permanent. It has been suggested to cut out the cortical brain center, from which the painful nerve has its origin, if this can be determined by central localization.

Trigeminal Neuralgia.

Trigeminal or trifacial neuralgia, sometimes called prosopalgia or tic douloureux, gives rise to excruciating attacks of sudden pain in

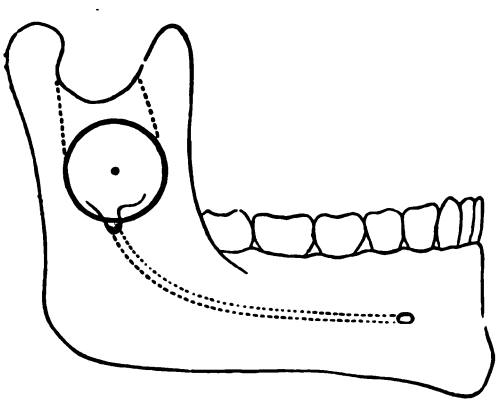
FIG. 90.



Resection of the second (superior maxillary) division of the trigeminal nerve. (KOCHER.)

the distribution of one or more of the divisions of the nerve. It is a disease of middle or advanced life and has been called epileptiform neuralgia. The violent twinges of agonizing pain may occur with great rapidity and be induced by attempts to speak, chew or swallow. The disease is apparently due to nerve changes and endarteritis of the nerves and Gasserian ganglion.

FIG. 91.

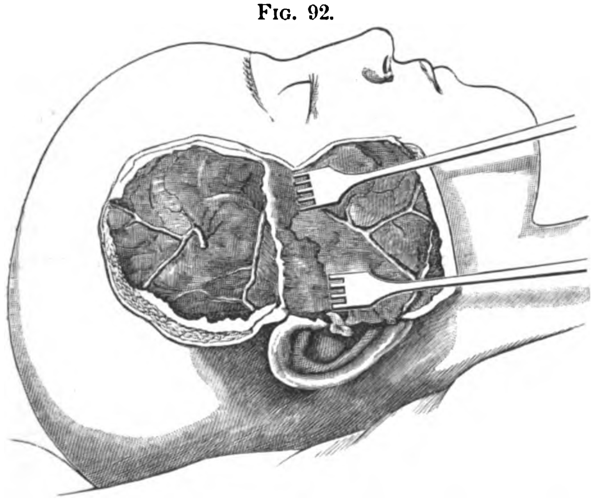


Side view of lower jaw, showing position of trephine opening in the operation for deepening the sigmoid notch. The dotted lines above the trephine opening indicate the extent of the bridge of bone which needs removal. The inferior dental canal and its anterior and posterior openings are indicated.

The patient usually comes to the surgeon after repeated failures to obtain a permanent cure with medicine. Any one or all three of the divisions are to be subjected to neurectomy extending back to the exit from the cranium. The relief so obtained usually lasts for some months or years. If the neuralgia returns it is proper to excise the Gasserian ganglion.

The supraorbital nerve is reached by an incision along the supraorbital arch, after which the nerve should be cut off as far back in the orbit as possible. If the nerve comes through a distinct foramen, this

FIG. 92.



Osteoplastic flap turned down, exposing the dura mater and middle meningeal artery. The brain and dura are then pushed upward so as to expose the petrous bone with the ganglion lying on its apex. (HARTLEY.)

foramen may be converted into a groove by cutting out the edge of the bone with a chisel and then a hook can be inserted above the globe of the eye so as to enable the surgeon to drag the nerve forward. The best exposure of the infraorbital nerve is obtained by an osteoplastic resection of the malar bone which is sawed through near the infraorbital foramen and near the zygoma and frontal bone and turned outwards. This operation gives opportunity to remove the nerve back to the round opening, whence it comes from the cranium.

The inferior dental is best reached by trephining the ramus of the lower jaw just below the sigmoid notch, to expose the nerve before it enters the inferior dental canal; the mental foramen is then uncovered and the roof of the canal removed by chisel circular saw. The ganglion of Gasser is reached by an osteoplastic resection of the skull made in the temporal region. By a trap-door opening in the temporal region, the base of the brain is uncovered and lifted with the dura mater from the middle fossa so as to give access to the ganglion.

TRAUMATIC DELIRIUM TREMENS.

Definition.—This is a nervous affection characterized by muscular tremor and a peculiar restless delirium, which not infrequently follows the receipt of injuries by those accustomed to alcoholic stimulation.

Causes.—Some writers under the terms traumatic delirium and nervous delirium describe a condition, frequently very similar to delirium tremens, which is said to occur in patients free from the alcohol habit and to depend upon nervous prostration, often associated with shock and hemorrhage. It is possible that failure to investigate previous habits with judicial acumen has allowed to arise a confusion between delirium dependent simply upon traumatism and delirium induced by traumatism in alcohol drinkers. The muttering delirium and muscular twitching that supervene in nervous prostration or asthenia, from surgical as well as from medical causes, and the noisy delirium after injury, that is usually exhibited by quick, rapid and full pulse and by febrile reaction, are two very different conditions to which the name traumatic delirium may with propriety be applied. These forms of mental disturbance—which might be called, in the one case, nervous or asthenic traumatic delirium and, in the other case, septic or inflammatory traumatic delirium—arise without reference to personal habits. These two conditions may perhaps be intermingled with alcoholic traumatic delirium, or traumatic delirium tremens, as it is here termed.

The group of symptoms here described as traumatic delirium tremens, is found especially, if not exclusively indeed, in those whose nervous systems have undergone, prior to injury, the deterioration due to absorption of alcohol. The amount of drinking requisite to induce the predisposition varies with the individual. The repeated ingestion of quite small quantities of alcohol may give rise to the delirious susceptibility. It is possible that a similar deterioration of constitution and consequent liability to trembling delirium may be caused by the opium, chloral, tobacco and other similar habits.

Traumatic delirium tremens may follow even slight injuries, but compound fractures and burns seem to have a special tendency to develop this serious complication. Its occurrence should not be ascribed necessarily to the restraint imposed upon the patient's habits by the injury, but to a traumatic disturbance of a previously unstable nervous equilibrium.

Traumatic delirium tremens occurs, because obscure chronic changes in the nervous tissue or blood, or perhaps in both, have rendered the alcohol drinker susceptible to such an outbreak upon the application of any disturbing influence. The receipt of injury is a sufficiently perturbing force, especially if the patient be on the verge of an idiopathic attack.

Pathology.—The alteration in nerve structure or blood, which is the essential pathological factor of delirium tremens, is unknown to us. An abnormal amount of serum is usually found in the substance of the brain and within its ventricles, and meningeal congestion and hemorrhage are often seen; the cells of the gray matter, the cerebral connective tissue and vessels show sclerotic or fatty changes and the liver, kidney and digestive tract exhibit the characteristic lesions found in chronic alcoholism, but there is nothing to which one can point as the distinctive lesion of delirium tremens.

Symptoms.—The initiatory symptoms of traumatic delirium tremens are sleeplessness at night and slight tremor; the latter is readily noticed by ordering the patient to hold out the hand with widely separated fingers. Subsequently restlessness, insomnia and tremor increase, and delirium is shown.

The delirium, which is often first exhibited at night, is peculiar. The patient sees numerous small animals or insects creeping over the bed and about his person, or is pursued by some hideous specter. Hence, he is constantly endeavoring to eject the vermin from his clothing, or trying to escape the persecutions of his tormentor. He may, in his efforts to get rid of these disgusting and distressing annoyances, leave his bed and jump from a window or down a flight of steps. The mental condition is one of depression, trepidation and great activity. He is exceedingly restless and is constantly chattering in a low tone; but though he may cry out because of fear, he shows little or no maniacal excitement. He is good-natured, not prone to violence, and can often be aroused by emphatically spoken words to an understanding of his surroundings; but he soon relapses into the previous incessant chattering and motion. Very often a single idea recurs again and again to his delirious fancy, and not infrequently the delirium has a comical or tragico-comical aspect. The muscular tremor is not like the twitching of tendons seen in asthenic conditions, but resembles the shakiness, from want of coördination, seen in cerebro-spinal sclerosis. Often there is hurry in movement, and the limbs or tongue will then be thrust forward with a jerk. The tremor of delirium tremens reminds one much of the movements that would be expected in an association of chorea with sclerosis of the nervous centers.

During these symptoms the patient is unable to sleep, is incessantly in motion, and has a bright eye with dilated pupils and an unsteady restless look. He exhibits a moist, flabby, tremulous tongue, with a whitish fur; desires no food; has constipated bowels, and passes a scanty, high-colored urine. In idiopathic delirium tremens of moderate severity there is no great acceleration of the pulse, and the temperature does not rise much above 100°, except during active muscular exertion. In those graver cases, which Magnan calls febrile delirium tremens, the bodily heat is apt to remain in the neighborhood of 102°–105°, though there is no incurrent affection to keep up the temperature, and the pulse rate is also increased. In traumatic delirium tremens the constitutional disturbance, due to the wound, affects the pulse and temperature. The patient will often remove the dressing from his wound or subject the injured limb to violent motion without appearing to experience pain.

Traumatic delirium tremens, as a rule, arises within two or three days after the receipt of injury and lasts usually not more than five or six days. The illusions are apt to continue during the night, even after the patient has become convalescent and quite rational in the daytime.

Diagnosis.—The peculiarity of tremor and delirium renders the diagnosis easy, except from the condition called above nervous or asthenic traumatic delirium. The existence of the described symptoms is, therefore, not absolute evidence of previous habits of stimulation, since it is possible that great nervous strain prior to injury may lead to a similar delirium. Usually, however, alcohol seems to be the predisposing cause.

Prognosis.—Death may occur from exhaustion, coma or some intercurrent affection; and is sometimes inexplicably sudden. The character of the traumatism may determine the mode of death. Pneumonia is frequently associated with delirium tremens. It is often, in fact, the exciting cause of the delirious outbreak, and, of course, in traumatic cases, greatly diminishes the chance of recovery. When the temperature shows a tendency to remain high without a sufficient traumatic cause, and especially when the tremor affects all the muscles of the trunk as well as those of the head and extremities and is not arrested during sleep, the prognosis is bad. A history of previous attacks of the disease renders the outlook more grave.

Treatment.—It is important to bear in mind that delirium tremens is an asthenic condition. Depressants are, therefore, injurious. Five or ten grains of calomel or one or two Seidlitz powders may be administered in the beginning of the disease, or when its occurrenee is feared, because of the anorexia and gastric derangement.

Concentrated liquid food with bitter tonics and capsicum add to the patient's strength and tend to give tone to the impaired digestive organs; bathing, Turkish baths if possible, and mild diuretics may be prescribed in the endeavor to eliminate the alcohol that has entered the system. Chloral (gr. x–xx) with potassium bromide (gr. xxx–xl) should be given every two or three hours as soon as sleeplessness and slight tremor is noticeable. No visitors should be allowed in the room. If the development of the attack is not prevented, the same treatment is continued, but the doses may be increased. The object is to quiet the nervous system and produce sleep. In this endeavor an occasional dose of morphia (gr. $\frac{1}{4}$–$\frac{1}{3}$) may be combined with the chloral and potassium bromide. The excessive use of opiates is undesirable for it is not narcotism that is desired, but sleep.

Cerebral congestion is induced by overdosing with morphia. If fatty heart exists opiates should be pushed, perhaps, rather than the chloral and bromide of potassium. The combination treatment by the three hypnotics allows the surgeon to diminish or increase each element according to indications. Tincture of digitalis (♏x–♏xxx) is valuable in cases of weak, but not fatty, heart, where there are pallor and cyanosis with probable anæmia of the brain. Strychnia has a high value. Hyoscine hydrobromate (gr. $\frac{1}{100}$) and other hypnotics may prove serviceable.

Mechanical restraint with straps and the straight-jacket is only to be adopted when efficient watching and soothing by attendants are impracticable. All such apparatus excites the patient and is very liable to interfere with respiration. The best appliance is a loose, but strong, garment consisting of trousers and shirt in one piece, with loops attached for fastening the patient in bed. Fractures should be dressed with plaster-of-Paris bandages, because ordinary splints will probably be displaced by the patient. Alcoholic stimulants in small amounts, administered only when food is given, are often judicious. Whiskey or brandy (f℥ij to f℥iv daily) in the form of milk punch or eggnog is probably the best form of administration. Many patients will not require any stimulants whatever. Vomiting occurring in delirium tremens is to be treated by milk and lime water, cracked ice, effervescing drinks, subnitrate of bismuth, pepsin, and carbolic acid mixtures.

Nervous traumatic delirium tremens is to be treated by bromides, chloral, hyoscine and nerve tonics, and presents a favorable prognosis.

Septic or inflammatory traumatic fever requires judicious antiseptic treatment to combat the local infection from septic products, cold to the head, and hypnotic remedies. It occurs when the septic fever is at its height and is often more conspicuous at night; resembling in this latter respect alcoholic traumatic delirium.

INSANITY AFTER OPERATIONS.

A post-operative insanity is sometimes observed; but the etiology of the condition is not understood. It is to be treated on general principles and usually subsides within a comparatively short time.

TRAUMATIC NEUROSES.

Persons who have received injuries under circumstances of great fright or horror may, even if the organic injury be slight, suffer profound nervous and mental depression. Those of a neurasthenic or hysterical disposition may develop similar symptoms from insignificant injuries, unaccompanied by any special horror or anxiety.

The symptoms vary, but the fact of the injury is usually so impressed upon the mind of the patient as to determine their character, at least to a certain extent. Among the general symptoms are irritable and frequent pulse, headache, sleeplessness, indigestion, mental foreboding, loss of memory, disturbances of vision and loss of strength and weight. The hysterical manifestations seen in such cases are those seen in hysteria unconnected with a traumatic cause, and may include epileptiform attacks, local loss of muscular power, anæsthesia, hyperæsthesia and vaso-motor changes.

The traumatic neuroses are often very difficult of diagnosis, because their resemblance to gross organic lesions is great. It is difficult, for example, to be certain that no damage was done to the viscera when persistent vomiting and grave deterioration of health have followed a blow on the epigastrium. Careful observation will usually convince the surgeon that the symptoms are psychic and not due to structural damage.

The treatment consists in encouraging the patient, allaying his forebodings, building up the health with tonics, and gradually directing his mind away from his symptoms. The management of this class of cases demands the highest professional skill; and is often unsuccessful until the patient is separated from sympathizing and solicitous friends.

NEURECTOMY OF THE IMPORTANT NERVES.

In exposing nerves there is no objection to raising a flap of skin and superficial fascia so as to get room to see the anatomical relations. It was formerly the custom in ligating arteries and exposing nerves to make a linear incision; but it will be found in both cases that the raising of a horseshoe-shaped flap will make identification of the landmarks much more easy.

Trigeminal.—The method of exposing and excising the divisions of this nerve have already been described under the treatment of trigeminal neuralgia.

Facial.—An angular incision about two and a half inches long is made immediately behind the auricle with the apex of the angle pointing backward over the tip of the mastoid process. The nerve will be found in the bottom of the narrow space between the sterno-mastoid muscle behind and the parotid gland in front. It lies at the depth of about one inch and upon the fascia covering the muscles on the front of the vertebral column. The nerve is rather small, but will be found about a quarter or half inch in front of the middle of the anterior edge of the mastoid process.

Spinal Accessory.—A three inch incision along the anterior edge of the sterno-mastoid muscle and beginning at the point of the mastoid process will enable the surgeon to reach this nerve. The cervical fascia should be opened, the tissues of the neck relaxed, and the sterno-mastoid muscle drawn outward and backward. The nerve will then be found crossing the transverse process of the atlas.

Brachial Plexus.—This plexus may be uncovered in the neck by an incision above the clavicle and parallel to it similar to that employed for ligation of the subclavian artery. An incision which is perhaps a little better is that beginning a little above the middle of the clavicle and extending upwards parallel to the anterior border of the trapezius muscle.

Median.—A cut along the inner border of the biceps at its middle will give access to the median nerve where it crosses the brachial artery obliquely from without inwards. Near the wrist the surgeon reaches the median nerve by an incision along the ulnar side of the radial flexor of the wrist.

Ulnar.—The incision for reaching the ulnar nerve in the middle of the arm should be parallel to that given for the median nerve but half an inch nearer to the inner side of the arm. This nerve can also be uncovered with ease by an incision between the internal condyle of the humerus and the olecranon. At the wrist the ulnar nerve is found along the radial side of the tendon of the ulnar flexor of the wrist. It is necessary to cut through two layers of the deep fascia.

Musculo-spiral.—The line of this nerve is shown upon the skin by stretching a string from the tip of the acromion to the external condyle of the humerus. The nerve is easily found on making an incision on this line half way between the external condyle and the insertion of the deltoid. The nerve lies in the intermuscular space between the biceps and triceps. The edge of the long supinator will assist in identifying the position of the nerve. The supinator should be drawn outwards.

Radial.—To find the radial nerve an incision should be made on the outer side of the forearm about three inches above the wrist. The nerve will be found passing under the tendon of the long supinator on its way from the palmar surface of the forearm to reach the back of the wrist.

Great Sciatic.—A line drawn downward from a point half an inch nearer the tuberosity of the ischium than the trochanter to the middle of the popliteal space indicates the course of this nerve. A three-inch incision on this line beginning just above the gluteo-femoral crease will uncover the nerve. The gluteal muscle should be drawn upward a little and the biceps and other hamstring muscles should be pulled inward. Flexion of the knee will render displacement of the hamstring muscles easy. In the popliteal space the sciatic nerve or its continuation, the internal popliteal, will be reached by a vertical incision in the median line. The external popliteal nerve is found just inside of the tendon of the biceps at the outer edge of the popliteal space. The incision should be made parallel to this tendon running down over the fibula.

Anterior Crural.—A vertical incision beginning a little above Poupart's ligament over the hollow between the psoas and iliac muscles will give access to this nerve.

Anterior and Posterior Tibial.—These nerve trunks lie to the fibular side of the corresponding arteries and are reached by the same incisions as are employed in the exposure of the arteries.

Internal Saphenous.—This nerve is reached by an incision along the posterior margin of the sartorious muscle, opposite the internal tuberosity of the tibia. It lies behind the internal saphenous vein.

Musculo-Cutaneous.—For the exposure of the musculo-cutaneous nerve an incision should be made a little below the middle of the leg in a line drawn from the front of the head of the fibula to the posterior border of the external malleolus.

CHAPTER XV.

DISEASES AND INJURIES OF THE HEART AND BLOOD VESSELS.

Thrombosis and Embolism.

THROMBOSIS, the formation of a coagulum during life, depends on the fibrinogen in blood serum becoming united with paraglobulin as a result of the action of the fibrin ferment. All of the ferment and much of the paraglobulin are contained in the leucocytes and are released by the disintegration of these cells. The endothelium of the vessels seems to control this disintegration, and its integrity keeps the blood fluid. If the endothelium is altered, thrombi are apt to form. If the surgeon desires coagulation in a vessel, he mechanically injures the endothelium, as in stopping hemorrhage by ligation and torsion and in introducing foreign bodies into aneurismal sacs. Other causes of endothelial lesions and therefore of thrombosis are foreign bodies, emboli, inflammation, gangrene, degenerative changes and micro-organisms.

Thrombi may be composed principally of red corpuscles, of white corpuscles, of fibrin or of globulin, or they may be mixed thrombi and be developed in layers. They are quite different from clotted blood formed after death.

Red thrombi finally become decolorized. They and other thrombi may become organized, that is, changed into connective tissue supplied with blood vessels ; become calcified ; or undergo softening. The last change is usual when bacterial contamination occurs.

Embolism.

Transportation of materials from one part of the vascular system to another is called embolism. An embolus is anything so carried in the blood. It may be a vegetation from a cardiac valve, globules of fat, bubbles of air, fragments of tumors, hooklets of echinococcus cysts, or other foreign bodies, or a portion of a thrombus. Fragments of thrombi sometimes carry with them attached micro-organisms.

The importance of embolism will be understood when it is remembered that the particles transported in the circulation may plug up a small vessel, so that obstruction to the blood flow occurs. The plugging depends on the relative size of the embolus and the caliber of the vessel. Obstruction is apt to occur in that region of small capillaries which is first reached by the floating particle. The lungs, liver, kidneys, spleen and brain have intricate networks of capillaries. Hence embolic occlusion is apt to occur in that one of these organs which the embolus first reaches. The embolus may however pass one or more systems of capillaries before its transit ceases. If the embolus is infected it is likely to set up at the seat of the plugging (infarction) a process similar to that present at the seat of its origin. From this new site of the pathological process, secondary emboli may start on their journeyings. This has been explained in the discussion of pyemia.

The occlusion due to embolism may be: temporary, because the collateral circulation gives a sufficient blood supply to the anæmic area beyond the plug and no special damage occurs; or permanent. In the latter case the conical area supplied by the branches of the plugged vessel remains anæmic or, because of coagulation necrosis, becomes hemorrhagic from reflux of blood from surrounding tissues. Gangrene may supervene in front of the plug, either from want of sufficient blood supply or because the tissue resistance is lowered and infection readily permitted. Gangrene of the bowel thus occurs from embolic occlusion of mesenteric vessels and gangrene of the foot or leg from similar plugging of the popliteal artery.

Fat embolism, due to the entrance of fat into the veins, has already been discussed in connection with shock, with which it is sometimes confused clinically.

Air embolism, or the entrance of air into the veins, will be considered under wounds of veins.

Examination of the Blood.

The blood contains three forms of corpuscles; the red (erythrocytes), the white (leucocytes) and the blood placques. The blood contains about 5,000,000 to 5,500,000 erythrocytes in a cubic millimeter. The placques consist of colorless protoplasm about 2½ microns in diameter and are found in the proportion of one blood placque to twenty red corpuscles. They are more numerous during recovery from acute and extensive suppuration and in some other medical and surgical conditions.

The white cells, or leucocytes, rapidly increase in number during acute inflammation, probably because they are needed to destroy microorganisms by the process of phagocytosis. In normal conditions their relation to the erythrocytes is from 1 : 700 to 1 : 1000. In inflammation the leucocytosis may be so marked that this proportion is greatly increased. Leucocytes are divided according to their staining peculiarities into: 1, lymphocytes, or small mononuclear leucocytes; 2, large mononuclear leucocytes; 3, polynuclear or neutrophilic leucocytes; 4, transitional forms of leucocytes; 5, eosinophilic leucocytes. These varieties occur in rather constant proportions in normal blood; and it is, therefore, incumbent upon the scientific surgeon to recognize the probable value of deviations from this standard. The proportion of lymphocytes is from 20 to 30 per cent. of the whole number of leucocytes, while the large mononuclear forms exist in the proportion of from 2 to 3 per cent., the polynuclear about 65 to 75 per cent., the transitional 3 per cent., the eosinophiles from 2 to 4 per cent. The first form is believed to be derived from the lymphoid tissues, while the fifth form originates in bone marrow; the other three forms take their origin, it is thought, in the spleen and bone marrow.

The red cells vary in shape, size and number. In acute anæmia and in some other conditions nucleated red corpuscles are found. It is believed that the erythrocytes are formed principally from the nucleated red marrow cells seen in bone. It is stated that after hemorrhage red blood corpuscles may be formed at the rate of 50,000 per cubic millimeter in a day. In some diseases blood cells are found which seem to be different from those found in normal blood. (Plate VI.)

The number of leucocytes in a cubic millimeter of normal blood is about 7,500 to 5,000,000 or 5,500,000 of red cells. Some variation occurs after eating and in pregnancy. If the white cells vary 1,500 above or below this number, an abnormal relation is considered present. It is the polynuclear cells which are especially increased in number in leucocytosis.

Leucocytosis, an abnormal proportion of white blood cells, is determined by making a blood count. This is done by actually counting the white and red corpuscles in a definite amount of blood by means of a hemocytometer; or getting the relative proportion by means of a centrifugating apparatus, called a hematocrite. The erythrocytes and the leucocytes have a different specific gravity; they can, therefore, be separated by centrifugal force and their relative proportion may thus be estimated. The percentage of hemoglobin present in a given blood is usually determined by comparison with different shades of red glass. The instrument commonly employed, called a hemometer, is used in a darkened room and illuminated by a single flame, so that the blood can be compared with the arbitrary standard of color. The hemoglobin in red corpuscles of normal blood should be of a tint from 90 to 100 per cent. as red as the shade of red taken as a standard. The estimation of hemoglobin is of value to the surgeon.

Surgical Uses of Blood Examinations.

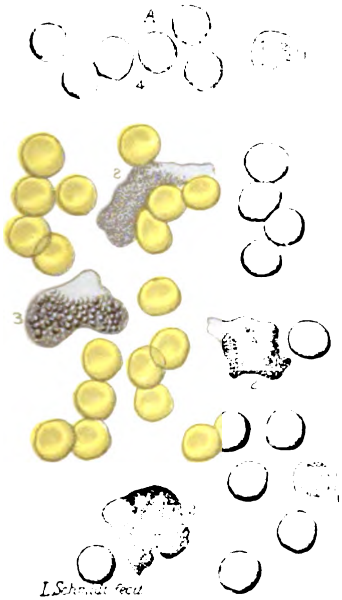
Leucocytosis, which is a temporary increase in white cells as distinguished from leukemia in which there is a permanent increase, is usually found in suppurative inflammation even if the suppurative focus is small. The paraglobulin and fibrin ferment, which cause coagulation, are largely supplied by the leucocytes; hence, disintegration of leucocytes releases these substances and gives rise to thrombosis, which is a frequent condition in inflammation.

An unusual number of eosinophilic leucocytes points to an unusual activity of pathological processes in the bone marrow, from which this form of corpuscle is derived.

Appendicitis is an inflammatory condition and therefore is accompanied by leucocytosis. This circumstance may aid in the diagnosis, since uncomplicated typhoid fever, which may present similar symp-

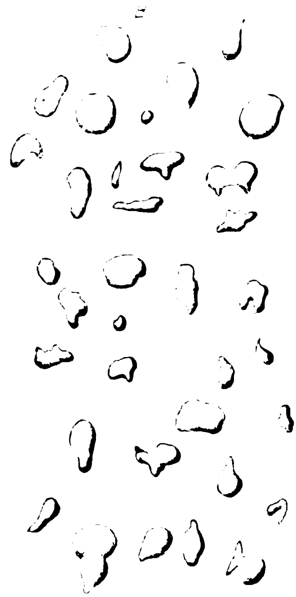
PLATE VI.

FIG. 1.



Elements of Normal Blood.

1, Small Mononuclear Leucocyte; 2, Neutrophilic Leucocytes; 3, Eosinophilic Leucocyte; 4, Normal Red Blood Corpuscles. Unstained Specimen.

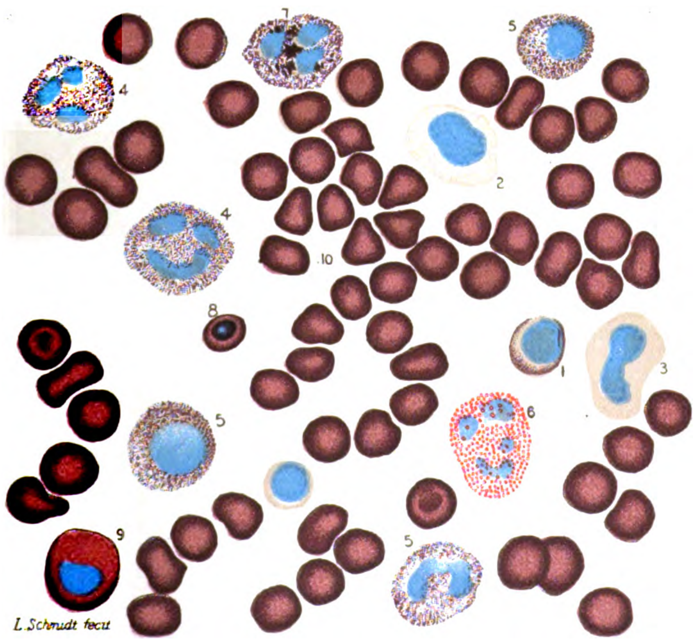


Poikilocytosis.

Unstained Specimen taken from a Case of Pernicious Anæmia. (Personal Observations.)

[Charles E. Simon.]

FIG 2.



The Various Elements of the Blood Stained with Ehrlich's Tri-acid Stain.

1, Small Mononuclear Leucocytes; 2, Large Mononuclear Leucocytes; 3, Transition Form; 4, Neutrophilic Leucocytes; 5, Myelocyte; 6, Eosinophilic Leucocyte; 7, Melaniferous Leucocyte; 8, Normoblast; 9, Megaloblast; 10, Normal Red Corpuscles. (Personal Observation.)

[Charles E. Simon.]

toms, shows no leucocytosis. General sepsis is said to be differentiated from uncomplicated typhoid fever by the absence of leucocytosis in the latter disease. Surgical complications, such as abscess and thrombosis, and inflammatory diseases of the lung, need not be suspected in typhoid fever, it is asserted, if the blood count shows a normal number of leucocytes.

Acute intestinal obstruction may be diagnosticated from appendicitis or suppurative peritonitis by the absence of leucocytosis. On the other hand, leucocytosis is present in soft and rapidly growing malignant tumors and in sarcoma of bone; but is absent in tuberculosis and chronic arthritis. In suppuration and in cases of septic infection the white cells are increased. It is said that there is no need of redressing wounds in which high temperature suggests pus formation, unless leucocytosis is found by a blood count. In a similar manner a suspected meningeal suppuration, due to ear disease for example, may be differentiated from typhoid fever with cerebral symptoms by the presence of leucocytosis in the first disease and its absence in the latter.

Study of the erythrocytes, or red cells, also furnishes diagnostic information. In acute anæmia and in many chronic anæmias nucleated red cells are seen. After hemorrhage the prognosis can be determined to a certain extent by studying the increased proportion of hemoglobin in the blood. The rapidity of a return to a normal proportion furnishes an index of the rapidity of the return to health. The hemoglobin is reduced greatly in malignant disease. The reproduction of hemoglobin occurs after removal of malignant tumors, but is retarded or again decreased by a recurrence of the malignant disease.

DISEASES AND INJURIES OF THE HEART AND PERICARDIUM.

Wounds of the Pericardium and Heart.

Punctures and small incisions of the pericardium, if uncomplicated with injury to the internal mammary artery, heart or lungs, present no marked symptoms, and are usually soon repaired by a local pericarditis. Such wounds, if aseptic, are made almost with impunity in treating pericardial effusions by aspiration and incision.

Larger wounds are much more serious by reason of the suppuration more likely to occur and the involvement of neighboring structures. The treatment of pericardial wounds consists in rest, antiseptic dressings, and, if suppuration takes place, free exit for the pus by incision, drainage and frequent irrigation. If pericardial effusion occurs after a contusion or laceration of the membrane, blisters, diuretics and hydragogues should be employed as in rheumatic pericarditis. If the effusion persist and the symptoms become urgent, pericardicentesis should be performed.

Wounds of the heart are generally, but not necessarily fatal. Patients have survived many years with foreign bodies buried in the cardiac walls. The diagnosis is obscure, though signs of internal hemorrhage, or profuse external bleeding with syncope, or great shock with irregular and feeble action of the heart, occurring after a wound of the pericardium, make it probable that the heart has been injured.

Small cardiac wounds may not be followed by much bleeding, because the peculiar interlacing of the muscular fibers causes the opening to be closed as by a valve. In other cases the pericardium may become filled with blood to such an extent as to make the cardiac sounds and beat almost imperceptible. Death may arise from interference with the heart's action in this manner when the wound itself is not necessarily fatal. The hemorrhage from the heart may be slow or be arrested by a clot forming in the orifice. This may be washed out when reaction from shock occurs, and secondary hemorrhage and death may thus take place. Men may walk after wound of the heart. Dyspnoea, pain, pericardial distress and a systolic-bellows sound have been observed in heart wounds, but these symptoms and signs are not always present.

It should be remembered that the heart lies obliquely between the upper margin of the third costal cartilage and the top of the sixth cartilage, and that it extends from a line about one inch inside of the left nipple to a point a little beyond the right margin of the sternum. Wounds of the auricles are more dangerous than similar injuries to the ventricles.

Wounds of the heart must be treated by absolute rest in the supine position, by cold to the front of the chest, morphia, atropia and digitalis. Incision of the pericardium, removal of the clots, and antiseptic injections may be advantageous. Suture of the heart has been done successfully. Resection of the costal cartilages will be necessary in order to gain access to the parts. A trap-door incision may be made and the resected parts subsequently replaced.

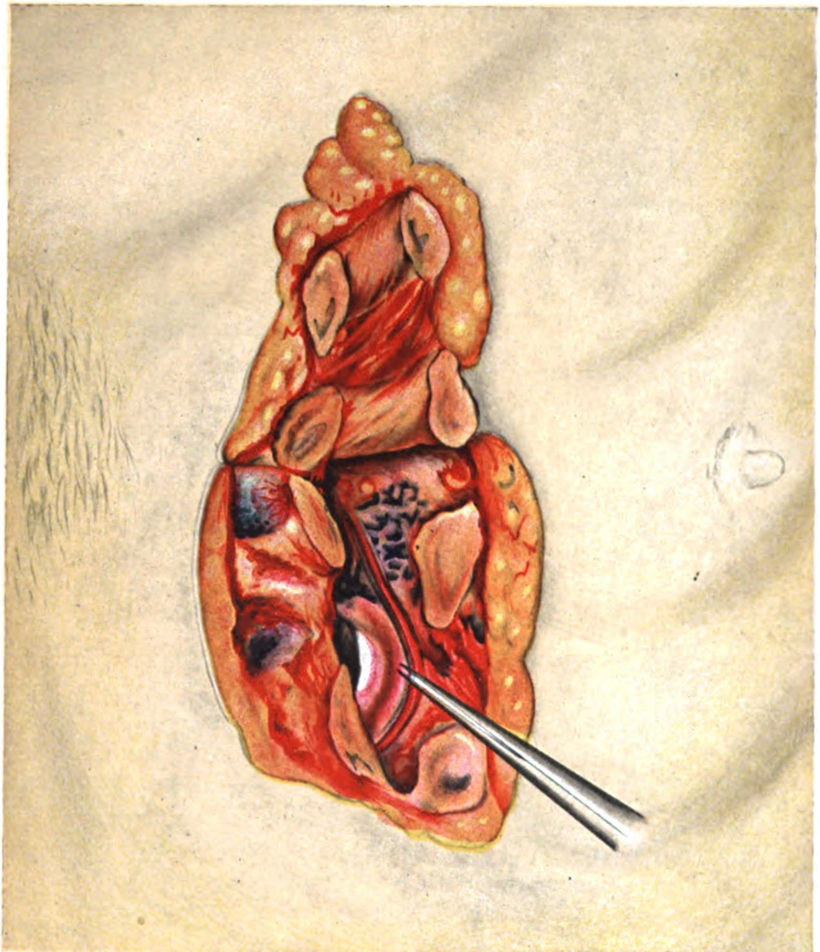
Tapping the Pericardium or Pericardicentesis.

In pericarditis with effusion and in cases of hydropericardium from renal disease, the pressure exerted upon the heart by the accumulated fluid is at times a mechanical cause of death. Hence, it may become necessary to withdraw the fluid by aspiration. In all cases of pericardial effusion which present dangerous symptoms of heart failure, aspiration should be performed as soon as it is evident that medication is not lessening the embarrassment of the central organ of circulation. It is bad practice to delay operation until exhaustion, pulmonary engorgement and degeneration of the cardiac muscle render permanent relief impossible. A moderate quantity of serum suddenly effused will exert more pressure on the heart than a much larger amount poured out in so gradual a manner as to allow the pericardium to become stretched. Hence, the symptoms, and not the amount of serum, must be the guide to operation.

The best points for aspiration[1] of the pericardium are close to the

[1] American Journal Medical Sciences, December, 1897.

PLATE VII.



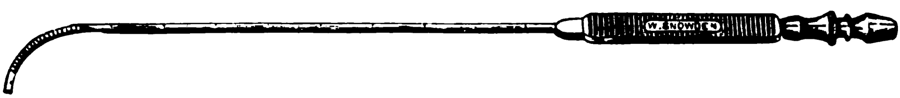
Author's Chondro-plastic Method of Pericardotomy, by a Trap-door Excision of Costal Cartilages, which avoids Injury to the Pleura and Internal Mammary Vessels.

[The flap, consisting of portions of the fourth and fifth cartilages and the attached soft parts, is turned upward, exposing the left lung covered with pleura and the internal mammary vessels. The forceps is seen holding the vessels and the edge of the pleural sac outward, so as to expose the white pericardium, in which an opening, indicated in black, has been made.]

base of the ensiform cartilage in the fossa, between it and the seventh left costal cartilage and in the fifth interspace, just above the sixth rib, about five or six centimeters (2–2¼ inches) to the left of the median line of the sternum. The former point avoids injury to the pleura. The ordinary aspirating needle or the pericardial aspirating trocar may be employed. In all cases the vacuum chamber should be attached to the puncturing instrument as soon as its point is buried beneath the skin, in order that the flow of fluid may indicate the moment when the pericardium is entered.

The pericardial aspirating trocar recommended consists of a moderate size aspirating needle, within which slides a canula with a flexible end. During penetration of the chest wall the canula is retracted, so that

FIG. 93.



Roberts's aspirating pericardial trocar.

the flexible end is contained within the needle. Afterward it is thrust forward to guard the sharp point of the needle and prevent scratching of the heart's surface when withdrawal of the fluid causes the pericardial sac to collapse.

If there coexists pleural effusion of considerable amount, the pleural sac should be aspirated first, because it is difficult to discriminate between respiratory distress due to pulmonary pressure and that resulting secondarily from interference with cardiac action. This rule applies to pleurisy of the right side as well as of the left.

When the amelioration of symptoms following pericardial aspiration is not permanent, because reaccumulation takes place, the operation should be repeated. It is better to vary the point of puncture, lest, on account of adhesion of the layers of pericardium at the original point, the heart be wounded at the second tapping. Should repeated tapping be demanded, some irritating fluid, such as tincture of iodine, may be injected into the sac, with the idea of producing adhesion of the two layers of pericardium.

When aspiration has shown the pericarditis to be purulent, incision and the introduction of a drainage tube of rubber are required. The cavity can then be washed out daily with antiseptic solutions, and purulent accumulation with its attendant dangers of pressure on the heart and septicæmia avoided. The best method of pericardotomy is by a trap-door resection of the costal cartilages. (Plate VII.)

Incision may be useful in certain cases as a diagnostic procedure, when doubt exists as to the condition being dilated heart or pericardial effusion.

DISEASES AND INJURIES OF THE ARTERIES, VEINS, AND CAPILLARIES.

Hemorrhage.

Definition.—An escape of blood from the vessels is called hemorrhage, and is either spontaneous or traumatic. When the blood is discharged, not upon the surface of the body or into a cavity, but into the meshes of the connective tissue, the term extravasation is generally used. An extravasation into the connective tissue beneath the skin is often designated a subcutaneous hemorrhage.

Varieties.—Traumatic hemorrhage is primary when it immediately follows the receipt of wound; intermediary, when it occurs after reaction from the shock of injury and before the lapse of twenty-four hours; and secondary, when it takes place between the end of the first twenty-four hours and the completion of cicatrization of the wound.

Intermediary, often called recurring, hemorrhage arises because the force of the circulation has, from the establishment of reaction, become sufficient to displace the clots which, during the previous condition of feeble circulation, prevented bleeding.

It may, therefore, occur from small vessels that did not, at the time the wound was dressed, seem to demand ligatures or other treatment; or from larger ones, to which ligation, torsion or acupressure was carelessly or imperfectly applied or in which the wound was so small that no hemorrhage supervened until the circulation had fully regained its force.

Secondary hemorrhage may be due to any constitutional condition, such as hematophilia, septicæmia, pyæmia, hepatic disease or renal disease, which interferes with the plastic changes and organization of the internal clot that constitute Nature's method of permanently sealing wounded vessels. Hence, when the ligature is absorbed or the wall of the vessel ulcerated through at the point of ligation, bleeding supervenes.

Secondary bleeding may also be caused by an unrecognized contusion or abrasion of the vessel wall which has subsequently given away at the injured spot, by failure of the surgeon to secure the distal end of the artery or to tie a wounded branch situated just above the ligature. In the last two instances the establishment of the anastomotic circulation may be followed by bleeding. Sloughing in the wound, atheroma of the arterial wall, septic processes due to septic ligatures or dressings, badly applied ligatures, premature softening of a ligature, and the rush of the blood-current through a large branch given off just above the point of ligation are usual causes of secondary hemorrhage. Secondary bleeding usually does not occur earlier than one week, or later than three weeks, after the time of injury or operation. Septic causes are responsible for the majority of cases of secondary hemorrhage. Aseptic surgery has almost made secondary hemorrhage unknown.

The occurrence of profuse secondary bleeding is generally preceded by a slight flow of blood, which, when observed during the progress of cicatrization, should always be looked upon as a warning of grave import. There may be several slight hemorrhages from the wound, and then a profuse bleeding which may quickly destroy the enfeebled and anæmic patient.

Blood starts from a wounded artery in a rapid stream, and, as each beat of the heart gives an increased impulse to the blood-current, the jet gains force and is propelled further, synchronously with the cardiac pulsations. The blood is of a bright red color, unless the patient is deeply anæsthetized or partially asphyxiated; then respiration and oxygenation are imperfectly performed, and the blood is dark. When an artery has been completely divided, the hemorrhage from the end further from the heart may not be rhythmical until the collateral circulation is well established.

Venous hemorrhage is characterized by a steady flow of dark blood, which is not affected by the heart's action. The stream may show a tendency to rise and fall in a sluggish manner with each respiratory act, but never spurts. If the bleeding occurs at the bottom of the wound the blood may become reddish from admixture with air before it reaches the surface.

Hemorrhage from capillary vessels, called parenchymatous hemorrhage, occurs as an oozing of blood. The steady stream has a color less red than arterial and less purple than venous blood.

Causes.—Solution of continuity of vascular walls is the common cause of hemorrhage, but bleeding does occur at times from mucous and serous surfaces without apparent lesion. Here the quality of the blood is probably at fault. Cirrhosis of the liver and poisoning by phosphorus and some other substances are said to cause this form of blood transpiration. It must be recollected that hemorrhage from any part may be vicarious to menstruation or other customary loss of blood.

Constitutional Effects of Hemorrhage.—In certain cases no blood is visible externally, though a sufficient quantity to cause fatal anæmia has been poured out into the intestines, uterus or abdominal cavity; or into the cellular tissue surrounding the perforated vessel. Such concealed hemorrhages are to be recognized by the constitutional effects produced by the withdrawal of blood from the vascular channels.

The general symptoms of hemorrhage are influenced by the constitutional characteristics of the patient and the vessel from which the blood flows, but depend more especially upon the quantity of the blood lost and the rapidity of its escape. Children and the aged are greatly affected by the loss of blood. Arterial hemorrhage may be expected to produce greater depression than a similar loss from veins, for the obvious reason that venous blood is, in a certain degree, an effete fluid.

When a violent and profuse gush of blood occurs from rupture of a large arterial trunk, death is rapid. The blood in all the arteries has a recurrent tendency, and, instead of being forced by arterial and cardiac contraction into the peripheral vessels, it flows toward the wound; hence there is a consequent venous stagnation which gives a livid tinge to the otherwise pallid surface. The patient who has fallen to the ground in a state of syncope, gasps for breath, throws his limbs about restlessly, and, after convulsive twitchings of the facial and other muscles, expires. Profuse hemorrhage from a large venous trunk causes death in a somewhat similar manner. A less impetuous loss of blood, whether arterial or venous, causes a feeble and rapid pulse, sighing respiration, pale conjunctivæ and lips, a cold clammy skin, dilated pupils, restlessness, and a confused mind. The patient feels weak and thirsty, is giddy, has impaired vision and hearing, or, perhaps, sees luminous spots or hears unusual noises, experiences a sense of suffocation, but feels no special pain, and rather suddenly loses consciousness. During this state of syncope the breathing is almost entirely diaphragmatic and the heart's pulsation can scarcely be detected. This lowering of circulatory tension gives an opportunity for coagulation in the wounded vessel, and the bleeding is arrested. The patient now recovers from the condition of insensibility, and perhaps vomits as he returns to consciousness. The increasing force of the heart's action, however, is soon sufficient to cause the blood current to force the clot from the interior of the injured blood vessel, and hemorrhage, with the train of symptoms mentioned above, recurs. This alternation of bleeding and spontaneous arrest is kept up until death occurs from anæmia of the nervous centers. Sometimes delirium, convulsions and hemiplegia precede the fatal termination. In very slow hemorrhage there arises great debility, with waxy looking skin, œdema of the dependent parts, and a tendency to syncope on assuming the erect posture. A blood examination will show the characteristic diminution of erythrocytes and hæmoglobin.

After death from prolonged or repeated hemorrhage the tissues are soft and flabby, because the fluids have been absorbed to fill the emptied blood vessels. This explains, also, the thirst felt by the patient. After serious hemorrhage has been stopped a stage of reaction often supervenes, to which the name hemorrhagic fever has been applied. The symptoms are febrile manifestations and a frequent, quick pulse, accompanied by irritability and restlessness of mind and body. Occasionally hemorrhage is followed by a chronic anæmia, which is extremely rebellious to treatment. The febrile state, above mentioned, is to be met by rest, sponging the surface, cold to the head, nutritious fluid food and tonic remedies.

Nature's Mode of Arresting Hemorrhage.—Obscure is the means by which spontaneous cessation of hemorrhage is determined in those unusual cases of oozing, without apparent lesion of the bleeding surface, which have been mentioned.

Hemorrhage, from vessels in whose walls a solution of continuity has been produced by accident or operation, often ceases spontaneously. It usually does so in veins, except those of great calibre, and in arteries smaller than the radial and facial. The method employed by nature in arresting hemorrhage is the same in arteries and veins, though in the latter the sluggish blood current does not demand such active contraction and retraction of the walls of the vessel.

When an artery has been completely divided, nature promptly institutes steps, which are intended to cause a temporary arrest of the escape of blood until a permanent occlusion of the open extremity can be accomplished. The same series of changes occur in both the cardiac and distal ends of the cut vessel. The temporary means consist of: (1) Contraction and retraction of the cut end; and (2) clotting of the escaping blood in and around the sheath of the vessel.

The permanent means are: (1) The formation of a clot within the artery; (2) plugging of the orifice, and union of the edges of the cut extremity by the ordinary process of repair; and (3) cicatricial contraction of the walls of the vessel by which an impervious fibrous cord is produced.

Temporary Means.—The contraction of the walls of the vessel, which extends up to the first branch, gives its section a flattened or ovoid shape, and, by diminishing the calibre, lessens the size of the blood stream. At the same time, the retraction of the cut end of the artery within the sheath leaves a space between it and the wound in the nonretractile sheath, which detains the escaping blood and encourages coagulation. Coagulation also takes place outside of the wounded sheath. Lacerated vessels, by the irregularities of the torn ends and of the sheath, encourage this clotting and, if large, may soon stop bleeding.

FIG. 94.

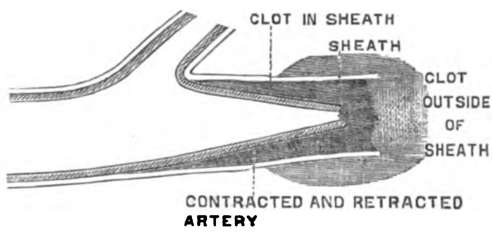


Diagram of Nature's temporary method of arresting hemorrhage.

These provisions of Nature may at first fail to stanch the bleeding, because the force of the heart is sufficient to drive enough blood through the contracted vessel to wash away the intra- and extra-vascular clots. As the continuing hemorrhage increases the coagulability of the blood and weakens the cardiac power, perhaps to syncope, the time arrives when these temporary expedients of Nature stop the flow. Cardiac strength then returns and may, by the increased intravascular pressure, cause recurrence of the bleeding. In many instances, however, the temporary means are effective until permanent changes can be brought about to repair the vascular traumatism.

Permanent Means.—When a temporary check has been given to the flow of blood, a coagulum gradually forms within the artery. This is conical in shape, with its base situated and fixed at the opening, while its apex, lying loose in the lumen of the artery, extends as high as the first branch. The base of this internal clot corresponds in size with the interior of the vessel, which it fits like a cork.

After the deposition of this internal coagulum and sometimes without its formation, for it may occasionally be absent, an exudation of inflammatory lymph occurs in the stump of the artery and around it and the sheath. This plastic material unites the edges of the wound and seals the orifice by a button-like plug of exudate. The internal blood coagulum is at its base more or less intimately associated and commingled with the plastic deposit. Organization of the exudate, disappearance of the blood-clot and permanent cicatricial contraction of the vessel to the first important collateral branch go on, until finally from the first branch above nothing remains but an impervious fibrous cord.

FIG. 95.

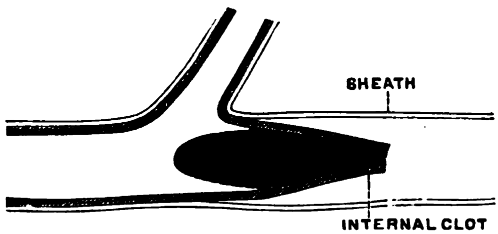


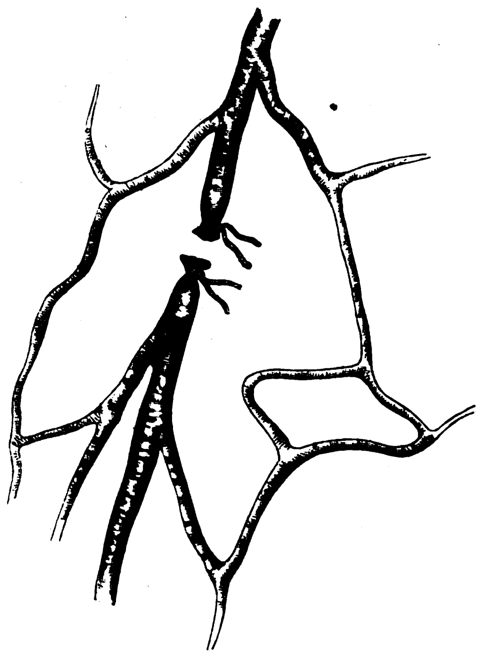
Diagram of internal clot formed in Nature's method for the permanent arrest of hemorrhage.

Hemorrhage from a wound partially dividing an artery is controlled in a similar but not identical manner. Contraction and retraction of the vessel cannot occur ; but blood is effused within and around the sheath and thus, unless it rapidly escapes to the exterior of the body, causes pressure upon the wounded artery. This causes temporary arrest of the blood escape. An internal coagulum may then be formed. Lymph is subsequently effused, the cavity of the vessel is occluded and fibrous metamorphosis with obliteration of the vascular channel is permanent. If the wound is less in extent than one-fourth the circumference of the vessel or if it is longitudinal and consequently gapes very little, hemorrhage may cease and repair occur by plastic exudation, without much encroachment upon the lumen of the vessel. In such cases, however, the internal and middle coats are seldom firmly repaired, and the force of the circulatory current is very apt to eventually cause stretching of these tunics. Thus may arise traumatic aneurism.

Collateral Circulation.—When the passage of blood through an artery is arrested by division, ligation or any form of obstruction, the parts beyond receive, at first, less blood. As a consequence, absence of pulsation, lowered surface temperature and impaired muscular power result. Soon, however, the anastomosing branches and capillaries of the same and of the neighboring arteries dilate by a vital process and carry more blood to the part than is normal. This is shown by increased redness and unnatural elevation of temperature, which, in the case of obstruction of large arteries, only occurs after the lapse of many hours. After a time the duty of supplying the distal region becomes relegated to a few branches, which remain permanently enlarged. The functions of the part are then carried on exactly as they were previous to interference with the blood-supply.

The establishment of the collateral circulation necessitates a reversal of the blood-current in some vessels, but this is not opposed to physiological processes. In aged subjects, whose vessels are apt to be rigid and atheromatous, dilatation of the arteries and capillaries cannot always be rapidly and readily effected. Hence, in such subjects gangrene of the peripheral region from deprivation of blood is more frequent than in the young. The collateral circulation is usually effected by the anastomosis of the branches on the same side of the body and not by inosculation with branches coming from vessels across the median line. Thus, when the right common carotid artery is ligated, the exterior of the head is supplied by the inferior thyroid, a sub-branch of the subclavian, furnishing blood to the ramifications of the superior thyroid, a branch of the external carotid. The current in the superior thyroid is reversed, and the blood emptied into the external carotid, which carries it to the face and scalp. The interior of the head is nourished by the vertebral, a secondary branch of the subclavian, communicating within the skull with the cerebral branches of the internal carotid. Little dilatation occurs in the branches inosculating with the corresponding vessels of the left side.

FIG. 96.



Collateral circulation after wound of artery and ligation.

When a vein is wounded or obstructed, repair and the collateral circulation are effected and established in a similar way. If there is failure in reaching this result, venous congestion and œdema occur in the parts below, and may be the cause of moist gangrene.

Hemorrhagic Diathesis.—In some persons a peculiar constitutional tendency, often inherited, causes profuse and almost uncontrollable bleeding from slight wounds, such as simple punctures and tooth extraction. Spontaneous hemorrhage from the nostrils, kidneys, intestines or bronchial tubes and large extravasations into the cellular tissue after bruises may occur in such subjects. Hemorrhagic diathesis or hematophilia is usually exhibited in childhood, and is frequently unknown until a trivial injury discloses its existence, for such patients often enjoy vigorous health. A liability to joint affections similar to rheumatism and to inflammations of the lungs has been said to coexist with the hemorrhagic diathesis. As age advances the bleeding tendency may disappear. In some instances there are attacks of spontaneous hemorrhage, though wounds may be inflicted with impunity in the intervals.

Males are much more frequent subjects of hematophilia than females. The cause of the condition is unknown. There at times appear to be deficient coagulability of the blood and unusual thinness of the internal coat of the vessels.

The tendency to hemorrhage is to be combated by saline laxatives, iron, ergot, lead and opium. Quinine in large doses has been recommended. All operations are to be avoided. If wounds occur and bleed, pressure by bandage or ligature, or acupressure must be employed. The actual cautery is a valuable local agent.

Treatment of Hemorrhage. CONSTITUTIONAL MEASURES.—It is only after the bleeding vessels have been controlled or when hemorrhage is feared, but has not yet occurred, that general measures obtain much consideration. The patient should be kept quiet and recumbent, with the head low, in order to lessen the activity of the heart and prevent anæmia of the brain. Sudden elevation of the head may be followed by fatal syncope when much blood has previously been lost. The supply of blood to the nerve centers can be kept up, in those who have suffered collapse from profuse hemorrhage, by tilting up the foot of the bed and by encircling the four limbs with rubber bandages, as in the bloodless method of operating. This drives the entire volume of blood to the head and trunk. The elastic pressure can be continued, as we know from experience in operations, for at least an hour without harm to the extremities thus deprived of blood. This process is called auto-transfusion, because the patient has his own blood forced into the centers of organic life. If several limbs are bandaged, it is well to remove the pressure slowly and from one at a time, lest the sudden rush of blood into the limbs cause recurrent anæmia of the brain. If rubber bandages are not at hand, flannel or muslin bandages may be used; or digital compression of the abdominal aorta and of the subclavian or axillary arteries will prevent the exit of blood to the limbs, and thus leave more for distribution to the head and trunk.

Morphine, quinine, ergot, gallic acid, lead and iron, in full doses, have been recommended as internal hemostatic remedies, but local treatment is far more important and effective.

Hemorrhage renders patients thirsty because it drains out the fluids of the body. Hence water and liquid foods are acceptable and valuable. Perhaps water containing saline ingredients would be preferable to simple water. Tonics, stimulants and concentrated diet should be administered subsequent to profuse hemorrhage, to replenish the loss of the vital fluid.

Transfusion.—When death from violent hemorrhage is imminent, transfusion of blood taken from another person who is vigorous and healthy is proper. Venous or arterial blood may be used, and it may be injected into a vein or an artery. Venous blood is generally preferred, because more readily obtainable, and is usually transfused into a vein of the arm. If the blood is transfused from the donor to the receiver without being subjected to manipulation, the operation is direct transfusion. The indirect method consists in drawing the blood into a receptacle, removing the fibrin by whipping, and, after straining the defibrinated blood, injecting it by a syringe into the circulation of the patient.

In performing the operation it is important to keep the blood aseptic, at a temperature of about 100° F., to avoid the injection of portions of clot, and to prevent the entrance of air into the patient's circulation. The quantity of blood transfused should not exceed eight or ten fluid ounces, and should be injected very slowly. It is not unusual for a marked chill to follow the procedure.

Filling the depleted vessels with a sterile saline solution seems to be as effectual as transfusion of blood, and the latter procedure has practically been abandoned. The solution employed is a 0.6 of 1 per cent. solution of sodium chloride in water. This is sterilized by boiling, and injected, while at a temperature of 105° F. very slowly into a vein, by means of a fountain syringe or a piston syringe and a canula. Sodium carbonate is sometimes added to the solution. One formula is this: Sodium chloride 6 parts, sodium carbonate 1 part, distilled water 1000 parts. To every half liter may be added one drop of a saturated solution of sodium hydrate to render the artificial blood serum alkaline. The amount injected may vary from 1 to 3 pints, depending upon the effect on the pulse.

When the accurately prepared so-called normal saline solution is not at hand, warm water alone or with a little salt in it (about a teaspoonful and a half to the quart) may be used.

If opportunity to make an intravenous injection into the saphenous, median basilic or median cephalic vein is not afforded, the fluid may be forced into the subcutaneous tissue of the thighs or chest. This is accomplished with a syringe and a trocar or aspirating needle. When this cannot be done, rectal enemas of water may be employed.

Local Measures.—In all cases of bleeding the first step is to clean the wound and remove the loose clots. When operating the surgeon should bear in mind that considerable blood may be lost without very serious injury, and also that no artery or vein can bleed if it is compressed by the fingers. These facts give assurance that there is always time and means to control the bleeding, at least temporarily. Many arteries that spurt freely when first divided soon stop bleeding. Venous hemorrhage usually requires no treatment, for it unless from large veins ceases spontaneously.

Elevation of the part has a tendency to check arterial bleeding, and loosening of tight clothing or constricting surgical dressings will often cause venous oozing below the constriction to cease. Exposure of the bleeding surface to the air or the action of cold water or ice induces contraction of the vessels and diminution of hemorrhage. Laying open a bleeding cavity or removing the warm poultice-like clots from a wound has a tendency to check loss of blood from small arteries and capillaries. Ice may be thrust into bleeding cavities, but its chilling and depressing influence must be watched.

Chemical agents with astringent properties were formerly employed in surgery as blood arresters, under the name of styptics, because of their tendency to promote contraction of the vessels and surrounding tissues and because of their inducing rapid coagulation of the blood. If the hemorrhage is from veins, capillaries or small arteries, styptics may arrest it, but are needless because pressure by means of compresses or bandages is better. If arteries of any importance are the source of bleeding, styptics are inefficient and, therefore, worthless. They are objectionable because practitioners resort to them and lose valuable time when ligation, torsion or acupressure is required. Many of them, moreover, by irritating the surface and covering it with pasty clots, or by infecting it with germs prevent union by first intention. Hot water of about 120° F., locally applied, causes blanching of the surface and cessation of hemorrhage. It has the advantage over ice of not depressing the patient.

All the methods thus far mentioned are greatly inferior to pressure and to occlusion of each individual vessel by ligation, torsion or acupressure. When, as in deep cavities without bony walls, it is difficult or impossible to use ligatures or pressure, the cautery iron, heated only to a dull red color, may be employed to seal the vessels by converting the tissues into a dry eschar. Lidell advises in parenchymatous hemorrhage water of not less than 160° F. before resorting to cauterization.

Pressure is well adapted for temporarily arresting hemorrhage until ligation, amputation or other operative measures can be performed. It is also of great value in the permanent arrest of bleeding in those cases when there is no vessel of sufficient importance to require ligation, torsion or acupressure. Applied to the main artery in its continuity, pressure limits the flow of blood to the wound and thus checks bleeding. This, which may be called arresting hemorrhage by indirect pressure, is generally accomplished by means of a tourniquet or by pressure of the fingers. The pressure may also be obtained by using a conical bag of shot or a pyramidal compress with a coin at its apex, or by placing a roll of cloth in the flexure of a joint and bandaging the joint in a strongly flexed position. These methods are liable to do harm because they often interfere with the return circulation in the veins and thus induce congestion and œdema of the structures between the wound and the point where pressure is made upon the artery. They must be watched. Direct pressure upon the bleeding vessels in the wound is far better. An elastic bandage applied over a crushed and bleeding foot will stop all hemorrhage, and is far better than a tourniquet applied to the femoral artery, because, when reaction occurs and amputation is advisable, all the structures above the injury are in good condition and free from œdema.

A compress and an ordinary bandage, applied evenly and with moderate firmness, will arrest hemorrhage from capillaries, veins and the smaller arteries. A bleeding cavity should be plugged with aseptic gauze or compressed sponge, which may, at times, be held in position with a bandage. No styptic is required, for the pressure causes approximation of the vascular walls, which is followed by internal coagulation, fibrinous exudation, and finally by obliteration of the vessel. In wounds that are expected to heal by first intention the pressure is made upon the integument, after the parts have been properly adjusted.

In using pressure the surgeon must recollect that great force is not required, and that gangrene may result from tight bandaging. The oozing of blood stained serum through the dressings must not be mistaken for a continuance of the hemorrhage. Enough gauze dressing should be applied to prevent the possibility of this serum reaching the surface and becoming septic, between the surgeon's visits. A considerable degree of pressure may be made with impunity if there is a voluminous gauze dressing over the wound, because the elasticity of the dressing prevents the constriction from coming directly upon the tissues.

When bleeding from a wound is profuse, digital or instrumental pressure should be made upon the main artery, while the surgeon is tying or securing the vessels in the wound. The pressure can then at intervals be relaxed momentarily to allow the bleeding vessels to become distinguishable.

The common carotid artery is controlled by pressure made at the inner border of the sterno-mastoid muscle, on a level with the cricoid cartilage, and directly backward and inward against the cervical vertebræ.

The subclavian artery is controlled by pressure made above the clavicle, at the outside of the sterno-mastoid muscle and directly downward and a little inward, against the first rib.

The axillary artery is controlled by pressure made along the inner border of the biceps muscle and directed, through the upper part of the artery's course, outward against the shaft of the humerus.

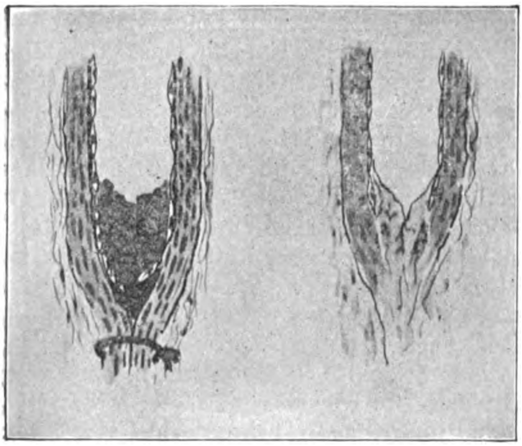
The femoral artery is controlled by pressure made below the middle of Poupart's ligament, and directed upward and backward against the head of the femur and ramus of the pubic bone.

Occlusion by Ligation, Torsion and Acupressure.—When hemorrhage comes from arteries, whose calibre equals or exceeds that of the facial or from veins which are so situated that pressure cannot be well applied, each vessel must be separately treated. The methods employed to bring the walls of the artery or the vein into apposition, and thus close the lumen, are ligation, torsion and acupressure.

Ligation is simply tying a string tightly around the vascular tube, and thus completely closing its calibre. Ligatures are usually round cords of silk or catgut; though wire, tendon, and other materials are occasionally employed. Flat ligatures are, as a rule, not desirable. Catgut ligatures are best prepared by the method described for the preparation of antiseptic sutures in the chapter on Essentials of Practical Surgery. Silk ligatures must be made aseptic by boiling or antiseptic by soaking in an antiseptic solution, before use.

When an artery is tightly tied with a ligature the external coat is deeply grooved by the constricting cord, while the middle and inner tunics are, on account of their brittleness, cleanly divided. The coats thus cut curl up more or less within the lumen of the artery and aid the coagulation and fibrinous exudation which permanently seal the vessel. If the ligature is septic, or becomes so, the external coat of the vessel gradually ulcerates at the constricted point, so that, in the course of a few days or weeks, the noose of thread is found lying loose in the wound. Sometimes a little slough from the external coat is found in the noose when the ligature becomes detached. Aseptic or antiseptic catgut and similar absorbable ligatures become absorbed in a week or two and do not cause ulceration of the outer tunic. Wire and silk ligatures, if not septic, may become encysted. Septic wounds are more liable to secondary hemorrhage than aseptic wounds, because of this possibility of ulceration and sloughing occurring in the vessels.

FIG. 97.

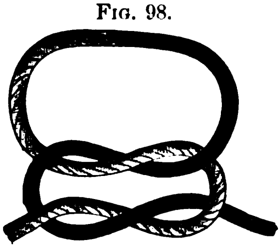


Obliteration of artery following ligation. (PARK.)

Veins have such pliable coats, that none, as a rule, are divided by the ligature, but all are simply corrugated at the point of constriction.

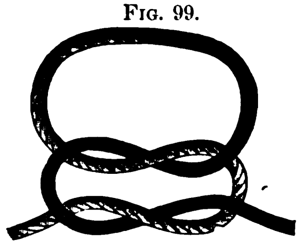
When a divided vessel in a wound is to be ligated, the surgeon either seizes the bleeding end with a pair of catch forceps and draws it out

FIG. 98.



Granny knot, which is never used in surgery.

FIG. 99.



Flat or reef knot.

from the cellular and muscular tissue in which it is imbedded or thrusts a sharp hook, called a tenaculum, into the wall of the vessel or the tissue surrounding it. The vessel is then isolated from other structures, as much as possible, and the ligature tied beyond the forceps or tenaculum, in a reef or flat knot. (Figs. 98 and 99.) Care should be taken not to include any nerve in the ligature. The accompanying veins and the muscular tissue around an artery are usually separated from it before the ligature is applied; but in smaller arteries it does no harm to include these in the knot.

When the knot is tightened, the forefingers or thumb should be placed upon the string close to the artery and firm, steady traction made. The amount of force required to tie even a large artery is not very great, and it should be done without jerking.

The giving away of the inner and middle coats is often distinctly felt by the surgeon. Ligation, as a rule, merely corrugates the inner coats of the veins. Catgut ligatures should be given an additional third tie, because of the liability of the knot when made with catgut to become loosened; or they should be tied in the so-called friction or surgical knot. In this the thread is given two turns instead of one in making the first half of the knot. Ligatures should have both ends cut off about one-tenth of an inch from the knot.

The method of applying ligatures to arteries in continuity, for the arrest of hemorrhage at a distant point and for the treatment of aneurism, will be described in the section which treats of the special ligations.

There are five rules to guide the surgeon in the use of ligation for arresting arterial hemorrhage:

I. In cases of primary hemorrhage do not ligate arteries which are not actually bleeding at the time, but have the patient carefully watched.

Reasons for this rule:

1. It is very possible that bleeding has permanently ceased.
2. It is difficult to be sure from which arteries the bleeding came.
3. All manipulations in wounds are to be avoided unless demanded.

Exceptions to this rule:

1. When a large vessel is plainly seen pulsating in the wound.
2. When the occurrence of even slight secondary hemorrhage would be disastrous; as in a very anæmic patient.
3. When, as in transportation, the patient will necessarily be away from surgical scrutiny.

II. In cases of primary and of secondary hemorrhage the ligature should be applied when practicable in the wound at the point where the artery bleeds, and not in the continuity of the vessel.

Reasons for this rule:

1. It is frequently impossible to know which artery is injured until the wound is opened.
2. Secondary hemorrhage may occur, even after ligation in continuity from the establishment of the collateral circulation. This secondary bleeding may come even from the proximal end of the cut vessel, if a branch of considerable size is given off between the wound and the point of ligation.
3. Ligation in continuity makes a second wound, and adds the possible complication of this wound to the patient's original dangers.

4. Ligation in continuity remains, as a reserve step, still possible, if ligation in the wound fails.

Exceptions to this rule:

None.

III. If the artery is completely severed both ends should be tied; if it is partly divided or punctured, a ligature should be applied to the vessel on each side of such wound.

Reasons for this rule:

The collateral circulation will probably cause secondary hemorrhage from the distal portion of the vessel, unless double ligation be adopted.

Exception to this rule:

When the distal end cannot be found; then pressure must be made in its neighborhood.

IV. If a large artery is wounded near its origin, tie it below the wound, and tie the trunk, from which it arises, both above and below the point of origin of the branch. If a trunk is wounded near the origin of a large branch, tie the trunk with two ligatures in the ordinary manner, and apply a third ligature to the branch.

Reasons for this rule:

The force of a large current of blood near the internal coagulum may lead to its displacement, and cause secondary hemorrhage when the ligature is absorbed or causes ulceration of the external coat.

Exception to this rule:

None.

V. When it is impossible or impracticable to tie the vessel in the wound, as in deep wounds of the pelvis, ligation in continuity may be permitted.

TORSION consists in occluding the cut end of the vessel by twisting it on its long axis. This is done by seizing the end of the cut artery with a pair of catch forceps, drawing it out of the sheath and giving it four or five sharp rotations. This twisting in the case of large arteries, like the femoral, should be repeated until the sense of resistance has ceased; but the end should not be twisted off. By this manœuvre the middle and inner coats are lacerated and curl up within the lumen of the artery, while the external tunic is twisted into a cord. This acts as a temporary plug until the internal coagulum and exudation of lymph are enabled to prevent hemorrhage and permanently close the orifice.

The twisted end is sometimes thrown off as a small slough; but if kept aseptic it becomes blended with the adjacent structures and is converted into fibrous tissue. In dealing with small arteries the ends may be twisted entirely off with impunity.

Some operators perform limited torsion instead of the free torsion just described. Limited torsion is performed by drawing the vessel out and grasping it transversely a little above the end with a second pair of forceps. When rotation is then made by means of the first forceps, the effect of the twisting cannot extend above the point held by the second pair. This method is convenient when the artery is loosely connected with surrounding parts.

The chief advantage claimed for torsion is that it leaves no foreign material in the wound as does the ordinary ligature. Aseptic catgut or silk ligatures being either absorbed or encysted do not act as foreign bodies, but allow the wound to be at once closed. It is, therefore, in this respect comparable to torsion. When the hemostatic forceps, used to arrest hemorrhage from cut vessels during the continuance of an operation are to be removed, a few preliminary twists given to the vessels will often avert the necessity of ligature.

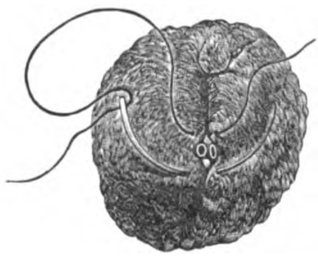
ACUPRESSURE.—Hemorrhage from a divided vessel may be arrested by introducing a long needle or pin into the surrounding tissues in such a manner as to compress the artery or vein. This compression, called acupressure, may be increased by adjusting a wire or thread around the ends of the pin as in the harelip suture or by twisting the tissues and the artery during the insertion of the pin. The pins, which must be aseptic, must not be permitted to remain in the tissues longer, at the furthest, than three days. Usually they should be removed in twenty-four or forty-eight hours. The time depends upon the size of the artery. Large arteries require longer pressure than small ones, to insure against secondary hemorrhage. Acupressure is a valuable means of arresting bleeding when the surgeon has no assistants and is in a hurry. It stops the hemorrhage until other methods can be applied. It is also useful as a preliminary to operations which must of necessity divide definite vessels. Thus the facial artery can be compressed before cutting into the cheek. So also the tissues around vascular tumors can be thus compressed by pins with threads wrapped around the ends before the excision is begun.

Acupressure acts as a hemostatic by bringing the vascular walls together and thus shutting out the blood current until repair goes on by exudation of lymph at the cut extremity of the vessel. An internal coagulum forms above the point of acupressure, but does not seem to play any part in the function of permanent repair. Permanent closure is effected entirely below the constriction caused by the pin in the same manner as in Nature's method of arresting bleeding and repairing cut arteries. If the pin remains long enough to destroy the structure of the inner coat, the same changes occur as after ligation. The pin may be so inserted as to press the vessel up against the overlying elastic skin and thus occlude its calibre ; or may be employed to hold the vessel in a twisted position and thus avert bleeding. Sometimes the pressure in the first method is increased by wrapping a ligature in an elliptical or a figure-8 manner around the ends of the pins.

Acupressure pins are removed by seizing the head and gently rotating and withdrawing the pin from the tissues, while the parts are supported with the other hand of the surgeon.

Acupressure is inferior to ligation, because the latter, when aseptic catgut or silk ligatures are employed, secures the greatest safety and has no tendency to retard primary union.

FIG. 100.



Artery occluded by suture. (ESMARCH.)

It is sometimes convenient to stop bleeding by including a small mass of tissue in a ligature, carried through the structures and around the bleeding area by means of a needle.

When it is difficult to apply ligatures or acupressure in deep wounds, the hemostatic forceps may be used to seize the artery and close the wound, and then be allowed to remain so attached as clamps for one or two days. If aseptic they do no harm, except to make dressing of the wound a little inconvenient.

Treatment of Secondary Hemorrhage.—The prevention of secondary hemorrhage is to be secured by obtaining rapid union in wounds. Hence aseptic healing is important.

When secondary bleeding is feared the patient should be kept absolutely quiet, and undue circulatory activity controlled by aconite, low diet, laxatives and possibly venesection. Morphia and ergotine given internally in full doses are beneficial under some circumstances. So also is partial compression of the main arterial trunk supplying the injured region, and elevation of the limb in which bleeding is feared.

In dealing with secondary hemorrhage the surgeon must not delay. In primary hemorrhage it is injudicious to take active steps when bleeding has already ceased, unless the circumstances are exceptional. The case is different in secondary bleeding. The first escape of blood, even in small quantity, calls for action, which may, it is true, be limited to elevation of the part and compression of the wound and main artery by compresses and bandages; but the second actual outbreak of hemorrhage imperatively calls for prompt surgical measures. If healing of the wound is still quite incomplete, the sutures should be withdrawn, the clots turned out and the vessel from which bleeding has come securely ligated. As it may be somewhat difficult to determine the exact source, every suspicious point should be ligated. If the softened or sloughing condition of the wound surfaces prevents satisfactory application of ligatures, pressure or the actual cautery may be available.

Opening the wound is the proper procedure even if union is well advanced, for the escaping blood has usually distended the wound cavity before the existence of bleeding has been detected; and by his action, moreover, the surgeon obtains the most accurate information possible of the character of the complication with which he has to deal. Acupressure is often a valuable means of arresting the bleeding either before or after the wound is reopened. By thrusting the pin deeply through the tissues and reinforcing the pressure with a strong thread wrapped around the ends, the surgeon is enabled to compress parts in which one or more bleeding arteries are situated. This manœuvre may be employed to avert the necessity of laying open the partially cicatrized wound, or to secure vessels whose patulous mouths cannot be found on the surface of the wound because of spontaneous cessation of bleeding.

Instead of an acupressure pin a strong ligature may be carried through the tissues by means of a long needle; by tying the ends of this cord together constriction may be effected that will restrain hemorrhage, but it must not be sufficiently great to cause strangulation and gangrene.

The elastic bandage applied with only moderate firmness over the wound proves at times a valuable aid in resisting secondary bleeding.

When secondary hemorrhage persists despite the direct treatment applied at the seat of trouble, it is proper to ligate the main artery in continuity, as is done in dealing with aneurisms. Such ligation should be performed as near the seat of hemorrhage as possible unless the anatomical relations of the regions make it known that the arterial anastomosis will soon establish such a collateral circulation that hemorrhage will probably recur in the original locality. Then it becomes necessary to select a higher point for the deligation. In secondary hemorrhage of the palm, for example, it is usually better surgery to ligate the brachial artery than to tie at the wrist the radial or ulnar or both; this is a fact because the anastomosis between the arteries of the forearm is so free.

Secondary hemorrhage may supervene after an arterial trunk has been tied in its continuity for the cure of aneurism or the arrest of hemorrhage at a lower point. Here the first step is to apply pressure to the seat of ligation by a graduated compress or by plugging the wound. If this fails the wound must be opened and a ligature applied at each side of the orifice in the vessel, which must then be completely divided between the ligatures, if the original injury did not do so, in order to allow retraction and contraction of its walls. In the event of this being followed by recurrence of hemorrhage, either a second deligation in continuity at a higher point, with or without contemporaneous ligation of one or more anastomosing branches, or amputation of the limb must be performed.

Gangrene is apt to occur when a second ligation is done in the lower extremity, because the collateral circulation is rarely sufficient to maintain the vitality of the distant parts. Hence, some high authorities have recommended amputation rather than second ligations for persistent secondary hemorrhages under such circumstances.

When the original source of secondary hemorrhage is a vessel near the aorta, pressure at the seat of bleeding is the only resource. Indeed, pressure, judiciously applied by pads, plugging and bags of shot, has at times been efficacious when ligation above the seat of hemorrhage has failed. This is due to the circumstance that the escape of blood comes very frequently from the distal portion of the injured vessel, to which the anastomosing branches have given an abundant blood-current.

WOUNDS OF VEINS.

The discussion of hemorrhage has involved some consideration of wounds of veins, but a few points remain that deserve more extended attention. The dangers from wounded veins are hemorrhage, septicæmia, diffuse phlebitis, fat embolism, and entrance of air into the heart.

The bleeding from large venous trunks may be as fatal as arterial hemorrhage, but that from small veins usually stops spontaneously unless there is some source of constriction upon the cardiac side of the wound. Blood flows from wounded veins in a dark rapid stream without showing the pulsatile action of the heart; it has, however, an increase in its force during each act of expiration, if the seat of hemorrhage is near the trunk. Pressure made on the cardiac side of the wound causes an increased flow of blood. This may be of diagnostic value in deep wounds, for blood from arteries may be dark during anæsthesia or when the bleeding comes from the distal end of a divided artery in one of the extremities.

Subcutaneous rupture of a vein from violence may occur. The extravasation of blood, even if large, is usually absorbed in a few days or weeks; but it may cause inflammation leading to abscess, if pyogenic bacteria gain access to it, or become encysted in a fluid state, giving rise to a fluctuating tumor called hematoma. Contusions of veins, as of arteries, may be unaccompanied by symptoms of special import until secondary hemorrhage occurs from the ulceration or sloughing of the injured vessel wall. When veins are completely divided slight contraction and retraction of the coats occur, but not in a sufficient degree to restrain hemorrhage from the larger vessels.

Incisions and punctures of veins, when not fatal, usually heal rapidly and perfectly by first intention, leaving no scar and not encroaching on the caliber of the vessel. Small wounds of varicose veins of the larger trunks may prove fatal from anæmia, if the bleeding is not arrested by pressure or ligation. Injurious secondary results may follow venous bleeding into the cavity of the cranium, thorax or abdomen. Often this is the chief danger. Wounds, even of the large cerebral sinuses, are not of very grave prognosis, if the blood is given full opportunity to escape, for moderate pressure arrests the hemorrhage in these venous channels of slow current.

Wounds of small or moderate size veins require little special treatment. Elevation of the part, removal of all constriction of clothing on the cardiac side of the injury and slight pressure by a compress and bandage are sufficient. In three or four days cicatrization occurs. Large veins require ligation. Styptics should never be employed. A catgut ligature may be applied below and another above the wound, if the vein is not completely divided; or the wound may be closed by fine catgut sutures or by lateral ligation. By lateral ligation is meant tying the portion of the wall of the vein immediately surrounding the wound. This is readily done in large veins by grasping the flaccid coats of the vessel with forceps or tenaculum and tying the ligature around the tissue so seized. Lateral ligature and suture do not entirely destroy the continuity of the vessel as does circular ligation above and below the wound. The method of repair after circular ligation of veins is similar to that which obtains in arterial ligation. The ligature does not, however, cut the internal and middle coats of the vein, but merely corrugates them; or, at most, divides only the inner layer of the middle tunic. Coagulation then occurs at the distal side of the ligature, and inflammatory changes ensue which permanently seal the vessel. In some cases the bleeding may be satisfactorily controlled by seizing the wounded portion with hemostatic forceps, so placed as to close the opening, and leaving them hanging in position for twenty-four or forty-eight hours.

Septicæmia is very apt to follow venous wounds, if the open vein or sinus is surrounded by unhealthy pus; hence asepsis is of supreme importance in treating wounds in which large veins are opened. Ligation by closing the open orifices tends to prevent such septic infection, and is, therefore, at times advisable in major operations, when sepsis cannot be prevented, even when there is no liability to venous hemorrhage. Fat embolism may occur through wounds of veins.

When the large veins of the extremities, such as the femoral or axillary, are wounded, ligation of the accompanying artery also may, according to some authorities, be proper and judicious after ligation of the vein. The flow of blood to the limb is thus diminished; venous congestion of the tissues is thereby prevented, because the equilibrium in the capillaries is less disturbed; and the possibility of gangrene is probably less. Further evidence of the advisability of such simultaneous ligation of veins and arteries is desirable. Its propriety in the upper extremity is doubtful, though it has a probable value in wounds of the femoral vein.

Trephining may be required after wounds of the sinuses of the dura mater to allow the removal of clots causing compression of the brain. Moderate pressure upon the injured venous channel with aseptic gauze will control hemorrhage. Hemostatic preparations of iron or other styptics should not be employed.

If from any cause the wound in a vein is kept widely open during violent inspiratory efforts, air may be sucked into the venous circulation and be carried to the right heart. This dangerous accident is especially liable to occur during operations in the vicinity of the internal jugular, subclavian, innominate and axillary veins; though it has been stated that it may happen in veins of smaller calibre and in those situated further from the heart. The manner in which wounded veins ordinarily become collapsed during inspiration usually prevents the entrance of air; hence it is only when some cause holds the lips of the wound apart that sucking air into the veins is possible. This may be due to inflammatory thickening of the walls converting the vein into a tube, the so-called canalization of the veins; to the vessel being imbedded in hardened tissue or in the substance of tumors, which prevents collapse; or to the efforts of the surgeon who, in attempting to enucleate a tumor or foreign body, pulls the walls of the vein apart at the time of a deep inspiration. The accident is less common since the introduction of anæsthesia, because there are less struggling and gasping on the part of the patient and more deliberation exercised by the surgeon. It is possible, however, that some of the deaths attributed to anæsthesia may be cases of air in the veins.

The symptoms of entrance of air into the veins are marked. During the progress of an operation a sudden sucking sound is heard; frothy blood is, perhaps, observed in the wound, the pulse fails, the heart beats irregularly and feebly, respiration is oppressed, and syncope or, perhaps, convulsion occurs. If the amount of air drawn in is small, recovery gradually takes place; if the quantity is considerable, coma and death supervene. The fatal issue may be immediate, but usually is postponed for a period varying from a few minutes to an hour. In cases that recover transitory paresis has been observed. Secondary pneumonia has proved fatal in others.

Occasionally a sound similar to that produced by air entering the veins occurs when the deep fascia of the neck is incised.

The pathology of the symptoms induced by air in the veins is not understood. It is probable that the air, causing a frothy condition of the blood in the right auricle and ventricle, prevents proper action of the valves and interferes with the blood transfer in the pulmonary circulation. Anæmia of the brain and other nerve centers is thus induced.

This serious complication of operative surgery, which is surely quite rare, is to be prevented by securing regular and quiet respiration during anæsthesia, by tearing the tissues in the vicinity of large veins apart with fingers and dull instruments, instead of using the knife, and by avoiding any posture or traction that tends to keep venous wounds gaping. When it becomes necessary to divide a large vein the surgeon should make pressure with the fingers upon the vessel at the cardiac side of the proposed wound. This should be done also when firmly attached tumors are being forcibly enucleated. It has been proposed to bandage the chest as a preliminary measure before operating in the region made dangerous by the situation of the large venous trunks. Thus unexpected deep inspiration is prevented.

When air has actually been sucked into the veins, prompt treatment is demanded. The vein should immediately be compressed at the cardiac side of the wound, and ligatures should then be applied on both sides of the orifice. The patient's head should be lowered, stimulants should be given, and artificial respiration instituted.

Galvanism of the chest and cardiac region, transfusion of saline solution, tracheotomy, venesection and pumping the air from the veins or even from the heart by the aspirator have been proposed. The injection of warm water directly into the heart-cavity has been suggested. If the symptoms depend upon failure of the valve action because of absence of fluid in the heart, this may perhaps be a rational therapeutic measure.

It is probable that the dangers of air in the veins and heart have been overestimated. It has been suggested that some cases of death supposed, from post-mortem examination, to have been due to air embolism may have been the result of infection with the bacillus aerogenes capsulatus. This organism causes a rapid development of gas in the tissues.

DISEASES OF THE VEINS.

Inflammation of the Walls of Veins or Phlebitis.

Varieties.—Non-traumatic phlebitis is quite rare, but occasionally occurs in the course of fevers, or as the consequence of syphilis, gout, and varicose veins, and possibly of exposure to cold. This form of venous inflammation is more apt to be located in the veins of the lower extremity than elsewhere, and does not often assume the dangerous characteristics that usually belong to traumatic phlebitis, because traumatic phlebitis is often septic. Traumatic inflammation follows contusion, rupture or incision of the venous walls, and may also be due to violent muscular contraction and pressure. Uterine phlebitis after parturition is a phlebitis possibly due to the cause last mentioned, but probably a result of microbic infection. Inflammation of the tissues around a vein may cause phlebitis, which is then to be considered a phlebitis secondary to peri-phlebitis. Traumatic inflammation of veins if aseptic is usually a localized affection of slight gravity. If, however, septic changes occur in the wound, especially it would seem when the orifices of the divided veins remain open, a diffuse or suppurative phlebitis of a most dangerous character may arise. Operation wounds of veins are usually of slight gravity, because the consequent phlebitis is an uncomplicated and localized aseptic inflammation.

Pathology.—Coagulation of blood in the living veins, technically called thrombosis, is always an accompaniment of phlebitis. This clotting may be the cause of the inflammation. Such is the case at times in the phlebitis secondary to varicose veins. Here the overstretched venous walls, with imperfectly-acting valves, allow retardation of the blood-current, and the consequent thrombosis sets up inflammation of the vascular tunics. On the other hand, thrombosis may be the result of inflammation, as is usually the case in traumatic phlebitis. Pyæmia occurs as the result of a purulent thrombo-phlebitis.

The pathological changes of phlebitis occur principally in the outer and middle coats, which in veins, indeed, are scarcely to be considered as two distinct tunics. Hyperæmia of these coats and infiltration of the spaces between their vessels with cells and serum are observed. These changes necessarily induce swelling, thickening and loss of flexibility of the walls, which may remain patulous when divided. The internal coat becomes cloudy, fissured and shreddy, and may be separated from its neighboring tunic by the disintegrating influences of inflammation. At the seat of inflammation coagulation takes place within the vein at an early stage of the phlebitis. If the clot is aseptic and remains so, the inflammatory process is localized. The vein may then be converted into an impervious fibrocellular cord, as occurs after arterial ligation. If the coagulum adheres to only one side of the vein, however, partial circulation may finally be established through the vessel; or, if complete removal of the clot by absorption occurs, the calibre of the vein may be perfectly restored.

The occurrence of suppurative and gangrenous inflammation of veins leads to disintegration or yellow softening of the clot and the dangerous septic elements are admitted into the general circulation. As a result, portions of the coagulum are worked loose and carried to the right heart and thence into distant arteries. Such plugs or emboli produce infarctions and abscesses, and because of an infective nature lead to pyæmic symptoms and death. It is for this reason that phlebitis, in broken down subjects or in those suffering from infected wounds, is regarded as a disease of grave prognosis.

Symptoms.—Inflammation of a subcutaneous vein gives rise in the course of the vessel to a hard painful cord, which is accompanied by some swelling and a distinct dusky red or copper color line upon the overlying skin. This hard line often has a knotted appearance at the situation of the valves of the diseased vein. Coagulation in the vessel impedes venous return from the distal part of the limb and causes œdema, which may be further increased by actual inflammation of the general connective tissue of the extremity. In the latter event, there is more induration than in simple œdema from circulatory obstruction. Stiffness of the limb affected with phlebitis and pain, often of a character resembling neuralgia, are present. Phlebitis, when not localized, usually extends in the direction of the heart. When the deep veins only are inflamed the vessels are not mapped out by the subcutaneous rigid cords that serve to distinguish superficial phlebitis, neither are the dusky red lines seen; but the painful stiffness and œdema are perhaps the only indications of inflammation. The diagnosis is consequently sometimes difficult.

The constitutional symptoms are slight in localized aseptic venous inflammation; but when the disease is more extensive, febrile movement is present. In the event of septic infection occurring, chills, sweats, high temperature, a rapid thready pulse and delirium are to be expected. Under such circumstances embolic abscesses and death from pyæmic symptoms may readily supervene. Embolic abscess of the liver may thus occur in portal phlebitis. A close connection exists between rapidly spreading phlebitis, with its ulceration and gangrene of venous walls, and diffuse cellulitis and erysipelas. They all tend to destroy life by the induction of septicæmic processes; and are due to mycotic infection. Aseptic phlebitis is, even when extensive, of favorable prognosis. Septic phlebitis is a very fatal disease.

Phlebitis is to be distinguished from inflammation of the lymphatic vessels, or lymphangitis, by the absence of glandular involvement and by the darker red of the cutaneous line indicating the course of the affected vessels. Neuralgia and neuritis are unaccompanied by the œdema which almost invariably attends phlebitis.

Treatment.—Phlebitis is to be treated by absolute rest of the part affected, and by the avoidance of all causes that might favor the separation or disintegration of the intravascular coagulum. Pyogenic and putrefactive infection must be rigidly averted. Slight elevation of the limbs to favor the return circulation is judicious and lessens pain. Leeching, lead water and laudanum, mercurial ointment, ichthyol, evaporating lotions, fomentations of various kinds, and tincture of iodine have been found useful as local measures. Quinine, iron, and rest in bed are essential in cases of even moderate severity.

When inflammation is spreading rapidly up the vein, the treatment should consist of prompt compression of the vein above and below the seat of thrombophlebitis, followed by incision of the vein walls, removal of clots and disinfection.

If suppuration, great œdema and diffuse cellular inflammation arise, free incisions parallel to the veins and into the thrombosed veins should be made. This procedure should be followed by thorough antiseptic irrigation and drainage. In these cases the constitutional treatment is that of septicæmia and pyæmia.

To remove the swelling and hasten the absorption of inflammatory deposits, due to phlebitis of a chronic type, elevation, friction, massage, and pressure by the elastic bandage should be employed.

Hypertrophy and Varicosity of Veins.

Definition.—When an abnormal quantity of blood is constantly carried by a vein, the vessel becomes enlarged in caliber and thickened in its coats. This constitutes hypertrophy of veins; and is seen, for example, when obstruction of a vena cava causes enlargement of the external epigastric vein and the veins of the anterior walls of the chest, and in other instances of unusual development of the collateral venous circulation. No treatment is required, for the condition is a compensatory one. When the amount of blood in a vein is diminished, as happens after amputations, venous atrophy results.

Varicose veins are veins which, on account of diseases of the walls, have become enlarged and more or less irregularly dilated and thinned, and in which the blood current is abnormally retarded. Varix, or varicose vein, is, therefore, a condition that should be distinguished from hypertrophy of veins. Varicocele and internal hemorrhoids are instances of varix in special localities.

Pathology.—Varicosity is most frequently met with in the veins of the leg, spermatic cord and rectum; though the condition may arise in any location, even, it is stated, in the veins of osseous tissue. The long saphenous vein is very frequently affected. The condition is probably due to a paresis of the muscular tissue of the vessel wall depending upon degeneration of muscular fiber or imperfect innervation. Any impediment of the blood current acts as a predisposing cause of varicose veins by increasing the intravenous hydrostatic pressure. Hence gravity has long been regarded as a prominent factor in the production of varix.

Heredity, debility, continued standing, the wearing of tight garters, and many other factors have been accused as causes of varicose veins; but there must be some as yet unknown influence that determines the occurrence of this pathological venous lesion.

The pathological changes found in varix are dilatation, increased length and tortuosity, hyperplasia of connective and other tissues causing irregular thickening of the venous walls, incompetent valves due to partial destruction of the leaflets or to the impossibility of contact resulting from the increased caliber of the vessel, and sacculation similar in appearance to the pouched condition of the colon. The irregular dilatations, causing sacculation, are especially prominent at points where two veins unite. The wall in such pouches is exceedingly attenuated. Chronic inflammatory changes are apt to arise in the tissues surrounding varicose veins, causing œdema, obstinate ulcers and even a condition resembling Arabian elephantiasis.

Coagulation may occur within varicose veins, and thus induce inflammation or occlusion and partial cure. Suppuration may occur from infection with pus germs. Calcareous degeneration of the clot sometimes takes place, and concretions, called vein-stones, or phleboliths, remain. These may be either free or adherent to the wall of the vein. They are also, however, found in veins not varicose, and are especially liable to occur in the veins of the pelvis. It is believed that these pelvic phleboliths may also be formed outside of the vessel and subsequently penetrate the venous walls.

Symptoms.—The symptoms of varix are dull pain, a sensation of weight or fulness, numbness, and perhaps some impairment of power. Inspection shows a characteristic, bluish, knotted, soft tumor, in which the dilated and tortuous veins can readily be recognized. Œdema, induration, eczema, and chronic ulceration of the skin are frequently present in varix of the leg of long standing. It is probable that the deep veins are affected about as frequently as the subcutaneous, but when the affection pertains only to the former the diagnosis is difficult. Gay thinks muscular cramps indicative of deep varix. Slight local varicosities of the cutaneous capillary veins are quite common in women, giving rise to an arborescent appearance of the skin without swelling or other symptom.

Profuse bleeding may supervene from perforation of a varix by ulceration. It is improper to say that the varicose vein bursts, since the ulcerative process begins externally. The copious hemorrhage probably comes from the cardiac portion of the vein, which is distended with blood and furnished with diseased valves incompetent to resist the backward current. Moderate pressure with a finger or compress will control the bleeding, which, if not arrested, may prove fatal.

Phlebitis, with its characteristic thrombosis, may be developed in varicose veins without any special assignable cause.

Treatment.—The distress produced by the existence of varicose veins can be greatly palliated by such artificial support as is obtained by covering the limb with elastic webbing, or a rubber bandage, applied smoothly and with very moderate pressure. To prevent cutaneous irritation from retention of secretion it may be necessary to cover the skin with a soft piece of cotton or linen cloth, before applying the rubber bandage. If ulceration exists, ointments or solutions can be thus applied before the bandage is adjusted. A silicate of sodium case, such as is used in treating partially united fractures, makes a convenient support for varicose veins of the leg. These appliances for pressure should be removed at night only after the patient has assumed the recumbent posture. Elevation of the leg while keeping the patient in bed and pressure of this sort will greatly hasten the cure of eczema and ulcers complicating varicose veins of the lower limbs.

The radical treatment of varicose veins consists in the removal of the vein or the occlusion of the caliber of the vessel; in other words, obliteration of the vein at the point operated upon, thus compelling anastomosing veins to carry on the circulation. The symptoms of varix are removed at the points of operation, and much relief may thus be afforded the patient; but the condition is often subsequently developed in the adjacent veins, either superficial or deep. Antiseptic surgery renders these operations trivial.

The most approved methods are subcutaneous ligation, and excision. Subcutaneous ligation is effected by carrying a catgut ligature beneath the dilated veins by means of a straight needle, which is then reëntered at the point of exit and thrust in front of the vein un-

FIG. 101.

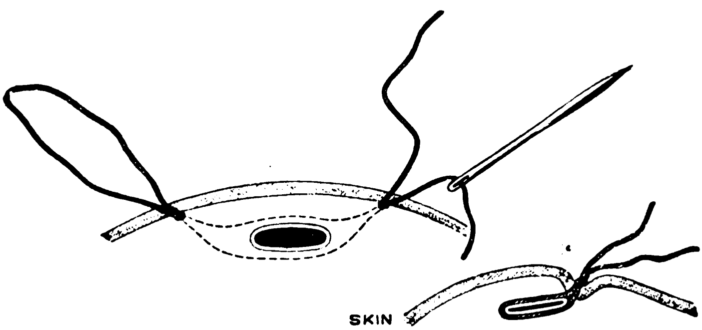


Diagram of subcutaneous ligation of varicose veins.

til it emerges at the first puncture. Withdrawal of the needle through this original opening causes the vein to be subcutaneously encircled by a loop of catgut. The ligature is then drawn tightly around the vein and the ends tied. The coats of the vein are thus brought into apposition, and internal coagulation, with consequent local plastic inflammation and occlusion, results at as many points as the surgeon has ligated. The catgut ligatures become absorbed and need no attention. The veins should be ligated at numerous points, and care should be taken to avoid transfixing the vessel with the needle. It is well to have the limb dependent, so that the vein may be distended to its fullest capacity and to insert the ligature nearest the heart first.

Excision of about two inches of the vein through an ordinary cutaneous incision is a successful method. Bleeding may be prevented by temporary acupressure above and below the point of excision. The divided veins are tied after the dilated portions have been removed. It must be done aseptically. After any of these methods of operating a bandage should be applied to the limb and the patient kept in bed. Elastic stockings or rubber bandages should be worn after the patient assumes the erect posture.

Patients with varicose veins, if debilitated, should be treated with tonics and made to refrain from occupations that require standing or other positions favoring venous stasis. If hemorrhage occurs from a varix, elevation and compression at the point of ulceration will arrest it.

DISEASES OF LYMPHATICS.

Wounds of Lymphatics.

The lymphatic vessels, which in their universal distribution exceed in number the blood vessels, are injured in all wounds. Lymph escapes from the severed vessels, but is mixed with blood and demands no especial notice. It is only when the thoracic duct, a large lymphatic trunk or a varicose lymphatic vessel is wounded that the escape of lymph is dignified by the name of lymphorrhagia. The fluid thus discharged is at times transparent, at other times milky in appearance, and may continue to flow for an indefinite time, if a fistula becomes established at the seat of injury. When a lymphatic vessel becomes occluded from pressure of a tumor or from disease, collateral lymphatic circulation is established, just as happens in veins. The lymphatic vessels and their valves much resemble veins as well in function as in histology. Lymphorrhagia is to be treated by pressure applied to the distal portion of the vessel, and lymphatic fistulas by compression and cauterization. Wounds of the thoracic duct and other large lymph channels should be treated by lateral ligature, suture and compression, exactly in the same manner as wounds of veins. The importance of the thoracic duct as a route for the chyle should prohibit its obliteration by suture or ligation. Incision of lymphatic glands is said to have been followed by lymphatic fistulas.

Inflammation of Lymphatic Vessels or Lymphangitis.

Pathology.—Lymphangitis, or angeioleucitis, is generally the result of traumatic infection. It should be remembered that, though traumatic in origin, it may first appear at a distance from the wound. Simple lymphangitis is much less dangerous than the septic form, which frequently has a fatal issue.

The pathological changes are similar to those found in phlebitis. The lymph loses its transparency, becomes opaque, and forms thrombi or clots of a pinkish color in the vicinity of the valves. These clots, by adhering to the vessel wall may cause occlusion or they may break down into pus. Thickening, opacity and dilatation of the walls of the lymphatic vessels occur and the internal tunic becomes uneven. If occlusion is produced, the ducts anastomosing with the obliterated vessel soon become distended and carry on the circulation of lymph. The connective tissue about the inflamed absorbents becomes infiltrated with lymph cells escaping from the vessels and peripheral œdema is induced by obstruction of the lymph current due to the internal thrombosis.

The infiltrated structures may be relieved of this inundation by absorptive processes, may suppurate, or may become indurated and hypertrophied. It is probable that occlusion of lymphatic vessels from repeated lymphangitis, occurring in connection with cutaneous changes, is a factor in the causation of certain cases of Arabian elephantiasis. Cellulitis and arthritis may be secondary to lymphangitis and even go on to suppuration.

Symptoms.—Inflammation of the fine capillary absorbent vessels, which form an anastomosing network, is called reticular lymphangitis, while inflammation of the larger ducts is termed tubular lymphangitis. Reticular lymphangitis occurs in patches and may or may not be associated with inflammation of neighboring ducts of larger caliber. The adjacent lymph nodes, however, are nearly always involved. The patches are hot, red, painful and surrounded by slight œdema, and may go on to suppuration. Slight wounds, such as needle pricks at the end of the finger, when infected and frequent contact with septic tissues, even without breach of surface, may give rise to reticular lymphangitis which is manifested by multiple spots of inflammation successively extending up the limb. Certain forms of felon are instances of lymphangitis, and the skin disease called erythema nodosum is believed by some authorities to be a reticular lymphangitis, with lymphatic œdema.

Tubular lymphangitis, when affecting the superficial vessels, is manifested by the appearance of vivid red cutaneous lines running from the primary lesion toward the heart. These lines mark the center of the inflamed ducts which, by palpation, can be felt as hard threads. There may be only slight tenderness along these red streaks, which by coalescence may make bands nearly an inch wide, but usually pain is marked and swelling of the limb observable. The nearest lymphatic nodes soon become swollen and painful. Subsequently a second group of more distant nodes may be similarly involved, though there need not be any marked evidence of inflammation of the lymphatic vessels connecting the two swellings. Resolution may occur in a week or ten days, though suppurative inflammation of the lymphatic glands or of the vessels is not unusual. Glandular implication is almost never absent in lymphangitis. It is stated, however, that in septic inflammation of the articular lymphatics such involvement may at times be wanting even when the synovial lymphatic structures show suppurative processes of great severity. The glandular inflammation, or lymphadenitis, results from the arrest of the causative bacteria in the sieve like structure of the nodes. When the deep lymphatics alone are inflamed the cutaneous redness is absent and the symptoms are obscure. Glandular implication is the only symptom which enables a diagnosis from cellulitis to be made.

In septic lymphangitis the constitutional symptoms are rigors, high temperature and other febrile manifestations, accompanied by great prostration, delirium and typical asthenic symptoms.

Violent lymphangitis is developed not infrequently in connection with dissection wounds, snake-bites, erysipelas, diphtheria, typhus and typhoid fevers and the puerperal condition. Uterine lymphangitis of a septic character, which may follow labor even when no injury to mucous membrane has been inflicted, is very prone to cause diffuse peritonitis, and is usually fatal. Patients in enfeebled health are more prone to septic lymphatic inflammation than those of greater resistive power. This form of lymphangitis may run an acute or a chronic course and is the forerunner of general septicæmic symptoms.

Lymphangitis is to be diagnosticated from phlebitis by the higher febrile temperature of the former, the more vivid red of the cutaneous lines and the associated glandular inflammation. In erysipelas the discoloration of skin is more diffused than in inflammation of the absorbent vessels.

Treatment.—The treatment of lymphangitis is very similar to that adapted to phlebitis. Septic infection is to be prevented by cleaning and thoroughly disinfecting wounds at the time of their reception. On the appearance of lymphatic inflammation the wound should be laid open and thoroughly disinfected with strong antiseptic solutions (mercuric chloride 1 : 300 or 1 : 500 or carbolic acid 1 : 10 or 1 : 20). If the existence of poisonous inoculation is suspected at the time, as is the case in dissection wounds, suction and cauterization should be employed. Absolute cleanliness and antiseptics should be enforced on the part of those examining and attending puerperal cases, since septic uterine lymphangitis is almost uniformly fatal. Local applications may be made along the course of the inflamed absorbent vessels when superficial. Moist antiseptic dressings, equal parts of extract of belladonna and glycerin, fomentations containing morphia or other narcotics, mercurial ointment and ichthyol have been recommended as topical measures. Penciling with nitrate of silver and wrapping in dry cotton have advocates. The limb should be kept elevated and at rest. Free incisions to evacuate pus must be promptly made. Constitutional remedies of a supportive kind are always judicious. Quinine, iron, morphia, and often alcohol are the drugs to be used. Œdema remaining after subsidence of the acute symptoms is to be treated by pressure with the elastic bandage, massage and passive motion of the joints.

Inflammation of Lymphatic Nodes or Lymphadenitis.

Pathology.—Inflammation of a lymphatic node, called lymphadenitis or simply adenitis, may occur without the existence of lymphangitis; but lymphangitis, as previously stated, rarely occurs without an accompanying lymphadenitis. The retentive or sieve-like function of the lymphatic nodes is the cause of their frequent implication secondarily to inflammation of the lymph vessels. All material conveyed along any of these ducts is compelled to pass through the reticular or net-like structure of the corresponding nodes. Here pigments from tattooing, septic particles, whether bacteria or emboli, poison from syphilitic or other inoculated wounds, cells from malignant growths, pus and abnormal lymph cells are filtered out of the retarded lymph current and remain to choke up the network of small spaces and channels of which the glands are in large part formed. When these filtered out particles cause stasis of the current, coagulation of lymph and inflammation of the gland structure, lymphadenitis, with its characteristic swelling, hardness and tenderness exists.

Causes.—Lymphadenitis then may be caused by direct irritation or injury to the gland or by any peripheral lesion or absorption that sends irritating substances to the gland. Acute lymphadenitis is usually septic; chronic lymphadenitis is usually tubercular. The lymph vessels between the periphery and the gland may be free from involvement, even though they have carried the irritative cause in the lymph current flowing through them. Lymphadenitis may be acute or chronic, and is due to infection by the tubercle bacillus, pyogenic organisms and other bacteria, as well as to direct injury. The character of the inflammation depends on the cause and the constitution of the patient.

Symptoms.—The symptoms of acute suppurative lymphadenitis are swelling and tenderness of the gland, lancinating pain increased by motion, and fever. The connective tissue around the gland becomes implicated in the inflammatory process, the overlying skin assumes the appearance of inflammation and suppuration occurs in the center of the gland or in the surrounding cellular tissue. Spontaneous evacuation of pus finally occurs. Cure by resolution without suppuration takes place in some instances of acute lymphadenitis, but the disease is so usually due to pus infection that formation of pus is common. Sometimes the tissues around the gland suppurate and on evacuation leave the inflamed gland exposed in the wound as a reddish gray mass. Tubercular lymphadenitis usually causes chronic enlargement of the nodes, without pain. Many associated glands become affected so that the large bunch or cluster gives rise to a nodular tumor. This may gradually disappear, but commonly the nodes undergo softening followed by caseation or puriform degeneration. The overlying skin becomes red and glazed and tubercular pus escapes through an irregular orifice, which, after a prolonged period of cicatrization, heals with a puckered cicatrix adherent to the deep tissues. A sinus frequently remains for months. The favorite site of tubercular lymphadenitis is the neck, because tubercular infection is easy through diseased teeth, the tonsils and oral mucous membrane. It occurs elsewhere, however as in axilla, groin and mesentery. In some regions of the body the lymphatic glands are scarcely perceptible by palpation through the skin until they become enlarged by inflammation, when the nodulation produced by them is sufficient evidence of adenitis. The inguinal bubo occurring after syphilitic inoculation affords a good example of the behavior of adenitis. If a whole group of nodes is inflamed, the obstruction to lymphatic circulation may cause œdema of peripheral regions. This may become established if the adenitis is chronic.

Treatment.—Acute lymphadenitis requires absolute rest of the part, disinfection of the wound of entrance of infection, as in lymphangitis, perhaps leeching, and antiseptic fomentations; blisters, or tincture of iodine painted around the inflamed gland may be serviceable. Injection of four or five drops of undiluted carbolic acid into the node by means of a hypodermic syringe is said to be serviceable. Pus should be evacuated by free incision, and the diseased gland and tissues removed by curetting. Carbolized oxide of zinc ointment, iodoform, and similar applications will facilitate cicatrization of the resulting ulcer. All sinuses should be laid open and scraped. Tubercular adenitis with its characteristic enlargement is best treated by stimulating applications such as compound iodine ointment and diluted mercuric iodide ointment locally; and constitutionally the hygienic and medicinal measures demanded by tubercular cases. Interstitial injections by means of a hypodermic syringe of two minims of a ten per cent. solution of zinc chloride or three minims of carbolic acid and glycerine has been recommended to cause diminution of large glandular masses. Caseous tubercular lymphatic glands should be enucleated, to prevent general infection of the patient; as should single groups of indurated glands producing deformity, such as occurs so frequently in the neck, if internal and local treatment does not dissipate the swelling. Operation should not be long delayed. The scarring is less conspicuous than the cicatrix of spontaneous or operative evacuation of tubercular pus.

Syphilis, malignant disease and benign tumors may affect the lymphatic glands, but these topics demand no special consideration here. The peculiar disease variously called lymphadenoma, Hodgkins' disease, pseudo-leukemia and malignant lymphoma, which is attended by enlargement of many groups of lymph nodes and by profound anæmia, is a medical rather than a surgical affection. In leukemia there is enlargement of nodes, spleen and the lymphatic tissues elsewhere with permanent leucocytosis. In leukemia and pseudo-leukemia excision of the enlarged nodes is improper.

Varicose Lymphatic Vessels.

Varicosity, or dilatation, of the lymphatic networks gives rise to small transparent vesicles, like boiled sago grains, which are more frequently seen upon the inside of the thigh and upon the genitals and the abdomen than elsewhere. When the superficial lymphatic trunks are the subject of this infrequent condition, the dilated portions give rise to larger and more elongated swellings. There is usually œdema of the peripheral parts. Lymphatic varicosities can readily be emptied of their fluid contents by pressure.

Arabian elephantiasis is at times complicated with lymphatic varicosity. Cystic dilatation of the lymphatic ducts occurs at times in the tongue, lips and neck.

A tumor formed of a congeries of dilated lymphatic vessels and similar in structure to the arterial and venous vascular tumor, or angioma, is occasionally developed. It is appropriately called a lymphangioma. Rupture or wound of a dilated lymphatic vessel is liable to be followed by a discharge of lymph called lymphorrhagia. If a fistula result, cauterization and pressure are proper. Lymphatic dilatation usually needs no treatment. The methods adopted in corresponding venous changes would be applicable.

INJURIES AND DISEASES OF ARTERIES.

Wounds of Arteries.

Pathology.—After contusion of arterial coats there is a liability to septic ulceration and secondary hemorrhage, which occurrence will, in open wounds, demand prompt ligation at both sides of the bleeding orifice. If the contusion has occurred subcutaneously, the ulcerative action will allow extravasation into the muscular and cellular tissues, which, if extensive, may call for incision into the tissues and ligation of the vessel at both sides of the wound, for ligation above the seat of injury or for amputation of the limb. By the advent of inflammation and thrombosis, a bruised artery at times becomes obliterated at the seat of contusion, and this occlusion may give rise to gangrene or visceral degeneration. Aneurism also may be developed after contusion of an artery.

Arteries may be torn completely asunder subcutaneously by violent manipulation, as in reducing old dislocations, or by accidental injuries. The extravasation which follows may be absorbed as the torn ends of the artery become sealed by obliterative inflammation or it may become surrounded by a capsule or sac, consisting of cellular tissue thickened and condensed by pressure and inflammation. The extensive character of the subcutaneous bleeding may lead to violent inflammation, and its interference with the peripheral circulation may, because of pressure, lead to gangrene. Amputation is at times demanded for such sequences of arterial rupture.

Subcutaneous extravasation of blood, from spontaneous or traumatic rupture or from direct wound of an artery, is sometimes termed aneurism. The term, even though qualified by the words false or traumatic, should be rejected, as it is misleading as well as unscientific. When the effused blood becomes encapsulated and the communication with the artery persists, the resemblance to aneurism is, however, great; but it is an arterial hematoma.

Complete laceration or tearing asunder of an artery in an open wound may be unattended by hemorrhage, because of the twisting and tearing of the coats at the time of injury. It is well, however, to ligate such vessels before the first dressing is applied, if they are seen pulsating in the wound. The two inner coats of an artery are sometimes torn in subcutaneous injuries, while the external tunic by reason of its elasticity remains intact. This partial rupture may subsequently become complete, by the giving way of the outer coat, and be followed by fatal extravasation. On the other hand, the torn coats may curl up, cause coagulation within the vessel, and thus lead to permanent occlusion or to arrest of circulation and consequent gangrene. Gangrene may arise also from the torn shreds acting as a valve and at once shutting off the blood flow to the parts beyond. Sometimes the injured region remains as a weak spot or cicatrix which finally becomes the seat of aneurism due to the traumatic lesion.

Wounds of arteries, inflicted by sharp instruments or spicules of bone, may, under rare circumstances, involve only the outer and part of the thickness of the middle coat. Such non-penetrating wounds give rise to no primary bleeding and will heal. Secondary hemorrhage may occur, if the wound is infected. Ligation on both sides of the wound and complete section of the artery between the ligatures may therefore be judicious, if septic contamination is probable. Penetrating arterial wounds, unless inflicted by very fine needles, are followed by hemorrhage, either at once or secondarily from ulceration.

The amount of primary bleeding from incisions into arteries depends on the direction as well as the size of the wound. Transverse wounds allow more gaping and, therefore, more bleeding than longitudinal incisions. Oblique cuts hold an intermediate position. Complete section of an artery is less dangerous in this respect than an incision involving only a portion of the circumference, for the former, by allowing contraction and retraction of the coats, affords an opportunity for spontaneous arrest of bleeding. This is the reason that, when cessation of bleeding is desired after arteriotomy of the temporal artery for therapeutic objects, the surgeon completely divides the vessel. Bleeding may at once cease after the division, though pressure is often needed in addition.

Arterial wounds may be followed by death, from external or internal hemorrhage, or may cause suppuration or gangrene secondary to burrowing of the extravasated blood in the cellular tissue. The tissues may cicatrize and traumatic aneurism be developed as a result of arterial injury. If the corresponding vein is wounded arterio-venous fistula is liable to develop.

Treatment.—The treatment of arterial wounds in the limbs should begin by resort to temporary compression by means of a rubber bandage tightly applied above the wound. The arrest of bleeding thus obtained allows opportunity for enlarging the wound in the structures overlying the vessel. This step should be followed by ligation of the vessel on both sides of the wound and by complete division of the artery at the point of injury. Two ligations are necessary in all such cases, because establishment of the collateral circulation will render secondary hemorrhage from the distal part of the artery almost certain. Gunshot wounds of arteries require similar treatment.

When the arterial lesion is subcutaneous or the communication with the air valvular, or when the superficial tissues have healed before the partially divided vessel has given way, large extravasation and burrowing of blood may occur. The symptoms are sudden prostration and syncope from the anæmia, and the development of a soft, somewhat elastic and fluctuating tumor, with, perhaps, an impulse, thrill and bruit, similar to what is found in an aneurism. Pulsation in the peripheral vessels may become absent and the limb œdematous and of low temperature. Pulsation will probably not appear in the tumor until the formation of a circumscribing cyst wall has begun. This diffuse extravasation may continue increasing until death results or gangrene occurs. Death may supervene by rupture and a discharge of blood and clots into some cavity, or from the skin giving way, through suppuration and ulceration, and allowing secondary hemorrhage. The treatment of such cases of arterial injury consists in applying pressure to the artery above the wound and over the swelling, and keeping the patient in bed and the limb at absolute rest by bandages and splints. The rubber bandage of Esmarch may be used temporarily to occlude the artery. Ligation of the trunk at some distance above the swelling so as to be above the first branch will generally succeed if these measures be inefficient. When it is impossible to obtain absolute rest or when ligation above the first collateral branch is inapplicable or inefficient, pressure on the artery above the wound must be made or artificial anæmia by the Esmarch method obtained, the tumor laid open, the clots turned out, the artery completely divided, and both ends secured by catgut ligatures. The easiest way to isolate the artery is to insert a probe into the opening and then dissect the vessel free. The ligature can then be readily passed around it by means of a curved needle with an eye near the point. If the artery cannot be compressed above the wound, the operator is to make a small opening in the skin and introduce one or two fingers of the left hand into the cavity of the tumor. He compresses the artery with his finger while the cutaneous wound is so plugged with the finger that no blood escapes. He then employs his right hand to enlarge the wound and tie the injured vessel.

When the extravasation is comparatively small and has become circumscribed by an adventitious sac of condensed and thickened connective tissue, laying open the cyst wall and tying both ends of the artery will often be quite easily performed, and, being the radical operation, is probably more judicious than ligation of the artery above the tumor. In the diffuse and profuse extravasations just discussed, ligation above the first branch is probably more judicious than searching for the arterial wound among the structures inundated with partially coagulated blood, and is certainly better than ligation immediately above the injured part of the artery. This position of the ligature is usually allowable only in the small extravasations, where there is little danger of secondary hemorrhage from the distal part of the vessel when the collateral circulation is established.

Surgical interference should not be adopted too hastily in small arterial extravasations, especially when they are subcutaneous or due to fractured bones injuring the artery. Spontaneous cure may be accomplished by the contraction of the condensed cellular tissue and coagulation of the blood. The encysting process, which causes the development of an adventitious sac, is the first step in such cases.

Recently there have been cases reported in which suture of wounded arteries was successfully done. Experimental work, especially that of Dr. J. B. Murphy, has proved the availability of this method of dealing with these dangerous injuries. Asepsis is essential. It seems possible also to successfully excise a damaged portion of artery and unite the cut ends. This may be done by turning portions of the wall outward so as to appose endothelium to endothelium; or the smaller tube may be inserted into the larger, which may be split in order to receive the former.

I have successfully closed a small puncture in the subclavian artery by grasping the wall around the opening with hemostatic forceps. The forceps were left in position for a few days.

Traumatic Aneurism.

Varieties.—Traumatic aneurism is a secondary result that occasionally follows arterial injuries. This term has often been improperly applied. It should be restricted to the following conditions:

1. Dilatation of the cicatricial tissue and adjacent arterial wall after a healed penetrating wound of an artery.

2. Dilatation and hernial protrusion of the uninjured inner coats through a wound of the outer tunic alone.

3. Dilatation of the outer tunic after an injury producing rupture of the inner coats alone. Such ruptures are, as a rule, produced only in vessels whose inner coats have been weakened by degenerative changes, such as atheroma. Hence, such cases have an origin which often makes the terms spontaneous aneurism and traumatic aneurism equally inappropriate, since two causative elements are present.

A limited extravasation of blood from puncture of one of the smaller arteries may become surrounded by an adventitious sac, formed by inflammatory condensation and thickening of the normal areolar tissue. This differs somewhat from the diffuse and burrowing extravasation spoken of on a previous page under wounds of arteries, and has more right to the title traumatic aneurism. Still it is not strictly an aneurism, though it is a blood tumor which pulsates and has a thrill and bruit. It is nothing but an encysted extravasation of blood; or, in other words, an arterial hæmatoma.

Treatment.—The proper treatment of traumatic aneurism is compression of the artery as near as possible to the sac; or, in the event of this procedure failing, ligation in the same situation.

Small or superficial traumatic aneurisms may be treated by incision of the sac and ligation of the artery on both sides of it. Dissection of the tissues so as to expose the sac and the artery, followed by ligation on both sides without opening the sac, is a good modification of the same method. Excision of the sac with the attached portion of artery, may be done after controlling the circulation with Esmarch's elastic bandage.

The different methods of ligation, described in the section on the treatment of spontaneous aneurism as Hunter's, Wardrop's, and Brasdor's methods, may sometimes, on account of the location of the tumor, be preferable to ligation immediately above the sac.

Arterio-venous Wounds and Fistules.

Definition and Pathology.—Punctured or gunshot wounds simultaneously penetrating an artery and an adjacent vein are liable to be followed by a persistent orifice of communication between the two blood vessels. Such fistulous communications which may form slowly have been improperly called arterio-venous aneurisms.

When the lips of the arterial wound remain in contact with and become closely adherent to those of the adjacent vein, a direct fistulous opening is established between the caliber of the artery and that of the vein. When the wall of the vein is pushed away from the wall of the artery and the extravasated blood burrows between them, a pouch or sac is developed, which communicates on one side with the artery and on the other side with the vein. The former condition has been termed aneurismal varix, the latter varicose aneurism. Neither of them is an aneurism, for they are not circumscribed dilatations of one or more of the arterial coats induced by the distending influence of the blood current upon abnormal vascular walls. Hence, to class them together under the general heading arterio-venous aneurism is obviously improper. The first form is exhibited as a varicose vein, or varix, with pulsation; and therefore may, perhaps with some degree of propriety, be called an aneurismal, or better, an aneurismoid varix. The second form is, in the development of its adventitious sac, identical with the encysted extravasation or arterial hematoma previously described, which is sometimes improperly termed a traumatic aneurism. The terms simple arterio-venous fistule and sacculated arterio-venous fistule would seem to well describe the two forms of preternatural arterio-venous communication.

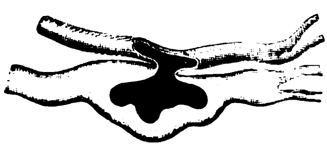
Arterio-venous fistules of both kinds very occasionally arise without traumatism. Ulceration or an abscess may open a contiguous artery and vein and permit the establishment of a direct or indirect orifice of communication. Again, a true aneurism may cause thinning and perforation of a vein upon which its sac presses. In this case, however, the condition is a sequence and complication of aneurism, not a new disease deserving a special name.

FIG. 102.

Case of sacculated arterio-venous fistule of right thigh due to gunshot wound of femoral vessels. (Author's Case.)

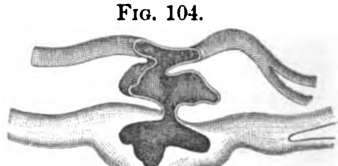
SIMPLE ARTERIO-VENOUS FISTULE OR ANEURISMOID VARIX.--**Symptoms.**--Aneurismoid varix is a dilated condition of the vein due to a direct fistulous aperture between it and an artery. It appears as a small, soft, bluish tumor, readily disappearing on pressure, which is the seat of a peculiar tremulous jarring or vibratory pulsation and a characteristic continuous, but remittent, purring murmur. The vibration and murmur are due to the injection of a small stream of arterial blood into the vein through a narrow orifice at each pulsation of the heart. This forcible blood current, by greatly increasing the intravenous pressure opposite the orifice of communication and by antagonizing the upward flow of venous blood, causes marked distention of the vein at the site of the fistule, and leads to hypertrophy and tortuosity of it and other veins in the vicinity.

FIG. 103.



First form of arterio-venous fistule. (WYETH.)

FIG. 104.



Second form of arterio-venous fistule. (WYETH.)

The vibration and murmur may be transmitted along the veins to a considerable distance from the opening; especially is this the case in an upward direction. The swelling, vibration and murmur are lessened by elevation of the limb, and increased by its being placed in a dependent position. Digital compression of the vein at the cardiac side of the tumor increases these phenomena, but similar compression on the distal side exerts no influence whatever. Compression of the artery above the swelling causes immediate arrest of vibration and murmur, which are at once reëstablished upon removal of pressure. Pressure upon the artery below may be expected to increase the size of the swelling.

The arterial trunk above the seat of disease may after a time become enlarged and pulsate more vigorously than the corresponding vessel of the opposite limb; but below the aneurismoid varix the artery and its branches become smaller and show diminution of the normal pulsation. The limb below the disease is usually weak and of lower temperature than normal. It may exhibit a hypertrophic condition of the skin, nails and hair, and become the seat of œdema, ulceration, hemorrhage, and perhaps gangrene. These secondary changes are due to interference with the normal circulation.

Aneurismoid varix of the scalp is sometimes followed by such a general hypertrophy of the venous and arterial branches that a mass of convoluted and pulsating vessels is formed which cannot be distinquished from arterial varix, the so-called cirsoid aneurism.

Simple arterio-venous fistule or aneurismoid varix is usually an affection of slow progress. If it does not increase or annoy by reason of its bulk or murmur, it requires no treatment.

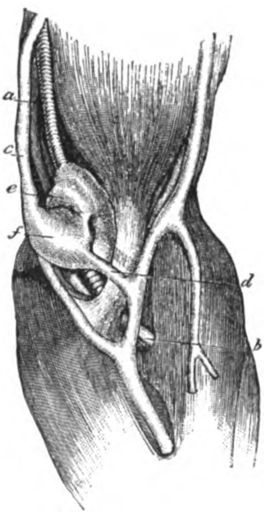
After arterio-venous punctures, which by the way have not infrequently been received during venesection at the elbow, the possible occurrence of fistule should be remembered; and an attempt to prevent such a sequence should be made by applying pressure to the wound and also to the artery above the injury.

Treatment.—If curative treatment is deemed necessary, continuous digital pressure upon the tumor directly over the orifice should be made.

The use of the rubber bandage may be advantageous if so applied as to stop the circulation through the limb, and yet leave the tumor filled with blood. Coagulation and consequent occlusion of the orifice may possibly be thus effected. Many cases will resist both of these plans of treatment. Then resort to ligation is justifiable in severe cases of the disease. The artery should be tied with catgut above and below the opening. The vein should be carefully separated from the artery at the point of ligation and left unmolested, since its ligation or destruction greatly increases the risk of gangrene of the already poorly nourished limb. In such a locality as the thigh, where the integrity of the femoral vein is so essential, it is better to omit placing the lower ligature on the artery and trust to elevation of the limb rather than to endanger the vein by rudely endeavoring to separate it from the artery. It sometimes requires great care during the operation to distinguish the thickened and pulsating veins from the artery.

SACCULATED ARTERIO-VENOUS FISTULE.—The so-called varicose aneurism is not an aneurism, but is a sacculated arterio-venous fistule, differing from the aneurismoid varix, or simple arterio-venous fistule, in having a sac or pouch between the artery and vein, from which there is one opening into the artery and another into the vein. In this sac, which is due to inflammatory condensation and thickening of the normal connective tissue, the arterial and venous blood currents meet and intermingle.

FIG. 105.



Arterio-venous aneurism at bend of elbow: *a*, brachial artery; *b*, radial artery; *c*, basilic vein; *d*, median basilic vein; *e*, aneurismal sac; *f*, dilated vein. (LE-NOIR.)

Symptoms.—The clinical history differs from that of simple arterio-venous fistule, or aneurismoid varix, in having certain additional symptoms. The same venous hypertrophy exists and the same vibratory or jarring motion and purring murmur are present in the veins, though less marked than in aneurismoid varix, because the arterial stream is not forced directly into the vein. A tumor more or less solid can often be perceived lying between the two vessels. This is felt to be the seat of a pulsation synchronous with the arterial pulsation and distinct from the tremulous jarring of the distended vein. Auscultation reveals a blowing murmur, like that of a true aneurism, which is additional to the purring murmur due to the blood entering the vein. Œdema, cutaneous hypertrophy, ulceration and other nutritive changes may occur, as in aneurismoid varix. The sacculated arterio-venous fistule differs from the simple fistule in its greater tendency to be progressive, and to lead, by the distention and enlargement of the sac, to sloughing of the skin and fatal hemorrhage. The sac, as a rule, gradually becomes somewhat hard from internal fibrinous deposition, and, indeed, this process occasionally causes spontaneous closure of the venous openings and simplifies the treatment of the disease. The progressive character of the condition is such that treatment is nearly always demanded.

Treatment.—Means to obliterate the sac should usually be undertaken, if the diagnosis from aneurismoid varix has been established. This differential diagnosis at times may be difficult. Digital or instrumental compression of the artery above the disease, combined with pressure directly upon the opening into the vein, should be the first resort. A similar method is to apply the rubber bandage tightly from the fingers or toes up to the tumor, to carry it with only moderate pressure over the tumor and finally to constrict the limb tightly above the seat of the disease. Thus the sac is left full of blood which, by the arrest of circulatory movement, is given an opportunity to coagulate and thus induce obliteration of the sac and closure of the fistulous apertures. Pressure, if it does not cause a radical cure, may at least close the venous opening and thus reduce the lesion to a more simple and manageable condition.

When pressure fails, ligation of the artery immediately above and below the sac is the proper procedure. The coats are usually healthy, since the condition is due in nearly every instance to a wound. Hence, the ligatures can be applied near the seat of disease. The neck of the sac also, if accessible, may be tied close to the artery. When the shrunken lower part of the artery cannot be found, it may become necessary to lay open the sac. A probe can then usually be passed down the vessel through the aperture connecting the sac with the caliber of the artery. In such operations it must be remembered that if the vein is first laid open, the surgeon sees only the venous opening into the sac. A second incision is then required to open the sac and disclose the arterial orifice. Care should be exercised to avoid tying or tearing the main veins of the limb. Such a complication adds to the risk of gangrene. When such venous interference is unavoidable in old and feeble patients, amputation will probably be preferable to the double ligation. In all these operations the rubber bandage should be applied as a preparatory step.

Coagulating injections into the sac after immobilizing the blood by an elastic bandage have been suggested. The method by ligation is probably less dangerous, and at the same time more radical in principle.

ARTERITIS AND DEGENERATIVE CHANGES IN ARTERIES.

Pathology.—Inflammation of arterial walls, if acute, usually involves sooner or later the three coats; but the pathological changes may begin or become more marked in any one of the tunics. Hence, we have the terms endarteritis, mesarteritis and periarteritis, expressing inflammation of the inner, middle, and outer coats respectively. Chronic arteritis affects principally the inner coat. Arteritis is caused by external or internal violence, such as wounds or lodgment of emboli; by extension of inflammation from surrounding tissues, as in phagedena; and by syphilis, rheumatism, gout, alcoholism, tuberculosis and renal disease. The results that may follow arteritis are fatty degeneration, atheroma and calcification of the tunics; occlusion or aneurismal dilatation of the caliber of the vessel; and suppuration, ulceration or perforation of the vascular wall. The organ sand structures supplied by the inflammed artery may suffer by loss of function and become the seat of gangrene secondarily to these sequences of arteritis.

The pathological changes found in traumatic arteritis are similar in character, whether they begin externally or internally. The inflammatory process commences in the tunic injured, but, as a rule, soon spreads to the other coats. Internal violence, such as is produced by the impinging of the blood-current or by the impact of an embolus, is more apt to induce an inflammation limited to one tunic than is external violence, which usually injures all coats simultaneously.

Traumatic arteritis from external causes must necessarily be accompanied by contusion, laceration or some such complicating lesion of the periarterial structures.

The pathological alterations seen in arteritis are very like those which have been detailed as occurring in phlebitis. The external tunic of the artery becomes unusually vascular and is swollen from infiltration by serum and white corpuscles, that have migrated out of the vasa vasorum. These changes cause thickening and softening. The middle and internal coats also are thickened and softened and the site of cell proliferation. The internal tunic loses its smooth, glistening appearance, is elevated in patches which are sometimes the seat of erosions, and usually becomes pinkish in color. The caliber, or lumen, of the vessel is lessened by the swelling of the coats, the projection inward of the inner tunic, and probably also by spasm of the inner coat. When there is rupture of the internal tunic, as happens in ligations and other injuries, there will be more encroachment and even occlusion of the lumen, for the roughened and projecting margins will cause fibrinous deposition. The formation of a coagulum consisting of white corpuscles and fibrin occurs in arteritis as in phlebitis, though less often, even without previous rupture of the inner coat. It is much more unusual in acute than in chronic arteritis. In syphilitic arteritis it is not infrequent. As in phlebitis the thrombosis is at times the cause, at others the result, of arteritis.

When complete occlusion of the artery and arrest of the blood current are produced by the pushing inward of the internal coat and by the deposition of cells and fibrin, permanent obliteration of the vessel may take place from organization of the cells of the coagulum, as was formerly believed, or from organization of the newly formed tissue springing from the normal cells of the internal coat. There occurs thus a species of cicatricial contraction, or arterio-sclerosis, which converts the former arterial tube into an impervious fibrous cord. Sometimes, however, on the other hand, the clot undergoing fatty degeneration is washed away as minute particles of fat which do no harm, and the artery regains its normal patulous condition. Sometimes fragments of the clot are detached and as emboli are carried onward until they plug some distant artery of smaller caliber. There they may be absorbed or may produce local anæmia and infarction. At other times disintegration of the primary coagulum occurs, due to septic or pyogenic bacteria, and septicæmia or multiple infective embolism and pyæmia may result.

When suppuration and ulceration occur, as happens at times in septic traumatic arteritis, there is great liability of perforation and hemorrhage unless the previous occlusion of the artery by a coagulum has been complete. Suppuration in the outer coat is generally diffuse, but in the middle tunic it may be localized as distinct abscesses. Pyæmic infarction is readily induced, if septic material from suppuration of the vascular walls or of the surrounding structures gains entrance to the blood current. The hyperplasia of connective tissue, which may take place in the middle coat as a sequence of arteritis, causes atrophy of the muscular and elastic fibers and renders the vessel less liable to resist the distending influence of blood pressure; hence, subsequent aneurismal dilatation may occur at the seat of the former arterial inflammation. Infective emboli, causing acute inflammation and softening, are believed to be a frequent cause of aneurism when occurring in the young.

Idiopathic arteritis is usually associated with, and a result of, inflammation of the structures surrounding the vessel, unless it be due to syphilis, gout or some similar dyscrasia. Many cases denominated idiopathic arteritis are really instances of traumatic inflammation, caused by the impact of the blood current or of emboli from cardiac vegetations against the internal arterial coat. Such are the cases of endarteritis and resulting fatty degeneration not infrequently found at the great sinus, the transverse arch and the bifurcation of the aorta, and in the innominate artery. Idiopathic arteritis presents pathological changes similar to those seen in traumatic cases.

Syphilitic arteritis is a chronic inflammation and occurs especially in the smaller arteries. The vessels of the brain are particularly liable to it, and, on account of the resulting circulatory interference, the disease in this locality is a serious one. Aneurism may be due to syphilitic arteritis of the aorta and larger vessels. The pathological changes arise chiefly in the internal tunic, which, by reason of the inflammatory proliferation of cells, projects into the lumen or caliber of the vessel and causes great narrowing or complete occlusion of the blood channel. Death from cerebral anæmia thus induced is not very infrequent. It is often impossible during life to diagnosticate syphilitic arteritis from atheroma. In fact, both diseases may exist at the same time. Atheroma is more common in the old than the young and causes arterial weakening and dilatation rather than occlusion. Atheroma is not so apt to attack the smaller vessels as is syphilis. After death microscopic examination shows that atheroma has a greater tendency to involve all the coats than syphilis, which is usually more or less limited to the internal coat.

Rheumatic arteritis is said to be rare. That it has not been studied as carefully as the other forms may be the reason for this supposition. Rheumatic inflammation of the lining membrane of the heart, which is similar to the lining coat of arteries, is certainly common. Mechanical strain put upon the coats of the vessel by reason of increased or unusual intravascular pressure is a cause of chronic arteritis. These chronic forms of arteritis are all allied to degenerative processes and have few well-marked symptoms.

Symptoms.—The symptoms of arteritis, when more or less acute, and the accompanying thrombosis are severe pain, tenderness and hyperæsthesia, in the course of the vessel and in the parts supplied by it, and impairment of muscular power. This pain may resemble rheumatism. The surface temperature is lowered and the skin perhaps mottled. When the vessel is superficial, a hard, pulseless cord may be felt or seen through the skin; if only partial occlusion has taken place, a jerky pulse may be perceptible. Secondary gangrene, with its characteristic symptoms, may arise from the interruption of circulation, especially in the old and feeble.

Treatment.—The treatment of arteritis consists in rest, wrapping up the limb in cotton to maintain heat, administering opium to relieve pain, and using tonics, stimulants and good food to prevent depression. As gangrene is a not unusual sequence, the husbanding of vital resources is required. This precludes the use of depressants in the early stages, unless the patient is unusually vigorous and the disease so situated as to render subsequent gangrene limited. Measures to obviate gangrene and to avert fatal hemorrhage from ulcerative perforation are to receive careful consideration. Syphilitic, rheumatic, gouty and other forms of arteritis should be treated with mercury, iodide of potassium, alkalies, salicylic acid, colchicum, etc., with a view both of preventing further progress and of perhaps effecting cure. Nitroglycerine and the nitrites would seem to be indicated to induce dilatation of the partially occluded arteries in which endarteritis is present. Microbic invasion of wounds must be prevented by rigid asepsis and antisepsis, since it has been shown that septic discharges are the chief cause of ulcerative and suppurative arteritis.

Atheromatous Degeneration and Calcification of Arteries.

Any form of chronic arteritis may terminate in atheromatous degeneration of the vascular walls. This condition is due to malnutrition of the arterial tunics and is a fatty degeneration of their cellular elements. It occurs as a secondary lesion, following chronic inflammation of arteries, and is frequently found in syphilitic and senile subjects. It differs from the primary and localized fatty change belonging to the pathology of endarteritis in being a secondary lesion, which affects the arteries generally and which is liable to give rise to thrombosis, embolism and hemorrhage. The destructive process, moreover, causes infiltration not only of the inner coat but also of the muscular and elastic coats, transforming the normal elements into granular material. Atheromatous degeneration is seen, on examination of the inner surface of the vessel wall, as numerous definitely outlined, soft, pulpy patches, which are scattered throughout the arterial system. The pulpy material found in the center of these softened spots gives the name atheroma to this peculiar molecular destruction, and under the microscope is found to consist of fatty and granular matter, mingled with cholesterin crystals and shreds of fibrous tissue. The middle coat soon becomes infiltrated with fatty particles, and the outer one also undergoes degeneration.

The weakening of the vascular wall may allow the blood pressure to cause aneurismal dilatation or rupture. The softening of the deep layers of the internal coat may give rise to the so-called atheromatous abscess; if the superficial layer is destroyed, the atheromatous ulcer remains.

At times calcareous degeneration of the tunics occurs as a secondary and conservative process, as if nature was endeavoring to counteract the effect of the softening influences of atheroma. Calcification is more frequent when the atheromatous change is slowly progressing, and the two processes may be going on together at the same time in the same locality. The chalky change begins in the inner and middle coats; but the entire vessel wall may be converted into a calcareous cylinder, though isolated plates of calcification are much more common. By the washing away of the pulpy or atheromatous material on the inner surface the calcareous plates may be uncovered. Sometimes the blood current gains entrance beneath the chalky portion of the wall and by a species of dissection separates the tunics or their different layers, and thus creates the so-called aneurism by dissection.

The atheromatous and calcific degeneration causes arteries to become brittle and inelastic, and roughened on the interior and exterior; and thus predisposes to loss of function and rupture, by which hemorrhage, occlusion and gangrene may arise. It is a common senile change and is particularly liable to occur in the arteries of the brain and in the main arteries of trunk and limbs. It is not uncommon as a ring of degeneration about the root of a large branch. Ligation of such diseased vessels is apt to be followed by secondary hemorrhage from the ligature cutting through the brittle walls. A broad, flat ligature to produce mere apposition of the arterial walls is proper under such circumstances. The weakening of the middle coat induced by atheroma is a frequent precursor of spontaneous aneurism. Some writers believe that the calcareous degeneration of arteries in the aged is not secondary to atheroma, but is a primary change and occurs in the middle coat first; while that secondary to atheroma begins in the internal coat. True ossification of arteries seldom, if ever, occurs. Cases so denominated are probably instances of calcification.

These degenerative changes cannot be arrested by any special line of treatment. The indications are to keep up nutrition, to avoid severe exercise, which causes increased blood pressure in the brittle arteries, and to perform none but necessary operations, because of the imperfect circulatory supply and the tendency to secondary hemorrhage.

Aneurism.

Definition.—An aneurism, strictly defined, is a circumscribed dilatation of one or more of the arterial coats, induced by the distending influence of the blood current upon abnormal vascular walls.

This definition properly excludes:

1. General dilatation with elongation of an artery (often called cirsoid aneurism, varicose artery and arterial varix).

2. General dilatation of small arteries and of capillaries (often called aneurism by anastomosis).

3. Arterio-venous fistule (usually called arterio-venous aneurism).

4. Separation of the arterial tunics by the blood current (usually called dissecting aneurism).

5. Extravasation of arterial blood due to spontaneous rupture (one of the forms of so-called false aneurism).

6. Extravasation of arterial blood due to wounds and injuries (called by some writers a form of traumatic aneurism).

These widely different pathological conditions often receive, though improperly, the name aneurism because they are tumors containing blood or blood-clots. They are not aneurisms according to the definition given above and as they present symptoms and require treatment different from aneurism they are discussed in their appropriate places elsewhere.

Varieties.—If the conditions mentioned above be excepted, there are only two forms of aneurism—the tubular or fusiform and the sacculated or sacciform.

Separation of arterial coats, which occurs at times as a result of arteritis by the blood insinuating itself between the layers of the middle tunic or between the inner tunic and the middle, is, under the name dissecting aneurism accepted by most writers as a form of aneurism. It is better, however, to reject it, since it differs from aneurism in every essential feature. It occurs chiefly in the aorta, which may show the separation through nearly its entire length. The blood current may separate the coats for a long distance or form a circumscribed sac within the thickness of the arterial wall. The blood may finally burst through the outer surface of the wall, and cause hemorrhage into the cellular tissue, or into the pericardial, pleural or abdominal cavity. Sometimes the diverted current reënters the caliber of the vessel through an opening, due, as was the opening of exit, to a patch of atheromatous softening. This tunnel-like channel, with the consequent thickening of the vessel wall, may cause the artery to present the appearance of being double. It would be possible for the separated coats to bulge into the caliber of the artery and by occlusion cause gangrene of the parts below. It is readily seen that this separation of arterial coats is very different from aneurism, and only corresponds to the definition of aneurism when a distinct circumscribed sac

FIG. 106.

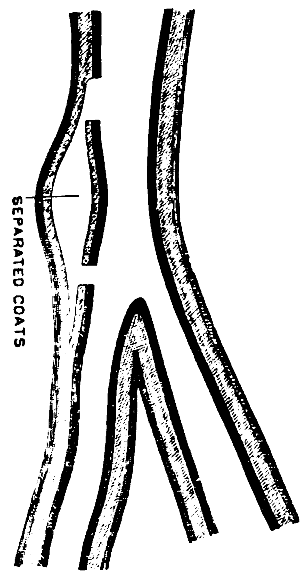


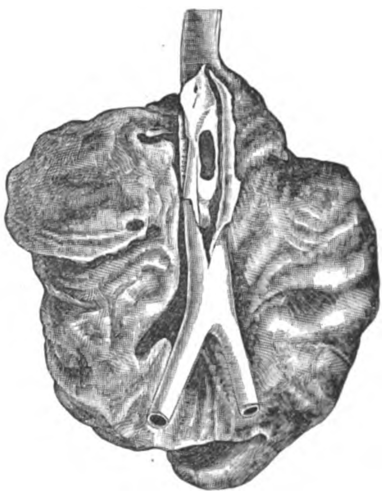
Diagram showing separation of arterial coats, often called dissecting aneurism.

is formed within the thickness of the vessel wall. This is of exceedingly rare occurrence. It is, therefore, better to limit the term aneurism to the two forms, tubular and sacciform, and dismiss the term dissecting aneurism entirely, using instead the words separation of arterial coats.

A fusiform or spindle-shaped aneurism is a dilatation or expansion of the entire circumference and usually of all the coats of an artery, while a sacciform aneurism is a sac or pouch, consisting of one or more of the coats, developed upon one side of the artery and communicating with the interior of the vessel by a narrow opening.

Fusiform aneurism is much less common than the sacciform variety, and is chiefly met with in the aorta and in the iliac and femoral arteries. The dilatation, though not always uniform, is usually more marked at the middle of the tumor and diminishes toward each extremity until the normal caliber of the artery is regained. This gives the aneurism, which necessarily has an opening of entrance and one of exit, a spindle shape. The walls of the tumor consist of degenerated and thickened arterial coats with a roughened inner surface. There is some increase in the length of the artery at the dilated and hypertrophied spot. This form of aneurism, unlike the sacciform variety, does not, as a rule, enclose laminated fibrin. Chronic arteritis with its consequent atheromatous degeneration of the arterial walls is the chief factor in the causation of such aneurisms. Traumatic fusiform aneurism seems to be almost an impossibility. Occasionally several fusiform aneurisms are developed in connection with the same artery, which is of normal caliber between the dilated regions. The lateral blood pressure in fusiform aneurisms is comparatively moderate in amount; hence they grow slowly and do not readily burst, but it is not unusual for a sacciform aneurism to be developed upon the surface of a fusiform dilatation and to cause death by rupture. In cases of very large fusiform aneurism of the aorta death may also occur from syncope, because the heart is unable to give sufficient forward motion to the mass of blood contained in the large tumor. Hence the circulatory movement in the more distant vessels is impaired and fatal syncope may supervene.

FIG. 107.



Carotid aneurism with artery laid open to show the orifice. (SCARPA.)

The sacciform aneurism is the more common variety of the disease, and is that which is meant when the simple term aneurism is used. Fusiform aneurisms are so infrequent, and in comparison with the sacciform variety so unimportant surgically, that further reference to them is scarcely necessary.

A sacciform aneurism is a sac or pouch developed upon one side of an artery, by localized dilatation of the arterial wall, and communicating with the interior of the vessel by a narrow orifice or mouth. The cavity of the sac has a much greater diameter than its orifice of communication with the artery, and it is, therefore, usual to speak of the body, neck and mouth of the aneurism. The walls of the sac may, if the tumor is small, consist of all three arterial tunics ; but usually it is only the outer tunic and perhaps part of the thickness of the middle tunic that form the sac.

As internal pressure causes further distention, the tunics become blended and finally may disappear at places and be substituted by an adventitious wall of condensed and newly formed cellular tissue. Sacciform aneurism may be developed upon the surface of a fusiform aneurism, which is, as has been seen, little more than a diseased and greatly enlarged artery.

Causes.—Any agency that lessens the power of the arterial wall to resist the stretching influence of the blood impelled by the cardiac impulse and any circumstance that diminishes the normal elasticity, by which the artery contracts as soon as this stretching influence is relaxed, must predispose to aneurismal dilatation. Hence the degenerative fatty change known as atheroma, which occurs in the arterial tunics as a result of arteritis, is the chief factor causing a predisposition to aneurism. Anything that induces the atheromatous change, such as advancing age and alcoholic intemperance, may be an indirect cause of aneurism. Unusual muscular exertion, by inducing violent heart action and preventing rapid admission of blood into the capillaries, causes increased intravascular pressure, and thus may be the immediate cause of an aneurismal dilatation. If the artery is previously atheromatous, the sudden strain causes the inner coat to give way at a point where an atheromatous patch is situated ; the fatty pulp, lying under the inner layer of the inner tunic, is evacuated, and thus in the integrity of the wall is made a breach, which allows distention to occur under the force of the blood stream. Continuously laborious occupation is not so dangerous in this regard, for the vessels seem to acquire strength by the gradual accession of great intravascular tension. It is a sudden strain, in vessels unused to such a degree of tension and which are previously degenerated, that tends to cause such damage.

External violence without a wound, such as blows and concussions, may loosen the membrane covering an atheromatous spot and induce aneurism in much the same way. Internal strain upon the arterial walls is increased by postures which cause flexures of the vessel ; by overtight clothing, especially around the neck ; and by the anatomical division of the artery into two branches of nearly equal caliber. The blood flow is retarded by these conditions, and consequently the lateral pressure is increased. Hence, aneurism is more liable to occur when sudden muscular effort is made or any unusual strain is thrown upon the walls of an artery under such disadvantageous circumstances. Sometimes a "giving way" sensation is felt at the time of the violent exertion. This is probably caused by a rupture of the middle coat, and may, perhaps, occur in a healthy artery.

There appears to be an imperfectly understood connection between heart disease and the occurrence of aneurism. Embolism is believed by some authors to cause the development of aneurismal dilatation. This is especially so in infective embolism from ulcerative endocarditis and other septic processes. As the aneurism occurs at and not above the point of lodgment of the embolus, the lesion is supposed to be due to a local arteritis resulting from the septic character of the embolus. This is the explanation of the well known non-occurrence of aneurism in cases of non-infective embolism.

Syphilis has been regarded by some writers as a cause of aneurism. This is doubtful, since syphilitic arteritis seldom attacks the larger arteries, and it is there that aneurism is more commonly met. Syphilitic arteritis is preëminently a disease of small vessels. It may be a factor in the causation of aneurism of arteries of the brain. Finally, wounds of arteries may be followed by aneurism. The subject of traumatic aneurism has, however, been discussed in a previous section and requires no further mention here.

When an atheromatous spot has given way, as described above, and the pressure does not cause complete perforation of the wall and hemorrhage, it is usually a sacciform aneurism that is developed. When, however, there is an absence of normal and of inflammatory adhesion between the tunics and their component layers, separation of the arterial coats may be induced by the blood current insinuating itself between them. Thus may be caused on rare occasion separation of the arterial coats, the so-called dissecting aneurism.

Pathology.—Dissection of a sacculated aneurism shows on the outside an investment or covering of cellular tissue, resulting partly from inflammatory condensation, partly from atrophy of the muscles and other structures that have been subjected to pressure by the increasing tumor. Within this more or less imperfect investment is found the true aneurismal sac, consisting of one or more of the arterial tunics which have become so thickened, blended, and changed by interstitial growth that it is usually impossible to determine their exact identity. The inner and middle coats can sometimes be recognized by the patches of atheromatous degeneration visible in their structure. In large aneurisms the two inner coats have usually disappeared; indeed, the outer one may be absent in places and its place be supplied by the external investment above mentioned and the laminated fibrin contained in the sac. The true sac is of varying thickness in different regions of the tumor.

It is evident that in all aneurisms, except in the very smallest, there must be a natural growth of the sac wall after the pouch has first been formed, for the area of tissue that constituted the arterial wall at the site of disease could not possibly be stretched so as to form a sac of such dimensions. The irregular thickening and thinning of the sac depend upon the force of the blood current in the aneurism. Where the blood impinges with the greatest force, there will the sac be thinnest. Inside the true sac there will nearly always be found numerous concentric layers of more or less completely decolorized fibrin. The layers of fibrin nearest the sac wall are tougher and more yellow than those nearer the center of the aneurism, which are softer and somewhat reddish. This laminated fibrin is found especially in those irregular pockets or pouches of the sac which are away from the rapid current circulating in the aneurism. This deposition of fibrin is encouraged by any agency, whether within the aneurism or entirely foreign to it, that diminishes the force of the current within the tumor. When fibrin has once begun to form upon the inner wall of the sac it has a tendency to increase by further deposition from the blood. Thus, layer after layer is formed. The outer layers, being the oldest, naturally become more decolorized and tougher. The laminated fibrin is a beneficial provision of nature, for by reason of its tough, fibrous nature, it strengthens the sac wall and acts as a pad to lessen the force of the pulsating blood current, which is tending to distend and rupture the sac. Moreover, it lessens the capacity of the sac, and by its continual deposition tends to fill up and obliterate the cavity of the aneurism. Fusiform aneurisms usually contain little or no laminated fibrin. At the center of the aneurism, within the concentric layers of fibrin there will be found a mass of soft, black or reddish black clot or a mixture of such clot and fluid blood. This soft clot may be an ante-mortem or a post-mortem formation.

The secondary changes produced by an aneurismal tumor are numerous and are due especially to the pressure exerted by its growth. Thus, œdema, varicose veins and venous occlusion may occur from pressure on the veins; and neuralgia, paralysis, anæsthesia, obscure pains and "tired" sensations may result from nerve compression. Aphonia may follow if the function of the recurrent laryngeal nerve is interrupted. Organs are displaced, bones and cartilages eroded and perforated, synovial sacs opened, gangrene of distal parts determined, and many other destructive processes inaugurated before death or cure occurs. Gangrene may be due to pressure causing interference with circulation to the parts below or to a portion of laminated fibrin or soft clot becoming detached and being washed into one of the distal branches and plugging it.

Symptoms.—The symptoms of aneurism are usually of gradual development, but occasionally it happens that the patient experiences a sensation of something giving way, which is accompanied by a sudden, sharp pain and is followed by the appearance of a tumor. An aneurismal tumor is usually rounded or oval in outline and is covered by healthy skin, unless suppuration or ulceration is taking place. These events occur only in the last stages of the disease.

An aneurism gives rise, as does any other tumor of similar size and location, to certain pressure effects. These symptoms are in no way characteristic and do not aid in establishing a differential diagnosis. In addition there are symptoms depending upon the relation of the aneurismal tumor to the circulation. These are peculiar, and, when found in combination, are pathognomonic of aneurism.

The pressure of an aneurism may give rise to a pain, numbness, muscular weakness or paralysis, venous congestion, œdema and varicosities, gangrene, obstruction to breathing and swallowing, tracheal tugging and many other symptoms due to interference with the functions of special organs. Hoarseness, spasmodic dyspnœa, cough or uncontrollable eructation may be produced by pressure upon the laryngeal or other branches of the pneumogastric nerve; facial distortion, deafness, ptosis or strabismus from similar involvement of cranial nerves; boring pain or even synovitis from erosion and perforation of bones and cartilages, and nutritive changes from involvement of lymphatic vessels or the thoracic duct. The pressure effects of an aneurism are apparently more rapidly developed than those of an ordinary tumor of similar size. This is probably due to the pulsating character of the former.

The symptoms due to the circulatory relations of the aneurism may be called intrinsic symptoms and are five in number, namely;—location, change in tension, pulsation, thrill, murmur. An aneurism is necessarily located in the course of an arterial trunk, and cannot be displaced from its connection with the artery. If occluding digital pressure is made upon the vessel below the aneurism, the tumor becomes more tense and less compressible; and, if the sac contains but little laminated fibrin and has thin walls, the tumor may even become larger than usual by the stretching influence of the unusual amount of blood dammed up in it. If the entrance of blood into the sac is prevented by pressure upon the artery above the aneurism, the tension is diminished and the tumor becomes comparatively flaccid and compressible. The elastic bandage when tightly applied to the limb, as in bloodless operating, often causes a marked diminution in the size of the tumor. It may do harm, however, by displacing portions of fibrin and causing embolism.

The compressibility or non-compressibility of individual aneurismal tumors is chiefly determined by the absence or presence in them of a large amount of laminated fibrin. The variation in compressibility or tension, observed when the exit or entrance of blood is checked, is due to the degree of distention of the sac by its circulating blood contents. When the sac contains much fibrin or has a thick wall, this symptom is not well marked.

The pulsation of an aneurism is a peculiar expansive beat, which not only lifts the fingers or hand laid upon the top of the tumor, but drives apart the fingers or hands when the tumor is grasped laterally. This lateral pulsation is due to the fluid contents of the aneurism transmitting the shock of the heart beat equally in all directions. When the sac is largely filled with fibrin, and, therefore, has little blood contents, this lateral pulsation is less marked and only a dead thud is perceived.

Another peculiarity of aneurismal pulsation is the wave-like movement. The pulsation does not seem to affect all parts of the tumor simultaneously, but swells up somewhat gradually as if propagated from one point, and then in a similar way subsides. Pressure upon the artery above the tumor arrests pulsation; pressure below it and elevation of the limb have a tendency to make it more marked. Aneurisms with large orifices, and which contain little fibrin, present the most characteristic pulsation. In partially solidified aneurisms the pulsation may be absent or obscure, or may resemble the simple rise and fall of a solid tumor lying upon an artery. Pulsation may also be absent because of rupture of the aneurism, because of inflammatory infiltration between the sac and the surface, because loose clots have plugged the orifice of communication, or because the disease has just been spontaneously cured and the tumor has not yet entirely disappeared. When the artery is compressed above the seat of disease, so that no blood enters the sac, the tumor, as previously stated, becomes pulseless and flaccid. If the tumor is now grasped laterally and the pressure upon the vessels suddenly removed, the expanding pulsation, by which the sac is instantly refilled, is readily felt and even seen. When the sac has a large mouth, one pulsation distends it fully; if the orifice is small, the sac fills more slowly, but the first pulsations are strong beats.

The arterial pulse below the aneurism is much less marked than on the opposite side of the body. This may be due to pressure of the tumor on the artery, to arteritis causing occlusion or to the rigidity of calcification. It is possible that it may also be caused by the large amount of blood in the sac distributing the pulsation and lessening that in the current below. This variation in the two radial arteries is of aid at times in diagnosticating aneurism of the thoracic aorta.

Just after the heaving pulsation of an aneurism, the hand of the examiner can often perceive a peculiar tremulous or vibratory movement called the thrill. The thrill is due to the rebound of the blood column, and is said to be more distinct when the artery lies between the sac and the surface upon which the hand is placed.

The last of the five intrinsic symptoms of aneurism is the murmur, or bruit. This is an intermittent blowing, rasping or purring sound, due to the blood rushing through the narrow mouth into the dilated cavity of the sac. It is heard by applying the ear either with or without a stethoscope to the surface of the tumor. The tone varies greatly, depending on the size, shape and location of the orifice, its relation to the sac, and perhaps upon the character of the surrounding tissues. It is most distinct in fusiform aneurisms and sacciform aneurisms with large mouths. It is synchronous with the aneurismal pulsation and is stopped by pressure on the artery above the sac, but returns as soon as the pressure is removed and the blood allowed to flow into the sac. If the tension of the sac is lessened by elevating the limb or by compression of the artery above the tumor, the murmur may sometimes be heard in cases in which it was previously absent.

Increasing the tension by pressing upon the artery below would, on the other hand, have a tendency to diminish the murmur. If the orifice is very small or the sac nearly filled with fibrin, there may be no murmur generated. The aneurismal murmur is not infrequently absent, and, indeed, may be present at one time and afterward disappear. A double murmur indicates, according to Erichsen, a sacciform aneurism.

These intrinsic symptoms may not all be present in a given aneurism, but the association of two or more of them usually renders the diagnosis quite clear.

When an aneurism ruptures, permitting the blood and clots to become diffused, the tumor loses its definite outline and becomes rapidly larger. Pulsation, thrill and murmur become obscure or absent; pain increases, and coldness, lividity and œdema of the extremity are apt to occur. The subcutaneous hemorrhage may cause syncope. Coagulation of the blood and inflammatory condensation of the cellular tissue may in very occasional instances limit diffusion after the rupture and lead to spontaneous cure of the aneurism. Usually, however, the swelling increases and the case terminates in gangrene or suppuration, accompanied most likely with hemorrhage.

Diagnosis.—The differential diagnosis of aneurism from other tumors should always receive careful and systematic attention. No swelling near an artery should ever be laid open until the possibility of aneurism has been eliminated by accurate examination.

The pain caused by internal aneurism may, when the tumor is not easily discoverable, be mistaken for rheumatism or neuralgia. Such an error is hardly probable in the external aneurisms that come under the observation of surgeons. There are two circumstances that at times render the differential diagnosis of aneurism troublesome. First, there are pulsating tumors that are not aneurisms; and secondly, there are aneurisms that do not pulsate.

A solid or cystic tumor or an abscess situated over a large artery may show transmitted pulsation. The pulsation in such cases is not so expansive as in aneurism, but is rather a simple rise and fall which may be diminished or stopped when the tumor is pushed or lifted away from the artery. Flexing the limb so as to relax the deep fascia will probably lessen the pulsation, which, moreover, is sometimes felt only in the line of the artery and not over the entire tumor. There is no murmur, or if any, it is only a dull beating such as is heard when an artery is compressed with a stethoscope. The tension and size of such tumors are not affected by occluding pressure upon the artery above or below the swelling. The suddenness with which aneurisms regain their usual size when arterial pressure on the cardiac side of the tumor is removed is very characteristic, and is not present in tumors with a mere transmitted pulsation.

Cysts or abscesses communicating with a joint or with the abdominal or any other cavity may be partially emptied by pressure; but they refill afterward without reference to the arterial circulation. An abscess situated above or surrounding an aneurism will appear as a tumor having pulsation and some of the other symptoms of aneurism. Such cases are fortunately rare. The aspirator would be available for establishing the diagnosis. If the suppuration is due to rupture of the aneurism, the opening between the sac and the pus collection will permit hemorrhage to follow the opening of the abscess. Pulsation is usually feeble or absent in such conditions, and unless the previous history is obtained the surgeon may be misled into laying open the tumor. The fatal bleeding may not occur until some hours after the incision, because the laminated fibrine may for a time act as a barrier. A murmur should be carefully sought in such cases, since it is less likely to be absent than other aneurismal phenomena.

Some vascular tumors or angiomas resemble aneurisms very much. They are apt, however, to have a more spongy feel and are not so distinctly circumscribed as aneurisms. If the blood is pressed out of such a tumor it returns somewhat tardily and irregularly, causing the tumor to dilate slowly and unevenly and not with the sudden bound that is seen in aneurisms. Pressure upon the artery below causes no marked increase in size of the tumor. The pulsation is not as forcible or distinct as in aneurism, and it lacks the expansive and wave-like character of the pulsation found in the latter disease. The murmur is more confused and less well defined. The introduction of a hollow needle will probably give exit to blood; but the blood will scarcely spurt as in the event of puncture of an aneurismal sac, nor will the needle be likely to give to the surgeon's hand the sensation of having its end in a cavity. The use of the X-rays will at times aid in the diagnosis of aneurism; particularly in intrathoracic aneurisms.

Malignant tumors, especially sarcomas of the bones, may when very vascular assume pulsation. If in localities where aneurism is common, the diagnosis becomes at times almost impossible. The history of such growths generally shows that pulsation was not present when the tumor first appeared, and that the growth has recently become of softer consistence than formerly. Careful examination shows that the pulsation is not very distinct, that the murmur is soft and subdued, and that little variation in size is produced by pressure on the artery between the tumor and the heart. The pulsation and murmur after having once appeared do not, as in aneurism, become more conspicuous as the bulk of the growth is augmented; often these phenomena are perceptible only over certain parts of the tumor. Involvement of the adjacent lymphatic glands suggests malignant disease, which, moreover, is apt to be more or less irregular in outline. In very obscure cases an attempt might be made to remove a small portion of the interior of the tumor for microscopic examination by inserting an instrument such as is used for cutting out pieces of muscle in cases of suspected trichinosis.

Aneurisms that are devoid of pulsation may be mistaken for deep abscesses and for glandular, fibroid and other tumors. The pulsation ceases in an aneurism when spontaneous consolidation has occurred and when rupture or diffusion of the blood contents has taken place.

An aneurism, when spontaneously cured by consolidation, continues for a long time as a hard mass, which finally shrinks and disappears. Such a mass cannot easily be distinguished from other hard tumors except by the history. A tumor located near an artery, especially if it shows a tendency to decrease, should, therefore, be well scrutinized before any operative treatment for extirpation is attempted.

When a small rupture of the sac occurs, the effused blood conceals pulsation, changes the ordinary globular shape of the aneurism, and, by gravitating away from the seat of disease, may make the tumor appear to have a site distant from the line of the artery. Moreover, the superficial veins may become unusually marked, because the circulation in the deep veins is interfered with by reason of the pressure. This circumstance gives the tumor the appearance of malignant disease. Aneurisms, which are the seat of small ruptures, are, therefore, at times diagnosticated from solid tumors with difficulty. The diagnosis is easily made when the rupture is large, for the interruption of circulation in the limb below, the swelling, pain, ecchymosis and rapidly occurring suppuration or gangrene are quite distinctive. If suppuration occurs around an aneurism, pulsation may be absent. The careless surgeon may plunge a bistoury into such a swelling and cause fatal bleeding.

Finally, abnormal pulsation of an artery is at times noticeable in conditions of debility and in nervous subjects and may be mistaken for aneurism. The absence of lateral or expansive pulsation and of a tumor serves to dispel the illusion.

Course and Termination.—Untreated aneurism generally continues to increase in size until death occurs from: (1) Pressure interfering with important organs, such as the trachea, pneumogastric nerve or heart; (2) syncope, from weakness of cerebral circulation beyond the large sac; (3) embolism of the cerebral arteries from fragments washed from the laminated clots; (4) rupture and hemorrhage; (5) gangrene, from pressure on the vessels of the limb. When an aneurism bursts upon a serous surface the hemorrhage is usually rapid, and occurs through a slit or star-like tear; but when the rupture is upon a mucous surface, the bleeding is apt at first to be intermittent and so slight as scarcely to attract attention as it oozes through a small fissure. Subsequently, on the occasion of some increase in blood-pressure from emotion or exertion, a small slough gives way and a sudden gushing hemorrhage supervenes through a small circular aperture. Rupture upon the cutaneous surface takes place, as a rule, by the processes of ulceration or suppuration and pointing as in abscesses. Rupture of the sac may, of course, occur without external communication. In such cases the blood is effused among the muscles and fascias, and commonly leads very promptly to suppurative or gangrenous inflammation.

Occasionally, but rarely, an aneurism is cured spontaneously. Any agency that lessens the blood current, and thereby encourages the deposition of laminated fibrin and the coagulation of blood in the sac, may be a factor in this fortunate issue. Absolute quiet of mind and body and maladies, that depress the general circulation or draw the mass of the blood to a region distant from the seat of aneurism, have this tendency. The aneurism itself or some other tumor may compress the artery above the seat of disease, and thus diminish the current through the sac. Spontaneous cure may also occur from occlusion of the vessel above or below the disease by an embolic plug swept from vegetations in the heart or from the fibrin in the aneurismal sac; from inflammation of the sac wall, causing within the aneurism the formation of soft clot; from suppuration; from rupture; and from gangrene. Any of these processes may at times fortunately cause sealing of the vessel and obliteration or destruction of the sac; but they are dangerous complications not often attended by such a gratifying result.

Treatment.—The medical or constitutional treatment of aneurism is important, even in those instances that require additional surgical intervention. Absolute rest of body and mind must be enforced by keeping the patient in bed in the recumbent position, and free from the excitement of talking. He should be cautioned to avoid rapid or frequent movements of the limbs and not to rise in bed unless aided by attendants. He should not get out of bed on any pretence. The food should be limited in quantity, and free from stimulating or indigestible ingredients. Very little water or fluid diet should be given. The design of these precautions is to diminish the bulk and retard the circulatory force of the blood, in order that deposition of laminated fibrin in the sac may be encouraged. These objects may be further obtained, if the patient is robust and plethoric by a moderate bleeding from the arm and the administration of aconite and veratrum viride in comparatively small doses. Bromide of potassium, hydrate of chloral and the other narcotics may be employed here, and also in a debilitated subject, to induce circulatory repose. Iodide of potassium has been strongly recommended in the treatment of aneurism. It should be given in doses of 20 to 30 grains two or three times daily.

The medical treatment just delineated is almost the only treatment applicable to some internal aneurisms, as aneurisms within the cavities of the trunk are called. It should also be employed as an adjuvant to surgical measures in cases of external aneurism. Though cure of any form of aneurism by medical means is rather unusual, amelioration of symptoms and retardation of progressive enlargement are their common sequences. Fusiform aneurisms cannot, but sacciform aneurisms may, be cured by such measures.

Many surgical expedients have been devised for dealing with aneurism. There are three methods which are employed more frequently than the others.

These are:

1. Excision of the tumor.
2. Compression of the artery above the tumor by instruments, the fingers, flexion of the joint or the Esmarch apparatus.
3. Arterial ligation.

Galvano-puncture, acupuncture, the introduction into the sac of foreign bodies such as horsehair or wire, injections of coagulating liquids such as the iron compounds, manipulation which aims to detach fragments of fibrin and plug the distal orifice of the sac, and the other proposed methods are either inferior to, or much more dangerous than, the procedures mentioned above. Still it may be justifiable to resort to one of these methods when those recommended are impracticable. Thoracic aneurisms have been cured by the introduction of thin gold wire into the sac, through a small hollow aspirating needle, and the passage of the galvanic current into the sac by means of the wire.

Amputation may be demanded as a last resort, in order to save life, in aneurisms of the extremities that threaten immediate death from hemorrhage or gangrene.

EXCISION of the aneurismal sac is applicable to small and to some large aneurisms. The method is simple. After the application of the Esmarch apparatus the tumor is dissected out as any other growth would be and the vessel tied above and below the seat of dilatation. The wound is then brought together with sutures. A somewhat similar method, which may be called the incision method, is at times justifiable in large aneurisms, though it is seldom employed except in cases of rupture or accidental puncture of an aneurism. After the circulation has been controlled by compression or the Esmarch apparatus, the sac is incised so that the clots can be turned out and the orifice in the artery discovered. Into this aperture a probe is passed to enable the operator to detect the position of the vessel, which is then ligated above and below the opening. The wound is afterward brought together by sutures or packed with some antiseptic dressing and allowed to granulate.

COMPRESSION.—Proximal arterial compression is the form of compression adopted in practically all cases in which compression is employed; for even in those in which flexion is employed it is the compression exerted on the artery above the sac that is the chief element of value. Compression of the artery above the aneurism acts by diminishing or completely arresting the flow of blood through the sac. This, in the one case, encourages gradual deposit of laminated fibrin which finally fills the pouch and leads to solidification; and in the other, causes the sac to become filled with soft clot, after which, under the influence of absorptive and contractile influences, the aneurism shrinks and becomes obliterated.

It is probable that here, as in ligation, the more certain and safe treatment is that in which the pressure is so regulated that a small amount of blood is allowed to enter the aneurismal pouch during the application of the compressing force. Thus, a slow, laminated deposit of fibrin occurs and the sac becomes hard and solid. When sufficient pressure is made upon the artery to close its caliber entirely, the anastomosing arteries, if the pressure is continuous, will soon carry a small blood stream through the tumor, provided a branch leaves the main trunk between the seat of compression and the sac.

It takes longer to fill the sac with deposits of laminated fibrine than with soft, homogeneous coagulum ; but from what is seen after ligation, the former seems the surer and safer method. Therefore, complete

FIG. 108.

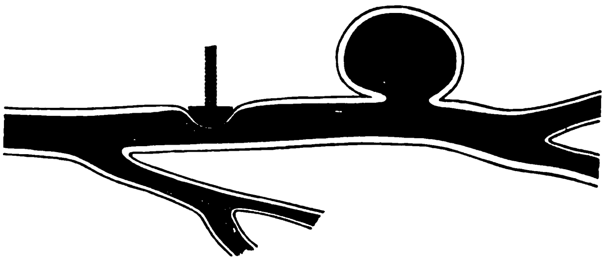


Diagram showing small amount of blood entering sac because pad of compressor does not entirely occlude the caliber of the artery.

compression, as a rule, should not be employed unless the pressure can be applied far enough above the aneurism to insure the existence of an intervening branch which will carry a gentle current of blood through the sac. Partial compression may be employed even near the aneurism because it allows a portion of the current to pass through the vessel at the seat of pressure and thus enter the sac.

By complete compression is not meant such a degree of force as will cause inflammation of the tunics and permanent occlusion of the artery ; merely such pressure as will bring the opposite walls of the vessel in contact and prevent the passage of the blood current during the continuance of the pressure. It should be continued for from four to ten hours, and usually requires anæsthesia during the whole period for the prevention of discomfort and actual pain.

Partial compression, which allows some blood to flow through the artery at the point of pressure, is more tolerable to the patient than complete compression and, therefore, does not require anæsthesia. Narcotics may be demanded, however, to relieve distress occasioned by the restraint. This method of treatment must be continued for days and perhaps for two or three weeks, because the blood current, though greatly diminished in volume, is sufficient to prevent rapid solidification in the sac.

Either form of compression may be employed continuously or interruptedly. Continuous compression is probably better than interrupted compression, whether complete or partial, because cure is more rapidly attained.

After an aneurism has been cured by compression there is usually no obliteration of the artery found at the point of pressure. In the sacciform variety there is in some instances no obliteration even at the seat of the tumor, but the circulation goes on through a groove or channel in the solidified aneurism. Fusiform aneurisms are not very amenable to treatment by pressure.

Before compression is begun the patient should be confined to bed for three or four days, that he may become accustomed to the restraint and to urinating and defecating in the supine posture. The limb should be shaved and washed, and the skin at the seat of proposed pressure sprinkled with chalk, oxide of zinc, soapstone or other unirritating powder. The bed should have a firm mattress upon it. The intelligent coöperation of the patient should be obtained, for much depends upon the continuous perfect adjustment of the compressing force whether it be digital or instrumental.

Bromide of potassium, chloral and morphia are often valuable agents for keeping the patient comfortable. When about to apply the compressing force the surgeon should, by momentary pressure on the distal portion of the artery, cause the sac to become well distended with blood. The finger or pad is then adjusted to the artery above the aneurism before the distal pressure is relaxed.

The best compressing force is that exerted by the human finger. This is called digital compression, as opposed to instrumental compression, which is obtained by tourniquets, suspended weights or some similar apparatus. Digital compression necessitates relays of physicians or trained assistants, since one person cannot exert effective digital pressure continuously for more than ten or fifteen minutes.

The femoral artery should be controlled by pressure below the groin directed backward against the head of the femur. The brachial artery at its upper part is compressed by pressure outward and backward against the shaft of the humerus. The amount of force should be no greater than that which stops pulsation in the tumor. It is for these reasons that the finger tip of an intelligent person is far better than any pad that can be devised by instrument makers. Complete occlusion can, therefore, generally be maintained without anæsthesia. Another, though indirect advantage of digital compression, is the constant presence of the assistants, which serves to interest and encourage the patient.

When trained assistants are not obtainable, digital has to be substituted by instrumental pressure. Sometimes one method may be used as an adjuvant to the other.

Various tourniquets and compressors have been devised for making pressure on the artery. The essential point is that the venous circulation shall be interfered with as little as possible; hence a small pad controlled by a screw or spring and a larger pad to make counter-pressure on the opposite side of the limb are characteristics of nearly all these instruments. Sometimes there is a series of small pads, so that pressure may be applied alternately to different parts of the artery and the integument be thus relieved of injurious pressure.

When the aneurism is of the brachial artery at the elbow or of the popliteal artery, compression by flexion may be employed as a method of treatment. This mode consists in keeping the elbow or knee firmly flexed so as to bend the artery and at the same time exercise pressure on the tumor itself. The circulation through the sac is thus greatly lessened. The flexed posture can be maintained by applying a collar around the limb above the joint and another below it, and preventing extension by a short chain attached to both. A more simple means is an ordinary roller bandage applied by figure of eight turns. The forced flexion should be sufficient to check pulsation completely in the sac, but the joint should not be flexed to such an acute angle as will make too violent pressure on the aneurism or injure the articulation. It is not satisfactory in large aneurisms nor in those tending to inflammation. Rupture or suppuration may be induced by it in such cases. In small aneurisms and as an adjuvant to digital or instrumental compression, flexion has a value. Cure of aneurism at the elbow or knee has occasionally been obtained by voluntary maintenance of the flexed position. So, indeed, has digital compression of the interrupted kind, exerted by the patient's own fingers, effected a cure of aneurism.

The last method of employing pressure is what may be called general compression and is accomplished by the Esmarch apparatus. A rubber bandage is applied, as in preparing for amputation, from the distal extremity of the limb to the lower end of the aneurism. The surface of the aneurism is then left uncovered and another elastic bandage firmly applied above it, or the first bandage is carried loosely around the location of the tumor and applied tightly to the limb above. Near the trunk the application of the bandage is discontinued and the limb is encircled by the thick elastic band, which plays the part of tourniquet. The access of blood to the limb is thus cut off and the other bandage or bandages are removed. The tumor, however, is left distended with fluid blood in a state of rest, which soon coagulates. It is perhaps well to delay a moment when the elastic bandage has been applied as far as the lower end of the aneurism, so that the current from above may fully distend the sac before the vessel is compressed on the proximal side of the tumor. The circulation should be kept out of the limb for about an hour, unless there is some contra-indication. Before the constricting cord is removed complete digital or instrumental pressure should be made upon the artery above it, lest the sudden current wash away or break up the soft black clot in the sac. This, or moderate compression at least, should be kept up for a few hours afterward to allow the clot to become firmer. Anæsthesia will be required when the Esmarch apparatus is used.

General compression seems to be most applicable to recent aneurisms of moderate size with walls that are not very thin. It is to be avoided or only applied with extreme caution and for short periods in patients whose vessels are markedly atheromatous. Danger of inducing gangrene is, under such circumstances, very great.

When ligation becomes necessary, after failure in curing by the Esmarch apparatus, the surgeon should not attempt to apply the ligature at the point where the constricting band encircled the limb. The peri-arterial structures are liable to be infiltrated or inflamed at this point. A higher or lower point should be selected. This rule should be followed in ligating after any form of compression has been previously employed.

The rules for employing compression may be formulated as follows: Use it:

1. In small aneurisms of recent development and when the success of subsequent ligation is not imperilled by its use.

2. When ligation is especially dangerous, as it is in the aged, during epidemics of erysipelas and in certain locations of the body.

Under the improved methods of modern aseptic surgery it is probable that ligation is as safe as, and at the same time more convenient and sure than, compression. The method of ligation to which the name of Hunter has been attached is here meant.

LIGATION.—Arterial ligation for the cure of aneurism has been practiced in four ways, of which two are practically valueless. Of the two remaining methods one is always preferred, except when the proximity of the aneurism to the heart renders its performance exceedingly dangerous.

FIG. 109.

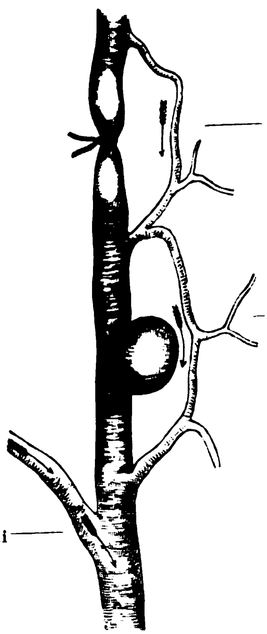


Diagram of anastomosis after Hunterian method of treating aneurism.

This method is called the Hunterian method. It consists in applying a ligature to the artery between the aneurism and the heart and at such a distance from the former as will insure the existence of a small branch leaving the artery between the ligature and the aneurismal tumor. The ligature on being tied arrests at once the current in the main artery and would entirely stop the blood flow through the aneurismal sac, if the small branch mentioned did not exist. This small branch, which has an anastomosis with branches given off from the main vessel above the site of ligation, soon, by dilatation and reversal of current, carries a small amount of blood into the main vessel below its origin and thence through the aneurismal sac. Thus, it is seen that the Hunterian method of ligation does not entirely arrest the current through the sac, but merely diminishes it very greatly. Deposition of laminated fibrin, which is the method of spontaneous cure which is most desirable, is thus determined; whereas entire arrest of the current would have caused the formation of soft clot in the sac, which may, it is true, cause final solidification, but which is apt to be followed by inflammation of the sac.

Of the three other methods of ligation one is a proximal ligation, that is, on the side of the disease nearer the heart, and two are distal ligations, that is, on the side away from the heart.

Table of the Four Methods of Ligation in Treating Aneurism.

PROXIMAL LIGATIONS.

Anel's.—Ligature applied close above aneurism with no intervening branch.

Objections: 1. Difficult, because artery is overlapped or displaced by sac.
2. Causes total arrest of blood current, hence soft clot and tendency to inflammation of sac.
3. Artery probably atheromatous, hence tendency to secondary hemorrhage.

Hunter's.—Ligature applied at some distance above aneurism, so as to have an intervening branch.

Advantages: 1. Easy of performance.
2. Causes partial arrest of blood current, hence firm fibrinous deposit in sac.
3. Artery much more likely to be healthy.

DISTAL LIGATIONS.

Brasdor's.—Ligature applied just below aneurism.

Objections: Same as in Anel's.

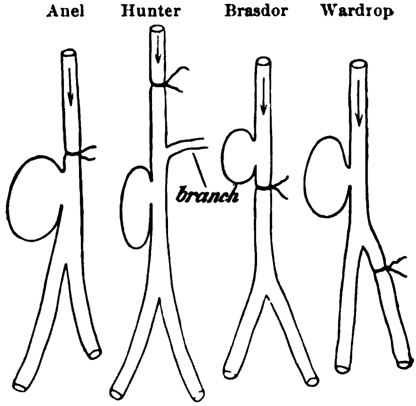
Wardrop's.—Ligature applied to trunk a little below first branch or to first branch a little below its origin from the trunk.

Advantages: Same in kind as those of Hunter's method, but it is less successful in causing solidification because current is not arrested sufficiently. Never used except in aneurism of innominate or of root of common carotid artery, and then it is adopted because the Hunterian method is impossible.

The Hunterian method of ligation must be considered more fully, since it is the one to be adopted when compression is not employed and extirpation by excision is considered improper.

When the catgut cord has been placed under the vessel and before the knot is tied, the artery should be compressed between the cord and a finger inserted into the wound, in order to prove by absolute arrest of pulsation in the tumor that the supplying artery has been exposed. Just before the ligature is drawn tight, it is well to make pressure for half a minute upon the artery on the distal side of the aneurism in order that the sac may be fully distended with blood before the circulation is arrested. A good size catgut or flat silk ligature is to be preferred. With ligation of the vessel, pulsation, thrill and murmur in the tumor immediately cease and the limb below shows some elevation of temperature. This usually, however, soon subsides, and the limb becomes cooler than normal.

FIG. 110.



Driagams showing Anel, Hunter, Brasdor and Wardrop methods.

Loss of muscular power, and pain and hyperæsthesia are frequently observed in the parts below the site of operation. The tumor at first feels softer than usual, but in a few hours becomes harder and more elastic. This process of solidification continues and in a few days is completed by the transformation of the sac into a hard ball. Contraction then begins and in the course of several weeks or months no tumor, or nothing but a slight thickening, is perceptible to the touch. In rare instances some enlargement of the tumor without return of pulsation may occur after ligation from influx of blood from the distal part of the artery. This is apt to lead to the suspicion that a malignant vascular growth has been mistaken for an aneurism. A subsequent solidification of the sac clears up the doubt. A similar condition may follow compression.

After the operation the limb should be enveloped in cotton or wool to maintain the temperature of the part, which has now a poor blood supply; and the patient should be directed to avoid attempting to move the extremity. Quiet should be obtained by anodynes, if necessary. The cotton tends to preserve an even temperature and protects from injurious influences the parts which have now a diminished circulatory supply. For a long time, even after consolidation of the tumor, all violent exercise of the extremities should be avoided. Impairment of muscular power, liability to suffer from exposure to cold, and other nutritive defects often remain permanently after arterial ligation for any cause.

The Hunterian method of ligation is usually followed by the development of two collateral circulatory arches: one between the branches above the ligature and those given off between it and the aneurism, and another between the branches below the aneurism and those above it. The distal anastomosis, which is that around the aneurism, is generally established more rapidly than that around the ligature, because the collateral branches in the former region have previously been enlarged by the circulatory interference occasioned by the pressure of the aneurismal tumor. This double anastomosis is due to the fact that the artery usually becomes obliterated at the seat of aneurism as well as at the seat of ligation, but is pervious between those points. If the sac solidifies and leaves the vessel pervious opposite the seat of aneurism or if the vessel becomes entirely occluded by clot or obliterated from the ligature to a point below the aneurism, only one collateral arch is developed.

Ligation is indicated for the treatment of aneurism:

1. When compression has been tried unsuccessfully or when compression and excision are considered less desirable than ligation.

2. When the aneurism has ruptured and caused hemorrhage into an articulation or into the intermuscular spaces; provided that the condition does not demand extirpation of the sac or amputation of the limb.

3. When rupture into one of the cavities of the body or upon the surface or the possibility of an early occurrence of such rupture threatens to destroy life by hemorrhage.

Ligation is contra-indicated:

1. When compression is evidently easily applied and likely to be successful.

2. When the operation is peculiarly dangerous on account of the location of the aneurism, the existence in the patient of extensive arterial or cardiac disease, or the prevalence of erysipelas or pyæmia.

3. When, on account of the proximity of large anastomosing branches or from any other circumstances, the operation would probably be unsuccessful and dependence must be placed upon the introduction of wire and the transmission of a galvanic current, or some similar plan of treatment.

The ease with which operation wounds heal under aseptic methods makes ligation a very favorite and successful means of curing aneurism. It is probably better than any other method.

The complications likely to arise after ligation, which may interfere with the successful solidification of the aneurism or tend to destroy the patient's life, are: recurrent pulsation in the tumor, secondary hemorrhage at the site of operation, suppurative and gangrenous inflammation of the sac, gangrene of the extremity, pyæmia, and, in special locations, secondary disease of the brain or thoracic viscera.

Recurrent pulsation is due to the anastomotic arch around the ligature allowing too free a blood current to enter the artery between the ligature and the aneurism. An anomalous distribution of the branches or abnormally large size of the usual branches is the cause of this undesirable freedom of the collateral current. The employment of the compression treatment, for a considerable period previous to a resort to ligation, is at times an agent in developing unusually free anastomosis. Recurrent pulsation develops within twenty four hours, and, if slight, is not likely to interfere with progressive consolidation of the tumor. Recurrence of pulsation after the lapse of several months is almost certainly due to the development of a new aneurism, near the site of the cured aneurism.

Recurrent pulsation should be treated by elevation of the limb and moderate compression of the tumor and of the artery above the site of ligation. If this is not successful, continued progress of the disease will demand Anel's method of ligation, excision of the sac or amputation.

As rapidity of union of the wound is a barrier to secondary hemorrhage, strict asepsis and antisepsis have made secondary hemorrhage very uncommon after ligation for aneurism. Mere approximation of the arterial walls by a flat ligature of animal nerve or tendon or by two round catgut ligatures placed close together, without dividing the internal and middle coats, will probably be found to be the safest means of ligating atheromatous vessels. The so-called stay knot is probably of no special importance.

When secondary hemorrhage occurs, it should be treated by pressure made upon and in the wound with plugs of sponge, or fine shot. If this fails the Esmarch apparatus should be applied, the wound opened freely and the artery ligated above and below the former ligature. In the event of the bleeding still continuing, ligation of the artery in continuity at a higher point is good practice in the upper extremity, but is very likely to be followed by gangrene if done in the lower extremity, where the establishment of sufficient collateral circulation is unusual. If the second ligation in continuity is done in either extremity, such a point must be selected as will permit subsequent amputation if this becomes necessary. Occasionally it is possible to control secondary hemorrhage by ligating in continuity the branch through which the blood finds its way into the distal portion of the trunk originally tied.

Suppurative or gangrenous inflammation of the sac may result from recurrent pulsation, from incomplete anastomosis around the aneurism, from complete arrest of circulation in the sac and consequent formation of soft clot, from the great size and thinned walls of the sac, and from external violence, such as may be sustained by rough handling or kneading of the tumor either before or after ligation. The symptoms of inflammation of the sac are those characteristic of a similar process elsewhere. Suppuration is exhibited by the ordinary signs of abscess. When an opening has occurred spontaneously or by incision, hemorrhage becomes a prominent symptom.

Suppuration of the sac is to be treated by at once applying a provisional tourniquet to the artery above the seat of ligation and laying open the abscess. If bleeding occurs the surgeon should proceed to turn out the clot, securing dangerous points by ligature or the actual cautery, make the wound antiseptic, pack it, and wait for it to heal by granulation. Sponge grafting would probably hasten cicatrization by causing granulations to fill the cavity more promptly. The patient must be constantly watched by competent surgical attendants, so that on the first sign of bleeding the artery may be controlled by digital compression, or by screwing down the pad of the tourniquet, which is kept loosely applied. If hemorrhage persists, amputation should not be long delayed by experiments with temporizing measures.

Gangrene of the limb is a formidable complication of ligation. Its occurrence may be due to rigidity of the arterial branches preventing sufficient enlargement for the establishment of collateral circulation, to pressure of the tumor upon the anastomosing branches, to injury of the main venous trunk at the time of ligating the artery and to exposure of the limb to heat, cold, or undue pressure soon after the operation. This complication arises within the first week or ten days, and is more frequent in the lower than in the upper extremity. The form is generally that of moist gangrene because venous obstruction is usually one of the factors in its etiology. Wrapping the limb in cotton to keep the temperature equable and to avoid injury, and slightly elevating it to encourage venous return are measures calculated to lessen the probability of gangrene. Gentle friction of the limb toward the body may sometimes be used to accelerate the venous blood current. When gangrene has begun after arterial ligation, but little can be done except to promptly amputate the limb high up. Occasionally laying open the sac and turning out all clots will relieve venous obstruction and restrain the progress of gangrene.

Ligation of Arterial Trunks in Continuity.

Arteries are tied in their continuity to lessen the circulation through aneurismal tumors and to arrest secondary hemorrhage, which pressure or ligation in the wound has failed to control. The special instruments required for the operation are a scalpel or bistoury, dissecting forceps, a grooved director, two metallic retractors with which to hold the margins of the incision apart, an aneurism needle and a strong antiseptic ligature of catgut, ox-tendon, silk or nerve.

The surgeon must first of all determine the exact course of the artery by the well known landmarks of clinical anatomy and the linear guides which are based upon its anatomical relations. If the artery is a superficial one its pulsation will aid in this determination. If a superficial tendon or muscle is one of the guides, it can be made to stand out prominently by getting the patient, before etherization, to use it voluntarily. The line of the tendon or artery can then be marked on the skin with a moistened aniline pencil.

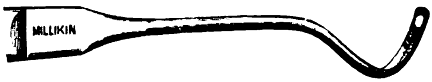
The second step is to decide upon the point of ligation. In secondary hemorrhage it is the best, if practicable, to expose and tie the vessel near the wound and on both sides of it. In the case of aneurism, the ligature should usually be applied sufficiently far from the aneurism to insure at least one small branch being given off by the trunk between the site of ligation and the aneurism. The ligature should always be applied at least one half or three quarters of an inch below the origin of any large branch or bifurcation of the artery. When

FIG. 111.

Grooved director.

this is anatomically impossible it is often wise to secure the branch also with a ligature to prevent secondary hemorrhage, which otherwise may result from the forcible collateral current developed in the branch or bifurcation.

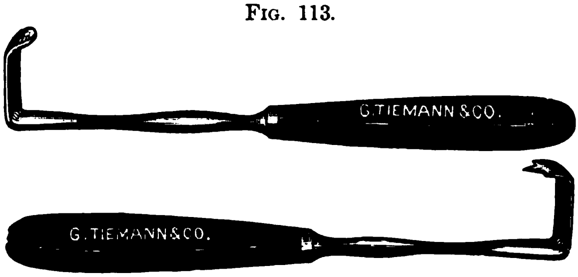
FIG. 112.



Aneurism needle.

The incision in most instances should be made slightly oblique to the course of the artery and with its center over the point chosen for ligation. When the artery is deeply located, whether from its anatomical relations or the obesity of the patient, a long incision is demanded. There is sometimes an advantage in raising an elliptical flap of skin and subcutaneous tissue, instead of making a straight

FIG. 113.



Blunt and sharp-pointed retractors.

incision, because it gives a better opportunity for recognizing the landmarks than a linear cut. Large superficial veins should be drawn aside, if convenient, though their division is of little importance. The deep fascia is to be incised in a similar manner as the skin; or it may be punctured and a grooved director slipped under it, after which manœuvre it is divided by carrying the inverted knife along the groove. The original length of the incision should be maintained until the sheath of the artery is reached. If the deep fascia is so tense as to prevent satisfactory investigation of the parts beneath, a short incision may be made across the middle of the longitudinal one.

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Muscular interspaces are guides to some of the arteries. These, on account of the fat deposited in them, are usually quite readily recognized as yellow lines. Another guide to them is furnished by the small vessels which ramify in them and perforate the fascia covering them. The proper muscular interspaces to gain access to the artery are next torn open with the rounded end of the director; or the wound is deepened by the careful use of the scalpel. As the situation of the artery is approached the forceps and the back of the scalpel's point are the safest means of separating the tissues. During this dissection the wound may be held open by blunt hooks or retractors, and the bulging muscles relaxed by bending the joints.

The larger arteries, with the accompanying vein or veins, are enclosed in a distinct fibrous sheath. This sheath is to be opened by pinching up a fold with small toothed forceps and making in it with the knife a cut about a quarter of an inch long. While the forceps holds the edge of the opening, the end of the grooved director or aneurism needle is introduced into the sheath on each side of the artery and used to break up the adhesions between the vessel and the sheath or the adjacent contents of the sheath. Isolation of smaller arteries which have no distinct sheath can be readily performed by using two pairs of forceps to pull away the small veins and cellular tissue.

The Esmarch apparatus is sometimes applied to prevent obscuration of the parts by hemorrhage during the operation. Usually it is unnecessary, for only a few small branches are divided.

It is well to remember the characteristics of an artery in the living subject. It has a pinkish white, smooth, shining surface and is compressible, feeling as it is rolled under the finger-tips as if two surfaces were slipping upon each other. A nerve has not this smooth, shining surface, but has longitudinal markings, due to its fibrous structure, and rolls under the fingers as a solid non-compressible cord. A vein is purplish, soft and flaccid, and from its distention with dark blood resembles a leech in appearance. It becomes more distended if pressure is made on its cardiac end. A small tendon is pearly white and glistening and gives, when seized, the impression of great density. Passive motion of the neighboring joint may prove its identity. The recognition of the artery is often aided by its location between two satellite veins and by its pulsation. Pulsation, however, may be absent, because exposure and manipulation sometimes cause arteries to contract and become temporarily pulseless. On the other hand, a deceptive pulsation may be transmitted to nerves or fascial bands lying over an artery.

After the artery has been recognized and isolated, the end of the curved aneurism needle, threaded with antiseptic catgut or silk, is carefully passed around it without disturbing its surroundings or pulling it from its bed.

If the artery has a single vein alongside of it the needle should be introduced at the venous side of the artery, since puncture of the thin-walled vein is thus less likely to occur than when the point of the needle is carried beneath the vessel from the side opposite to the vein. If by accident such a large vein is punctured during the operation, it may be well to extend the incision and tie at a higher point of the artery. Bleeding from the vein is to be controlled by lateral ligation or suture of the vein, if any venous hemorrhage of importance occurs. Before tying the ligature the surgeon should hold the artery in the loop of the string and compress it with a finger, to be sure that pulsation below is arrested by constriction of the structure encircled. This manœuvre proves or disproves the proper application of the ligature, which may be around the wrong artery or perchance around a nerve or piece of fascia. The ligature should be secured by a friction knot or a flat knot; and in the latter case it is well to tie the ends a third time after completing the ordinary double tie, for the catgut is apt to become loosened. During the knotting the index fingers should be carried into the depth of the wound in order not to raise the vessel from its bed. Sufficient tension should be put upon the first tie to insure division of the inner and middle coats of the artery. This is known by the sensation of cutting into the wall that is felt by the operator as the noose is tightened. When mere approximation of the inner tunic is desired, this cutting is avoided by using flat ligatures of nerve, tendon or ox-aorta. After ligation is accomplished the wound is approximated with sutures and dressed, cotton is applied around the limb to maintain an equable temperature, and the extremity is slightly raised to encourage venous return.

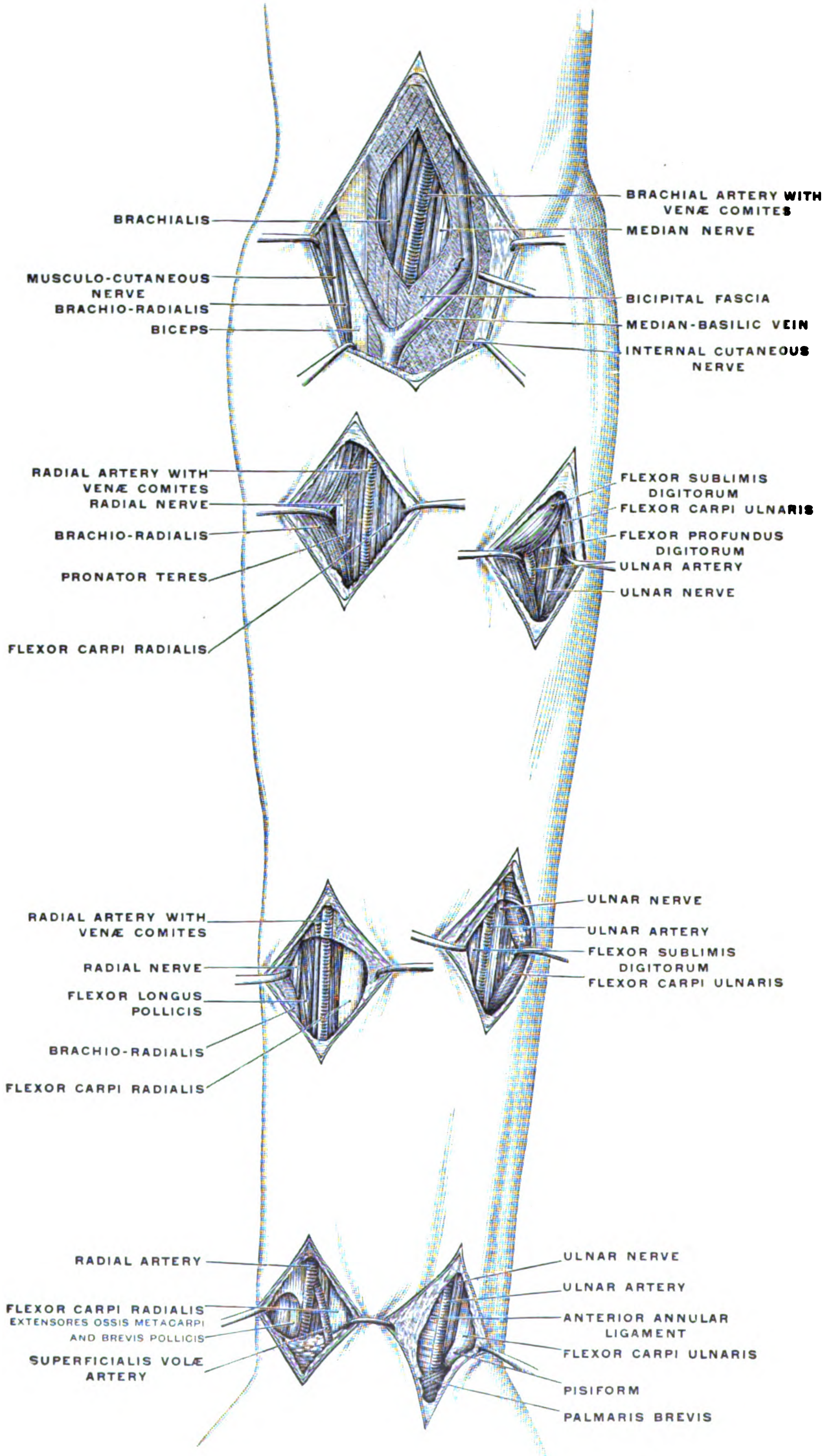
Ligations of Special Arteries.

Certain of the arteries are ligated in continuity with comparative frequency. The most eligible site for such ligations must be mentioned and the successive steps described. The unusual operations will be omitted.

Radial and Ulnar Arteries.—These vessels are seldom tied, except at the wrist. If deligation at a higher point of either artery is demanded, the surgeon usually prefers to secure the brachial. The radial artery above the wrist lies between the tendons of the radial flexor of the carpus and the long supinator, immediately below the deep fascia and upon the square pronator. Its direction and site are indicated by a line drawn from the middle of the bend of the elbow to the inner side of the styloid process of the radius. An incision one and a-half to two inches in length midway between and parallel to the radial flexor and the long supinator will expose the vessel with its satellite veins. The deep fascia must be divided with care or the artery may be wounded. The pulsation of the artery is readily felt before the skin is incised.

The ulnar artery at the wrist lies under the radial border of the tendon of the ulnar flexor of the carpus and between it and the superficial flexor of the fingers. The vessel lies under a layer of fascia

Fig. 114.



 Surgical relations of the radical and ulnar arteries. (Kocher.)

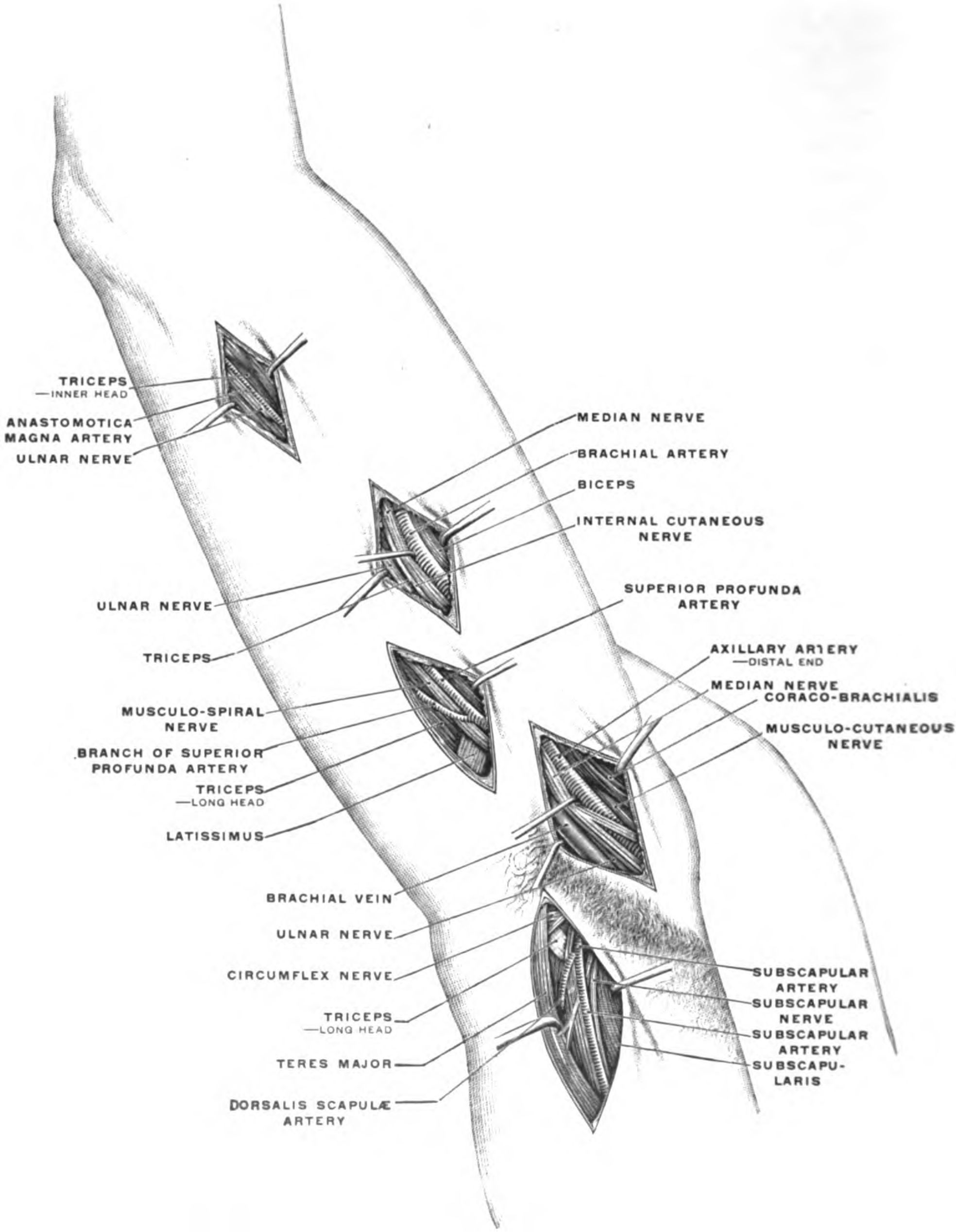
situated below the tendon; hence, it is necessary to divide two layers of deep fascia before reaching it. The ulnar nerve is situated at the ulnar side of the artery and close to it. The course of the lower portion of this artery is indicated by a line drawn from the inner condyle of the humerus to the radial side of the pisiform bone. The surgeon may depend upon this line for determining his incision, or may recognize the position of the tendon of the ulnar flexor of the carpus by its insertion into the pisiform bone, and make an incision of one and a-half or two inches along its radial margin. The glistening tendon, uncovered after dividing the deep fascia, should be drawn from the middle line of the arm, when the second process of deep fascia will be exposed. This must be opened before the artery is reached unless it has an anomalous course above the fascia. It is usual to pass the aneurism needle first between the artery and the nerve.

Brachial Artery.—The brachial artery in the middle of the arm lies along the inner border of the biceps; and upon the coraco-brachial, the anterior brachial and the inner head of the triceps muscles. The median nerve passes over it, though occasionally under it, from without inward. A satellite vein is to be seen on each side of the vessel, and the large basilic vein not far distant internally. A line drawn from the junction of the anterior and middle thirds of the axilla to the middle of the bend of the elbow indicates its course with accuracy. Its pulsation is easily felt. An incision two and one half or three inches in length is to be made along the inner side of the biceps; when the deep fascia has been divided, the muscular fibers of its margin will be fully exposed. Alongside of, or under the edge of, this muscle will be seen the median nerve, which is then drawn aside to reveal the artery lying beneath it. The nerve often shows marked transmitted pulsation. Sometimes the artery is more superficial than the nerve. The arm should at this stage be flexed at the elbow to relax the belly of the biceps. It is usually better to have an assistant hold the arm than to allow it to lie upon the table, because such pressure displaces the artery and pushes up the triceps, which may be mistaken for the biceps. The edge of the biceps should always be uncovered and identified; if it is not, the surgeon may work too far inward and backward and become confused by mistaking the ulnar nerve for the median, and the basilic vein for the artery. The vessel is to be sought at or under the edge of the biceps in an outward rather than an inward direction.

Since the brachial artery is not infrequently double or bifurcates into the radial and ulnar up near the axilla, it is important for the surgeon to remember this possible anomaly, and ascertain that he has secured that vessel which will diminish the blood supply as he desires.

Axillary Artery.—The third portion of this vessel can be reached with safety and ease. If ligation at a higher point is demanded by the exigencies of the disease, it is better perhaps to secure the third portion of the subclavian than to attempt ligating the first or second portion of the axillary.

Fig. 115.



Surgical relations of the axillary, subscapular, brachial, superior profunda and anastomotica magna arteries. The right arm is represented as raised almost to the perpendicular. (Kocher.)

The last, or third portion of the axillary artery, beginning at the lower edge of the lesser pectoral muscle, lies along the inner border of the coraco-brachial muscle. The median and musculo-cutaneous nerves lie on the outer side of the artery; the ulnar and internal cutaneous nerves and the axillary vein on the inner side. Sometimes there is a satellite vein on each side of the artery instead of the single large axillary vein on its inner side, which is then substituted by the continuance upward of the basilic vein.

A line drawn from the junction of the anterior and middle third of the axillary fossa to the middle of the bend of the elbow gives the course of this portion of the axillary and the greater portion of the brachial artery.

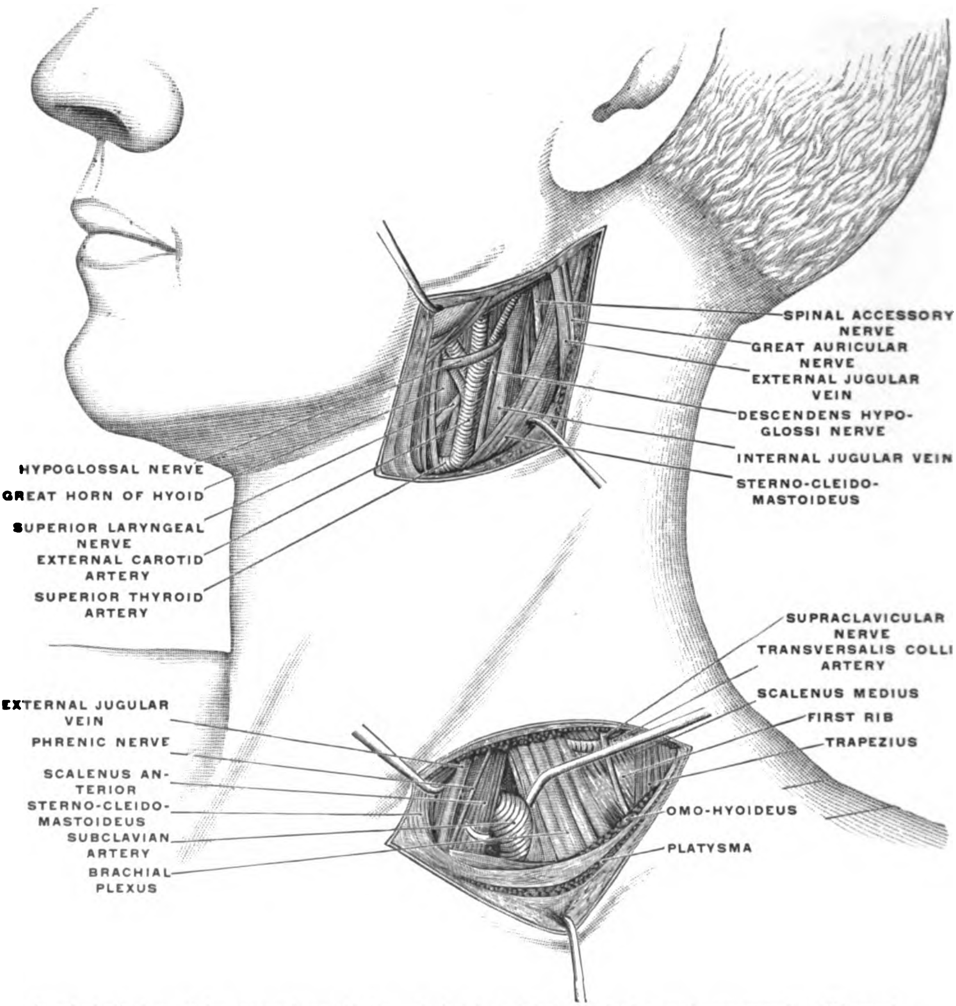
When the arm is placed at a right angle with the body the muscular margins of the axillary pit are prominently shown. With the limb in this position an incision three or three and one-half inches long should be made parallel to the anterior boundary of the axilla, and about one-third the width of the axillary space behind this boundary; or, in other words, directly over the head of the humerus and a little oblique to the line given above. The edge of the coraco-brachial muscle will be exposed. From this the operator searches in an inward direction, finding, first the median and perhaps the musculo-cutaneous nerve and then the artery, with the axillary vein and the ulnar and internal cutaneous nerves on the inner side.

The nerves, which vary somewhat in their relations, may be mistaken for the artery. Occasionally a muscular slip from the broad dorsal muscle crosses the artery. It is recognized by the transverse direction of its fibers. The ligature must be passed from within outward, and should not be applied near the origin of the subscapular artery.

Subclavian Artery.—The third portion of this artery extends from the outer margin of the anterior scalene muscle to the outer or lower border of the first rib, and is the only part of the vessel that can be ligated with comparative safey. It is situated in the triangle bounded by the clavicle and the sterno-mastoid and omo-hyoid muscles; and lies against the first rib, the anterior scalene muscle and the brachial plexus of nerves. The subclavian vein is situated below and in front of the artery, from which it is separated by the insertion of the anterior scalene muscle into the tubercle of the first rib.

To ligate the artery in its third position proceed as follows: Depress the patient's shoulder, turn his head in the opposite direction, and draw the skin of the supraclavicular fossa downward upon the clavicle with the left hand and hold it there. Then make an incision, three or four inches in length, upon the clavicle and following its curves, beginning a half inch from the sterno-clavicular joint. The tissues should be divided down to the periosteum. When the left hand has released its traction, the skin will slide upward and the incision will be located about half an inch above the clavicle. This manipulation of the skin preserves the external jugular vein from division by the incision. The wound should now be deepened by dividing the deep fascia and cutting the edges of the sterno-mastoid and trapezius muscles, if they prevent the wound being made deeper and of its original length. The fibers of the platysma myoid muscle in the superficial fascia will be noticed during the dissection. If the external jugular vein cannot be held out of the way with a hook, it is to be divided. A ligature

FIG. 116.



Surgical relations of the external carotid, lingual, facial, occipital, subclavian, and transversalis colli arteries. (KOCHER.)

should be placed also at the cardiac side of the proposed section before the division is made, lest air be sucked into the heart. As the wound is carefully deepened the surgeon's finger seeks, at its inner corner, the edge of the anterior scalene muscle as it goes down to its insertion into the first rib. The tubercle of insertion is often poorly developed, but the direction of the fibers, and possibly the exposure of the phrenic nerve running obliquely over the muscle, will serve to differentiate it from other structures.

If the omo-hyoid muscle or brachial plexus is recognized before the anterior scalene is seen, the search should be made in a direction downward and inward from those landmarks. The artery is finally uncovered beyond the outer border of the anterior scalene by opening with the forceps or director a layer of fascia extending over the vessel from this muscle. The artery lies at a depth of from one to three inches from the surface and runs in a downward and outward direction almost in the axis of the arm. The aneurism needle should be passed from above downward, because there is more danger of encircling the nearest cord of the brachial plexus than of injuring the vein which lies at some distance from the artery, though below it. This is an exception to the axiom which directs the needle to be passed, as a rule, first between the vein and the artery about to be ligated.

The chief errors to be avoided in the operation are injury to the veins and ligature of a portion of the brachial plexus. During the dissection the suprascapular artery or the tranverse artery of the neck may be divided and require ligation.

Common Carotid Artery.—The direction of the common carotid and its continuation, the internal carotid artery, corresponds with a line drawn from the sterno-clavicular joint to the tragus of the ear. The common carotid artery extends only to the level of the top of the larynx, where it bifurcates into the external and internal carotid arteries. The left carotid has its origin lower than the sterno-clavicular articulation, but in this intrathoracic portion of the artery surgeons have little interest. This circumstance, however, renders ligation of the carotid below the omo-hyoid muscle safer on the left than on the right side; because the ligature is further from the blood stream in the parent vessel. The external carotid at its origin lies from a quarter to a half inch nearer the middle line of the neck than the line given for the internal carotid.

The common carotid artery lies beneath the anterior edge of the sterno-mastoid muscle in a sheath, which also encloses the internal jugular vein and the pneumogastric nerve. The vein lies on the outer side of the artery, the nerve lies behind both and in the groove between them. The descending branch of the hypoglossal nerve formt a loop with branches from the cervical plexus, usually upon the front of, but sometimes within, the sheath. The artery becomes more and more superficial as it ascends. Its sheath is crossed by the omo-hyoid muscle about midway between the sterno-clavicular joint and the top of the larynx; or, in other words, at the level of the cricoid cartilages.

For ligation of the common carotid the patient's head should be thrown well back, with the chin turned toward the opposite side. A small pillow or roll of cloth under the nape of the neck enables the surgeon to keep the patient in this posture. An incision of two and a half or three inches with its center corresponding to the level of the cricoid cartilage should be made along the anterior edge of the sterno-mastoid muscle. When the fascia and the platysma-myoid muscle have been divided and the fibers of the sterno-mastoid become visible by the dissection, the margin of the latter muscle must be turned outward and the angle between it and the omo-hyoid muscle, with its obliquely ascending fibers, found. If the omo-hyoid is pulled inward and the sterno-mastoid outward, the sheath of the artery, with very possibly the descending branch of the hypoglossal nerve upon it, will be seen. The sheath will also be recognized by its slipping sideways between the finger and the vertebræ behind, and by the pulsating vessel within it. The external and anterior jugular veins should be drawn aside, if in the line of the dissection. When this cannot be done, they may be tied and divided. The sheath is then opened toward the tracheal side of the artery, which is isolated with care, and the needle passed from without inward, in order to avoid injury to the internal jugular vein laying on the outer side of the artery. This operation ties the common carotid artery just above the omo-hyoid muscle, which is the better situation for application of a ligature.

To ligate below the omo-hyoid, make a three inch long incision just in front of the anterior margin of the lower third of the sterno-mastoid muscle. Detach the inner portion of the muscle from the clavicle and turn it outward. The omo-hyoid and the sterno-hyoid muscles will thus be exposed. These are to be pulled apart by hooks, when between and below them will be seen bulging upward the sterno-thyroid muscle. The finger thrust down between the lower part of the omo-hyoid and the sterno-thyroid, which is on a lower plane, will feel the artery beating in its sheath.

It may be necessary to incise the sterno-thyroid in order to expose fully the sheath, which is then opened and the aneurism needle passed around the artery from without inward. In both operations the branch of the hypoglossal nerve should be protected from injury as much as possible.

Internal and External Carotid Arteries.—The common carotid artery should not be tied for a lesion of the external carotid or its branches when there is room between the bifurcation of the common trunk and the lesion to allow the safe application of a ligature to the external carotid. Ligation of the internal carotid should be performed in many conditions which formerly have been treated by tying the common carotid trunk.

For ligating the internal carotid an incision two and a half inches long, with its center about half an inch above the upper border of the larynx, should be made a little oblique to a line drawn from the sterno-clavicular joint to the tragus of the ear. The vessel will be found along the edge of the sterno-mastoid muscle. The hypoglossal nerve crosses the vessel about an inch above its origin, and the descending branch of the same nerve will probably be found running down the artery. The hypoglossal nerve and the digastric muscle, which also crosses the artery, should be drawn upward and the ligature passed from without inward, avoiding constriction of the internal jugular vein and the pneumogastric nerve on the outer side, the external carotid on the inner side and the hypoglossal nerve superficially.

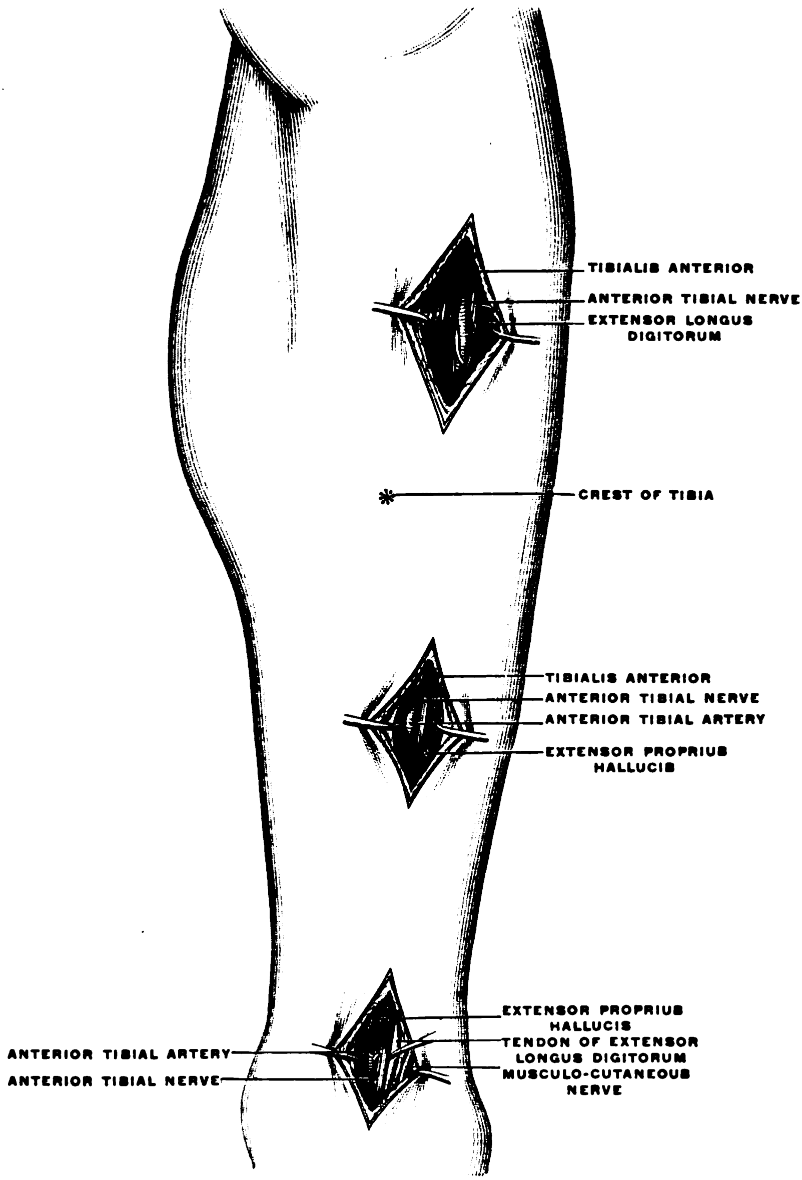
The external carotid, which also is crossed by the hypoglossal nerve and digastric muscle, may be tied by a similar incision, but it must be remembered that this artery is placed a little nearer the middle line of the neck than the internal carotid. If a large branch is given off near the point of ligation, it also should be tied.

Anterior Tibial Artery.—A line drawn down the front of the leg from the inner side of the head of the fibula to a point midway between the two malleolar prominences marks the direction of the anterior tibial artery. The vessel, throughout its course, lies along the outer margin of the anterior tibial muscle. At its upper part it is deeply placed upon the front of the interosseous membrane; but it gradually becomes superficial as it descends to the ankle, where it is found immediately under the deep fascia. It can be quite readily tied in its middle third by an incision, three inches long, made a little obliquely to the line given above. The operator, before incising the deep fascia, can usually define the intermuscular space bounding the outer border of the anterior tibial muscle by a yellowish white line of fat showing through the deep fascia. The deep fascia should be divided just as the skin and superficial fascia have been; after which the space between the anterior tibial muscle and the long extensor of the toes should be torn open with the finger or end of the grooved director. This procedure will expose a third muscle, the extensor of the great toe, lying between the two just mentioned and at a lower level. Search in the bottom of the fissure between this extensor of the great toe and the anterior tibial muscle will reveal the artery, with the anterior tibial nerve lying to the outer side or a little in front. It is possible that the extensor of the great toe may have its origin from the fibula lower than usual, then the vessel will be found in the same manner, but between the anterior tibial muscle and the long extensor of the toes.

The operator must remember to keep close to the outer margin of the anterior tibial muscle. If he mistakes the proper intermuscular space he will fail to reach the vessel. Passive motion of the great toe, of the smaller toes and of the ankle joint will enable him to distinguish the various muscular bellies in the wound.

Posterior Tibial Artery.—The course of this artery is indicated by a line drawn from the middle of the popliteal space to a point midway between the tip of the inner malleolus and the anterior border of the tendon of Achilles. The vessel, when it gets behind the inner malleolus curves forward and goes to the sole of the foot. Behind the malleolus it is covered only by the skin and the superficial and deep fascias. The deep fascia is very thick because of fibers prolonged from the lateral ligament of the ankle joint. Ligation of the artery at this point is readily effected by a crescentic incision of two inches in length, situated half an inch behind the malleolus, with its concavity toward that bony projection. A single large nerve, the posterior tibial, is usually found on the posterior or heel side of the artery; sometimes there are two small nerves, one on each side. The tendons of the posterior tibial muscle and long flexor of the toes lie in front of the

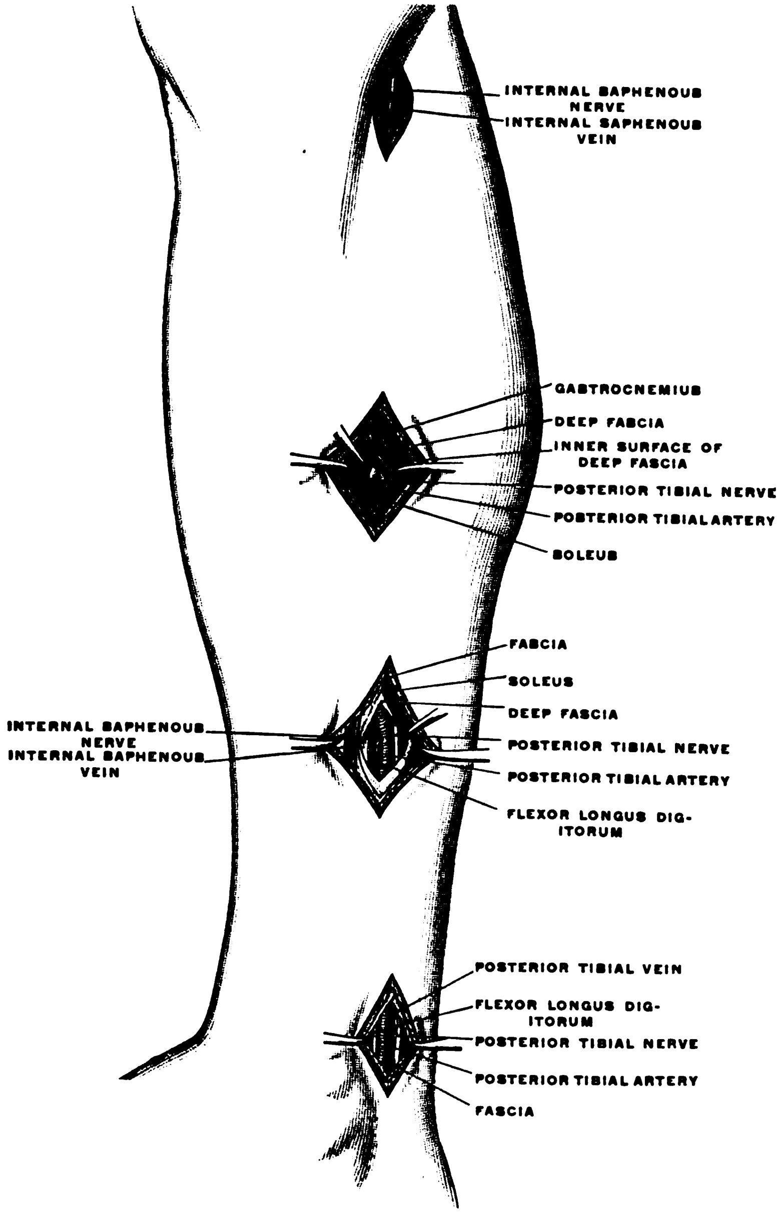
FIG. 117.



Surgical relations of the anterior tibial artery of the right leg. (KOCHER.)

artery—that is, nearer the malleolus; the tendon of the long flexor of the great toe behind it and deeper. Occasionally the artery bifurcates into the two plantar arteries before reaching the sole; in such a case the two vessels may be tied.

FIG. 118.



Surgical relations of the posterior tibial artery. (KOCHER.)

In the middle of the leg the posterior tibial artery lies beneath the gastrocnemius and soleus muscles and upon the posterior tibial muscle and the long flexor of the toes. It is separated from the soleus by a septum of the deep fascia and has the posterior tibial nerve lying on the outer or fibular side. The artery can be ligated from the side of the calf as follows: Lay the leg on its outer aspect with the knee flexed and the heel raised to relax the calf muscles. Make an incision of four or five inches, parallel to and half an inch behind the inner margin of the tibia. If the gastrocnemius is seen, draw it away from the tibia and expose the soleus; if it is not seen, the soleus will be exposed at once. The soleus is then to be cut from its attachment to the tibia by carrying the knife, with its edge directed against the bone, along the entire length of the cutaneous incision. By drawing the cut muscle outward the surgeon will uncover the septum of deep fascia that lies over the artery. The vessel can be seen or felt beneath this fascia about an inch from the edge of the tibia and is readily uncovered by incising the fascia, which may be thick, with the knife.

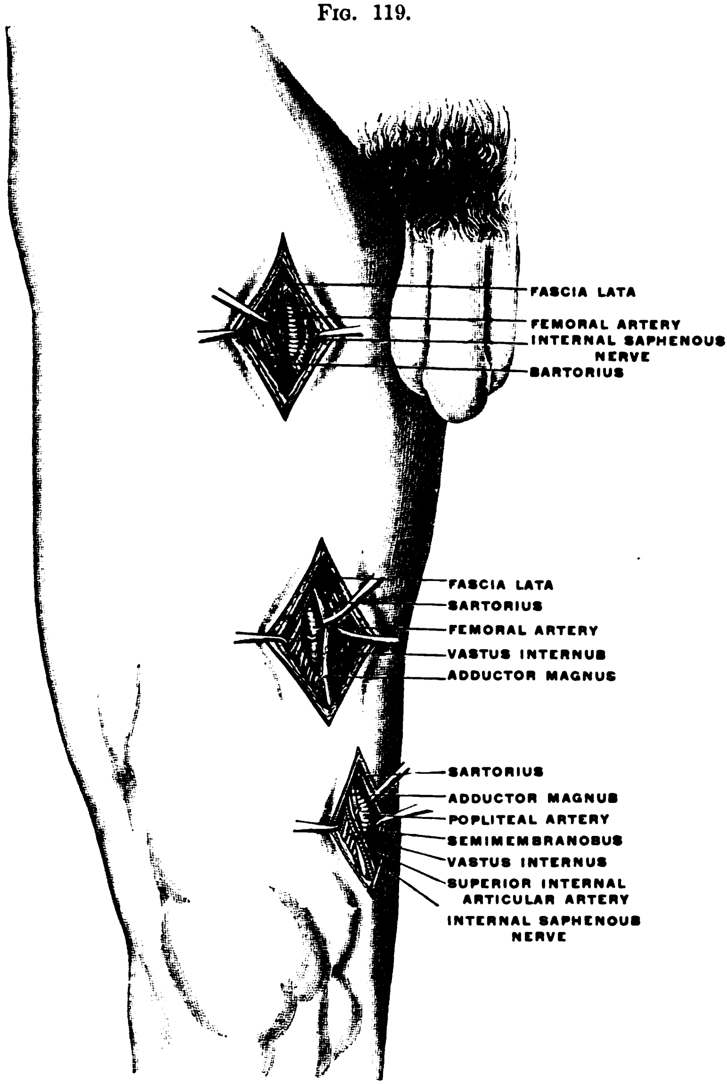
The operator may mistake the gastrocnemius for the soleus, because the incision was made too far from the tibia, or he may cut too close to the tibia and, therefore, fail to recognize the soleus and, as a result, separate not only it but the deeper muscles from the tibia and get down to the interosseous membrane.

The knife should be held with its edge toward the bone in order not to make an oblique section of the soleus. There is an intramuscular septum in the middle of the soleus which is parallel to the septum of deep fascia under which the artery lies. This may mislead the surgeon, who will think he has cut entirely through the muscle when he has only gone half way.

Femoral Artery.—The common femoral artery and the upper part of its continuation, the superficial femoral, have their course indicated by a line drawn from a point mid-way between the anterior superior spine of the ilium and the symphysis of the pubes, where the pulsation can always be felt, to the prominence of the internal condyle of the femur. This line bisects Scarpa's triangle, running from the center of the base through its apex. Scarpa's triangle is bounded by Poupart's ligament above, the sartorius muscle externally and the long adductor muscle internally. The apex of the triangle at the point of junction of these muscles is on the inner side of the thigh. The vein corresponding with the arteries lies upon their inner side except near the apex of Scarpa's triangle, where it passes behind the artery and finally gets to the outer side. The anterior crural nerve is on the outside of the common and superficial femoral arteries, and at a distance, except near the apex of the triangle where one of its branches lies close to the vessel. It is well to remember that in fat persons the fold of the groin is a little below Poupart's ligament, and does not, as in lean patients, correspond with the ligament.

The superficial femoral artery is to be ligated where it is crossed by the sartorius muscle at the apex of Scarpa's triangle, which is about four inches below Poupart's ligament. The thigh should be everted and an incision three or four inches long made at this point, a little oblique to the line of the artery, avoiding the internal saphenous vein. When the inner border of the sartorius is recognized by its fibers passing obliquely downward and inward, the proper landmark or guide has been found. The edge of this muscle should be turned up and under it will be discovered the sheath of the artery, running in

FIG. 119.



Surgical relations of the femoral artery. (KOCHER.)

the direction indicated by the line already mentioned. The vein will probably be a little behind the artery, though on its inner side. The ligature should be passed from within outward. The artery is so superficial that its pulsation can usually be felt through the tissues before the first incision is made.

The common femoral artery is readily secured by making an incision two inches long parallel to Poupart's ligament, and a half inch below its center. Some lymphatic glands may require pushing aside when the superficial fascia is being divided ; after which, incision of the deep fascia will disclose the sheath of the artery. The vein is on the inner side of the artery, hence the ligature should be carried around from the inner side.

External and Common Iliac Arteries.—The course of the common iliac artery and its direct continuation, the external iliac, is indicated by a line drawn from the left side of the umbilicus, on a level with the top of the iliac crest, to a point midway between the anterior superior spine of the ilium and the symphysis of the pubes. The upper third of this line corresponds with the common, the lower two-thirds with the external, iliac ; though this proportion often varies, because the bifurcation of the common trunk into external and internal iliac varies in location.

The common iliac has the peritoneum just in front of it and is crossed at its lower end, near the point of bifurcation, by the ureter. The rectum as it descends into the pelvis also crosses the left artery. The lower part of the common and the entire length of the external iliac lie along the inner border of the great psoas muscle. The common iliac vein on the left side of the body lies at the inner side of the artery ; on the right side it is behind the artery at its lower part, and on the other side above. This may be memorized by the fact that each common iliac vein lies on the right side of the corresponding artery.

The external iliac arteries are covered by the peritoneum and have the veins lying internally and the genital branch of the genito-crural nerve lying externally. Near Poupart's ligament the external iliac is crossed by the vas deferens and the spermatic vessels and gives off two branches. It must not be tied here.

The external iliac artery is reached for ligation by a crescentic incision of four or five inches in length, with its convexity downward, beginning an inch above and an inch outside of the middle of Poupart's ligament and ending at a point an inch above the anterior superior iliac spine. This will probably cut the superficial epigastric artery, which will require tying. The tendon of the external oblique muscle, which is exposed, must be divided to the same extent as the skin, either with the knife's edge held perpendicular to its surface or upon a director.

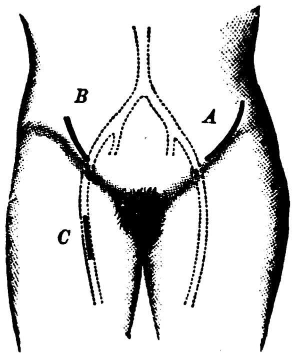
The fibers of the internal oblique and transversalis muscles must be divided in the same way. If it is preferred, the last may be divided on a grooved director. The transverse fascia is now exposed. It may be thick and white or thin and transparent. It should be carefully torn through with the forceps and fingers, when the bluish, though rough looking, outer surface of the peritoneum will be seen.

The operator with his finger loosens this serous membrane from the front of the iliac fossa and vessels ; beginning at the external end of the wound, where the attachment is least strong. The assistant, who, during the incision, was pressing on the belly wall to make the muscles tense, now puts a broad retractor into the wound and draws the peritoneum inward.

The artery and vein in a sheath of fascia will now be felt along the inner border of the belly of the psoas. After the sheath has been opened, the aneurism needle is carried around from within outward.

The incision given should be carefully followed as to length and curve through its entire depth. It should not go nearer the middle line lest it cut into the external abdominal ring, nor lower lest it open the inguinal canal or cut the deep circumflex iliac artery. When the director is pushed under the tissues it should be kept longitudinal, so as not to puncture deeper layers unawares.

FIG. 120.



Lines of incision for, *A*, common iliac; *B*, external iliac; *C*, femoral arteries. (STIMSON.)

It is wise not to incise all the way to its end, lest the peritoneum be folded over the extremity and thereby be wounded.

The common iliac artery can be reached by an incision similar to that used for the external iliac, but beginning an inch higher and extending about two inches further upward toward the last rib. The muscles and transversalis fascia are divided in the same manner as just described. When the peritoneum is pushed inward the ureter and spermatic vessels are carried with it, as they adhere to its outer surface. The artery can then be felt near the promontory of the sacrum. The needle should be carried from right to left on each side of the body, as the vein lies to the right of the artery in each instance.

The ureter might be tied instead of the artery if the operator is not careful, and in case of high bifurcation of the common iliac the ligature might in error be applied to the external iliac artery.

Internal Iliac Artery.—This vessel extends from the bifurcation of the common iliac at the sacro-iliac junction to the top of the great sacro-sciatic foramen with the ureter and peritoneum in front, its vein and the sacral plexus of nerves behind. It is ligated by an incision similar to that for tying the common iliac.

These methods of reaching the common and internal iliac arteries are somewhat complicated and difficult because of the great depth of the wound. Celiotomy in the median line or one of the semilunar lines with ligation of the vessel through the peritoneum is simpler, and therefore easier and safer. The preparation and early steps are those of any intraperitoneal operation. The intestines are then held out of the way with gauze pads, the peritoneum in front of the vessel incised for an inch or an inch and a half, and a ligature of catgut carried around the vessel with an aneurism needle. The wound in the anterior wall of the abdomen is then sutured. If the gaping of the peritoneum over the point of ligation is great a couple of catgut sutures may be used to bring the edges together. This transperitoneal method gives opportunity to place the ligature with ease and accuracy, but the ureter must be avoided.

ARTERIAL VARIX OR VARICOSE ARTERIES.

Arteries may become dilated and elongated, presenting a condition similar to varicose veins. The term arterial varix is generally applied to such a pathological change if the artery affected be a large vessel, such as the temporal, facial, or iliac; while to similar dilatation of the terminal subcutaneous arterioles, of a normal diameter of about one-fiftieth of an inch, the term cirsoid aneurism has been applied. The latter name should be discarded, since the condition has no pathological resemblance to aneurism. The term arterial varix, or varicose artery, should be used for dilatation and elongation of preëxisting arteries of any size, provided their preëxistence can be demonstrated clinically or microscopically. When there is a development of new vessels with arterial characteristics it is proper to call the mass or tumor an arterial angeioma.

FIG. 121.

Arterial varix of the palm and fingers. (AGNEW.)

A varicose artery in addition to being generally dilated, may show irregular pouches or sacculations. The middle tunic especially is thinned until the artery looks like a vein; hence the blood current may become very sluggish. The cause of the change is probably some obscure vaso-motor disturbance leading to loss of muscular tone in the middle coat. Atheroma seems not to be a factor in the causation.

Arterial varix is exhibited as a pulsating tumor with an irregular, nodulated surface, which usually shows the position beneath the skin of the dilated arteries. When the hand is applied to the tumor a vibratory thrill is felt that in some cases resembles the wriggling of a mass of worms. Pulsation may be distinct and is more general than the limited pulsation felt in an arterio-venous fistula. Auscultation reveals a blowing or cooing murmur. Pressure upon the afferent artery stops all movement and murmur. If there are several arteries, pressure on one merely diminishes these signs. When the disease affects a number of small arterioles, the tumor has a spongy feel and the outline of the vessels is not traceable through the skin. If an arterial varix shows no tendency to increase in bulk and is not threatening hemorrhage from inflammatory and ulcerative processes, it should be let alone. If treatment is demanded, excision or ligation should be done in the manner described in the section which discusses angeiomas. This is better than injection with coagulating fluids.

CHAPTER XVI.

DISEASES AND INJURIES OF BONES.

PERIOSTITIS.

Causes.—Periostitis, or inflammation of the fibrous membrane covering the exterior of bones, is caused by injuries, by certain constitutional conditions, such as rheumatism, gout, and especially syphilis, and by infection with the same micro-organisms that produce infectious osteomyelitis. Traumatic periostitis, unless also infective, is apt to be fibrinous. Syphilitic periostitis is apt to be a productive inflammation. The vessels of the periosteum, of the bone and of the medulla are continuous through the ramifications of Haversian canals and spaces. Hence, inflammation of one of these structures is usually associated with inflammation of the other in the same locality. As ostitis, or osteomyelitis, is really an inflammation of the medulla within the bone spaces, it may be the cause of periostitis; and periostitis may similarly be the cause of osteomyelitis.

Pathology.—The pathological changes seen in periostitis are congestion, thickening, and softening of the membrane due to rapid cell-proliferation and accumulation of the wandering blood cells. The deepest layer of the membrane, which is that which causes bone growth, is especially active in cell formation; hence, the membrane is raised from the bone by a subjacent exudate and becomes easily detachable. The bone immediately beneath the inflamed area also becomes inflamed and softened to a limited extent. If resolution occurs, this exudate is absorbed and the elevation, or node, caused by the cells and fluid beneath the periosteum disappears. At other times, the inflammation does not subside so easily, this new material becomes organized into bone, and there is left a permanent change in the contour of the skeleton. The entire bone may be enlarged if the periostitis is wide-spread. Flattened bony elevations or nodes are of frequent occurrence after syphilitic periostitis, and often aid in establishing the constitutional causation of later obscure lesions in other parts and tissues.

If bacteria be present in periostitis, suppuration may take place between the membrane and bone, giving rise to subperiosteal abscess, also called cortical osteomyelitis, and secondarily causing superficial necrosis of the bone in the vicinity. Periostitis of syphilitic origin occurring in the later stages of this constitutional disease is more prone to suppuration than when it occurs earlier. In diffuse suppurative periostitis the membrane is separated from a large surface of bone, and the vessels going to the bone are injured and stretched and become the seat of thrombosis. The surface of the bone, therefore, becomes necrotic. If there is concurrent suppurative inflammation of the marrow in the medullary canal, which is not infrequently the case, the necrosis will involve the entire thickness of the bone and not merely the outer surface. Death from pyæmia may occur in such conditions. Subperiosteal hemorrhages are sometimes found. This bleeding may be mechanical and due to forcible and rapid dissection of the membrane from the bone by the sudden inflammatory exudation. Acute infective periostitis is a very serious disease and is liable to be followed by septicæmia or pyæmia. It is usually associated with acute infective osteomyelitis.

Symptoms.—The symptoms of circumscribed periostitis, which is the most common form, are pain, often worse at night, tenderness on pressure, heat of the surface, circumscribed swelling and, perhaps, local œdema. Persons whose occupations require them to work at night and sleep in daytime may have more pain during the day than at night. The deposition beneath the membrane may cause the parts to feel boggy or puffy on strong pressure with the fingers. The swelling has not abrupt edges, but gradually reaches the level of the surrounding surface. The pain is often excruciatingly severe and of a throbbing character. Redness of the surface occurs late, or it may be absent during the progress of the inflammation. The tibia, clavicle, ulna and cranial bones are very frequently the seat of syphilitic periostitis. Diffuse periostitis, which is infective, is very acute in its course, while the circumscribed variety is often a chronic disease. The former attacks particularly the long bones of persons in early life, and is accompanied by violent constitutional disturbance. In this violent periosteal lesion chills, high fever and delirium occur, and are accompanied by rapidly spreading inflammation of the limb, which is shown by great pain, swelling, œdema, and enlarged veins from obstruction to deep circulation. Ostitis, endositis, epiphysitis, and even arthritis often follow in its train. Death from septicæmia or pyæmia is not uncommon. Diffuse suppurative periostitis of the digital phalanges is often called whitlow or felon.

The diagnosis of circumscribed periostitis is easy. It is usually syphilitic when not traumatic. The diffuse or suppurative form may be mistaken for diffuse cellulitis, but, as a rule, it does not extend beyond the joints at the extremities of the bone affected. Suppurative cellulitis frequently passes beyond joints. From rheumatism, periostitis is discriminated by the swelling, which is not apt to be situated at the joints, and by the evidences of suppuration in the purulent form of periostitis. Acute infective periostitis is often mistaken for rheumatism, and must be remembered as a possibility when violent general symptoms, in young persons, are associated with pain about the tibia and femur.

Treatment.—The treatment of acute periostitis of a sthenic type should consist of cathartics and diaphoretics combined with anodynes. The asthenic cases demand iron, quinine and stimulants, with concentrated food and anodynes. Locally, leeches, lead water and laudanum and moist antiseptic dressings should be employed in the acute form; tincture of iodine and blisters in the more chronic cases.

As syphilis is probably the commonest cause of non-traumatic periostitis, full doses of iodide of potassium should be administered. The dose should not be less than 10 grains three times a day after meals, and may be increased to 30 or 40 grains in a rebellious case. As this lesion is a manifestation of the later stages of syphilis, the iodides are possibly more efficacious than mercury. The two remedies may be combined. The pain of syphilitic periostitis, often called syphilitic neuralgia, can frequently be promptly cured by very large doses of potassium iodide. When the pain of periostitis of any origin does not promptly subside, free incision of the tense fibrous periosteum is the proper surgical remedy. The tension due to the subperiosteal exudation is thus removed, and as a consequence pain is relieved, resolution favored, and the danger of secondary necrosis lessened. In non-suppurative cases the incision is to be done subcutaneously, by passing a tenotome through the skin in one or more places and incising the periosteum freely and deeply in every direction, by pushing the knife as far under the tissues as the handle will allow. In suspected infective periostitis very free incisions must at once be made through the skin and other tissues directly down to the bone. No delay is permissible in instituting active operative treatment in this destructive disease. If the bone becomes necrotic notwithstanding this line of treatment, it should be removed as soon as the patient can bear the shock. Some reproduction of bone may subsequently take place, from the shreds of the periosteum not destroyed by the violent inflammation and from the medullary tissue in the interstices of the living bone. If great destruction occurs from involvement of the medullary membrane and the joints, amputation may be demanded.

OSTEOMYELITIS.

Causes.—Ostitis or osteomyelitis may arise from contusions of bone, fractures, amputations and other injuries; and from various constitutional deteriorations and mycotic affections, such as rheumatism, syphilis, tuberculosis and low fevers. Acute osteomyelitis, except when local as the result of injury, is an infectious process of great importance, and due to the pyogenic staphylococci or streptococci, the pneumococcus, the colon bacillus, the typhoid bacillus or other microorganisms. The tubercle bacillus causes infective osteomyelitis, but it is usually, though not always, chronic in character. Osteomyelitis is occasionally due to infection with actinomyces.

Pathology.—Inflammation of bone is pathologically identical with inflammation of the soft tissues, for it is the soft or animal tissue in the Haversian spaces, canaliculi and lacunæ of the bone that undergoes the morbid process. The earthy constituents cannot inflame; they only show the impress of the alterations induced in the vascular and other living tissues. It was formerly the custom to use the term osteomyelitis when the marrow was supposed to be especially affected, and ostitis for other cases. It is better to describe all forms as osteomyelitis.

The increased vascularity of inflammation is followed by softening of the bone, due to absorption of the earthy structure and the filling of the vascular canals and spaces with embryonic cells and migrating blood corpuscles. The coalescence of numerous canals and spaces, by the absorptive process exerted on their walls, makes the bone more porous, while the increase in cellular elements gives it a soft and spongy character. This process has been called rarefying ostitis, or dry caries, because the bone is eaten away as if ulcerated, but without any pus formation. Changes in shape of long bones or vertebræ, due to this process, occur, hence the name deforming ostitis. This is the change that occurs when aneurisms cause absorption of the bone, when sequestræ are loosened, and when the ends of broken bones are rounded off. The inflammatory cellular infiltration or exudate may be absorbed and the ostitis may thus be terminated by resolution without leaving permanent change. This is possible only in the early stages, or in a very mild degree of inflammation.

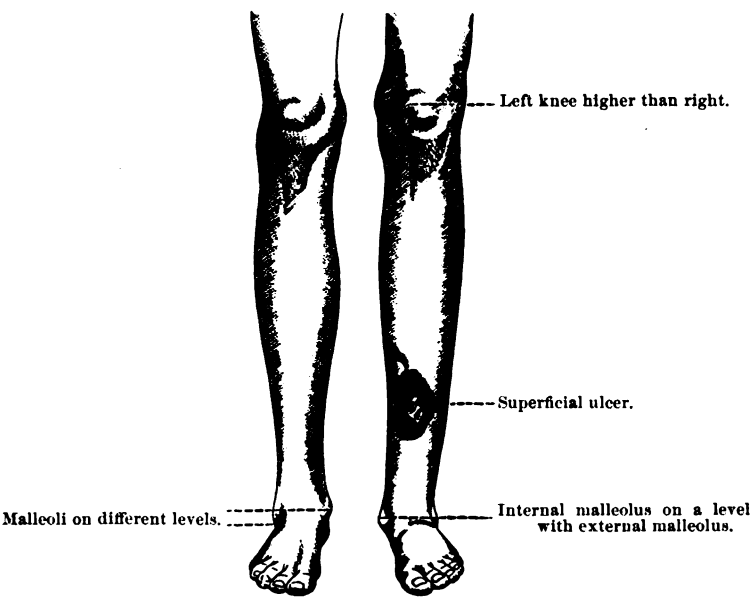
More frequently the cells become converted into osseous tissue, which, though formed in the widened Haversian canals and medullary spaces, encroaches upon the caliber of these channels so much that they become smaller than they were originally. Thus the bone becomes harder, and more compact or ivorylike, and, as a consequence, heavier than it was previous to the occurrence of ostitis. This is the pathological nature of most cases of chronic ostitis. As enlargement takes place both in diameter and length during the stage of softening and swelling because of the coincident periostitis and epiphysitis, an inflamed bone which is thus sclerosed becomes of greater bulk as well as harder than it was previously. This sclerosis or condensing ostitis, may be found accompanying rarefying ostitis in the same specimen.

The osteomyelic inflammation may terminate in necrosis or caries, or in softening and degeneration which will cause the so-called cold or chronic abscess of bone. Bone abscess may be due to tubercular, suppurative or syphilitic osteomyelitis. The various stages and results of ostitis may often be found in different parts of the same bone. When repair takes place after deforming ostitis, tubercular ostitis, or traumatic ostitis after fractures, the process is one of ossification of granulation tissue which fills in the gap. It is simply a bony transformation of scar tissue. The process is well shown in some cases of curvature of the spine cured without the formation of puriform discharge.

Acute infective inflammation of the bone may occur through traumatism or the organism may gain access to the bone through the circulation. In acute diffuse, or infective, osteomyelitis the marrow is injected and swollen, purple or marked with red, yellow and purplish streaks, and protrudes in a fungous mass from the medullary canal when the bone is sawed. Oil and pus escape from the canal when it is opened. Abscesses and thrombosis of veins are found in the tissues surrounding the diseased bone; bacteria are found in the marrow and other structures, and pyæmic abscesses frequently arise secondarily. It may occur in short or flat bones as well as in long bones, and is due to mycotic infection. The micro-organism or micro-organisms are obligate and facultative pyogenic bacteria. The infection may be a mixed one. The periosteum is often involved in a similar inflammation, but not necessarily so. The bones are in severe cases stripped of periosteum and become necrotic from one epiphysis to the other. Separation of the epiphysis from the shaft is common, and is due to destruction of the intervening cartilage.

Symptoms.—The symptoms of osteomyelitis are with difficulty differentiated from those of periostitis, with which the affection is so frequently accompanied. In the early stages the symptoms are often very indefinite. Dull, aching or gnawing pain, especially severe at

FIG. 122.



Hypertrophy in length and thickness of left tibia from inherited syphilitic ostitis. (Author's case.)

night and varying with the conditions of the weather, is a common symptom in chronic ostitis, and the inflammatory signs spoken of in the discussion of periostitis will probably be observable in the later stages.

Enlargement of the bone without much change in its outline was formerly thought to be characteristic of osteomyelitis, but it is due largely to the concurrent periostitis. In ostitis, unaccompanied by much periostitis, irregular flattened swellings on the surface of the skeleton change the contour greatly. Some of the increase in size in these inflammations is apparent, being due to the overlying soft tissues. A feeling of weakness and heaviness in the limb is frequently described by the patient. Lücke has employed percussion with a small rubber-tipped hammer to determine the existence and exact seat of osseous inflammations. Corresponding parts are struck and the existence of increased sensibility determined; and then its superficial or deep location estimated by the force required to develop tenderness. There is greater dulness on percussion when the bone is compact, or infiltrated with inflammatory exudations, than elsewhere.

Acute inflammation of the bone and marrow, called acute osteomyelitis or acute infective osteomyelitis, may be associated with a similar periostitis, and when it occurs without a recognized injury is often mistaken for rheumatism. The sudden development of fever, with chills and delirium and accompanied by severe pain and muscular spasm in the limb of a person so young that the epiphyses have not yet become united to the shafts, should excite suspicion. If redness and œdema occur, and especially if crepitation from inflammatory destruction of the epiphyseal cartilage is developed, or if the joint is involved, the diagnosis of infective osteomyelitis is confirmed. Abscess under the periosteum and muscles, necrosis, septicæmia and pyæmia are later symptoms. The symptoms of the different forms of infective osteomyelitis are not such as to permit a definite diagnosis of the infecting organism. That due to the pneumococcus is said to have a tendency to joint complications, with only a moderate tendency to cause abscesses under the periosteum, or necrosis. Its course is, however, rapid and its symptoms acute. The osteomyelitis caused by the bacillus pyocyaneus is believed to be more apt to have cutaneous eruptions as a symptom and to produce a particularly offensive pus. The type characterized by what might be called explosive symptoms, because of their rapidity and severity, furnishes a staphylococcus on bacteriological investigation. The streptococcus pyogenes is likely to be found in cases following typhoid fever and scarlet fever.

In the fulminant form the patient may show swelling and œdema of the overlying soft parts in forty eight hours and give evidences of actual pyæmia in a few days. The septic contamination of the patient and his death may occur with frightful rapidity. Thorough treatment by incision or trephining of bone, followed by curetting and disinfection of the medullary canal, if undertaken promptly will often save life and preserve the bone.

Thickening of the bone and early ossification of the epiphyseal cartilage may occur in osteomyelitis of only moderate severity. This disease is most frequently found in the long bones of the lower limb; and occurs before ossification of the epiphyseal cartilages, which is not completed in the tibia and femur until about the twentieth year.

Treatment.—The treatment of ostitis is almost identical with that of periostitis. If medical remedies fail a deep periosteal incision should be made, which may be at once, or subsequently, followed by longitudinal section of the bone with a chisel, a Hey's saw or the circular saw of the surgical engine. This incision should be deep enough to go into the cancellated structure or medullary canal of the bone. Cutting out one or more disks with the trephine answers a similar purpose in relieving tension and pain, and is often better than simple incision, even if there is no abscess cavity in the bone to be curetted.

Acute infective periostitis and osteomyelitis must be met by early and free incision of soft parts and periosteum, down to the bone, and thorough disinfection of the diseased tissue with antiseptic solutions. Corrosive sublimate solution (1 : 1000 or 1 : 2000) is probably the best; but it must be watched if repeated daily, so that it may not produce toxic effects. Free drainage and antiseptic washing of the cavity daily are essential. Separated epiphyses should be kept in position by splints; dead portions of bone removed and the patient kept alive by tonics, good food and stimulants until the force of the mycotic poison has been exhausted. When the infective inflammation does not involve the periosteum to any great extent, the danger of these diseases may not be quickly appreciated by the surgeon; because the focus of inflammation is in the medullary canal of the bone. A loss of precious time then sometimes occurs. The condition is practically a phlegmonous abscess enclosed in bony walls. A good opportunity for absorption of septic products is therefore furnished, without any reasonable chance of a rapid spontaneous evacuation of the pus. These circumstances constitute the danger of the condition to the integrity of the bone and the life of the patient. The local treatment consists in cutting into the bone with chisel or trephine and scraping out with a curette the inflamed and suppurating marrow. If necessary, more than one trephine opening may be made, or two or more such holes may be connected by cutting away the intervening bone with a chisel. Complete removal of the diseased tissue and disinfection of the cavity are the indications. Necrotic bone should be removed when it becomes loosened from the living osseous tissue. This is usually a secondary operation, unless trephining and curetting have been done in the early stages. The latter operations are indicated as soon as a probable diagnosis is made. It is better to operate too early than too late. Thorough opening of the medullary canal is imperatively demanded. A trough from one epiphysis to the other may be necessary to permit complete removal of the diseased marrow and softened bone. Incomplete operations may be the cause of the repeated inflammatory symptoms seen in some cases of chronic or subacute osteomyelitis. Such recurrences are common in cases allowed to go without operation, provided the patient does not die at the time of the original attack.

Amputation is sometimes necessary to save life in infective osteomyelitis and periostitis. In syphilitic and tubercular osteomyelitis the patient must be put on the proper internal treatment, as in periostitis from similar causes. In the septic forms stimulants, tonics and nourishing food are demanded.

NECROSIS OR MORTIFICATION OF BONE.

Definition.—Necrosis is death of bone in masses or in bulk, in contradistinction to caries, which is death in minute particles. It is pathologically identical with mortification or gangrene of soft tissue.

Causes.—Necrosis is caused by anything that at once destroys the vitality of the bone, such as intense heat or cold and crushing injuries; and by whatever prevents the continuance of the blood circulation through the Haversian canals and their ramifications, thereby interfering with the bone's nutrition. Obstruction of these blood spaces by the exudate of the osteomyelitis and detachment of the periosteum or inflammation of the marrow, by reason of suppurative inflammation of these structures, are the most common direct causes of necrosis. Osteomyelitis, whether central or cortical, is probably the most frequent cause. It acts by interfering with proper blood supply, which is arrested by stretching, compression and thrombosis of the vessels. Syphilis and tuberculosis may be causes. The depressed vitality of old age and of eruptive fevers, division or embolism of the nutrient artery of a long bone, and exposure to the toxic effects of phosphorus or mercury are occasionally causes of mortification of bone. If a piece of bone is torn loose from its periosteal attachments, as happens in compound fractures, necrosis is not apt to occur, unless the wound is infected with putrefactive or pyogenic germs. This proves that it is the septic character of a given periostitis that inclines it to cause necrosis.

Pathology.—The occurrence of necrosis more frequently in compact than in cancellated osseous structure is due to the greater ease with which the circulation is obstructed in the former unyielding structure. In the ordinary variety of necrosis the devitalized bone is dry and hard, and has a relatively large proportion of mineral constituents. When struck with a probe it often gives a sonorous note, but is not sensitive to touch, nor does it bleed. Its color is yellowish-white, unless it has become blackened by contact with putrid pus or other agents. The necrotic action may pertain to the surface of a bone (superficial necrosis), to a portion some distance below the perhaps healthy bone surface (central necrosis), or to the entire thickness of the bone (total necrosis). If death occurs in cancellated tissue, which is normally more vascular than the compact, the necrotic tissue, especially when the destruction is sudden, is moist instead of dry. Moist necrosis is evidently the result of septic infection of some sort. The dead bone has a dirty gray or greenish brown color, is moist and soft and emits a very offensive odor. The periosteum is usually found in a sloughing condition and shows little tendency to form new bone. Death from pyæmia is a common result of moist necrosis.

After osseous tissue has died, it is separated from the living bone by the process of rarefying ostitis or ulceration, exactly as gangrenous parts are separated from soft tissues. The adjacent bone becomes inflamed, softened and ulcerated, and soon a line of demarcation appears. It requires a long time, varying from weeks to months, according to the extent and situation of the necrosis, to effect complete detachment. Very often pus infection occurs and suppuration takes place between the dead and living bone. During the accomplishment of this process the overlying periosteum becomes abnormally active in producing bony tissue, probably because of the induction of a chronic periostitis, and deposits a layer of new bone. This new bone may form a covering over the necrosed part, or, if the latter is central, increase the thickness of the surrounding living bone. In this manner the devitalized bone is usually enclosed in a bony sheath or involucrum of irregular shape, which, however, conforms somewhat to the outline of the original bone. If the periosteum has previously been entirely destroyed, no encasement occurs. The dead portion of bone enclosed in the sheath is called the sequestrum, while the leaf-like portions detached in cases of superficial necrosis are termed exfoliations. In cases of total necrosis the endosteum may also furnish new bone, so that the dead structure lies between two layers of newly formed osseous tissue. There is usually no ensheathing in necrosis of the skull or of the cancellated bones.

Through the living bone, whether original or newly formed, which covers the sequestrum, narrow channels or fistules, called cloacæ, are established by the discharge, formed at the line of demarcation, making its way to the surface. These cloacæ communicate with sinuses extending through the overlying soft parts to the cutaneous surface, which sinuses are the remains of collapsed abscesses that were developed soon after pus formed in the bony structures.

The surfaces of a sequestrum or exfoliation are usually rough and jagged, because the living bone has been eaten away from it by rarefying or suppurative ostitis. The external surface of an exfoliation is sometimes quite smooth, since it may have been originally the normal surface of the bone. The sequestrum may be dense or spongy, accord-

FIG. 123.

9¼ inches

Cylindrical sequestrum from femur.

ing as it has been sclerosed or rarefied before death. After some amputations of the thigh in which the nutrient artery has been divided, necrosis of the area of bone nourished by this artery occurs, while the regions nourished by other vessels coming from the periosteum and endosteum remain healthy. As a result, a tubular or cylindrical sequestrum is formed and may, when finally detached, be pulled out from the sawn end of the bone.

Symptoms.—The early symptoms of necrosis, which is a result of osteomyelitis, are those of osteomyelitis followed by inflammation, and often suppuration, of the overlying soft parts. Through the openings or sinuses left after the evacuation of the pus, a hard and more or less rough surface can usually be felt with the probe if the necrosis is superficial. This is the dying or dead bone uncovered by periosteum. Bare bone, however, is not necessarily dead bone, for after periostitis. and osteomyelitis of a simple kind we may have an ulcerated surface of bone that is slow in healing. In cases of central necrosis the probe must be passed through the sinuses in the soft parts and the cloacæ in the involucrum or sheath before the rough sequestrum can be felt. Until sinuses and cloacæ have been formed it is practically impossible to diagnosticate the presence of necrosis. The fever and other constitutional symptoms may be marked during this early stage, but are apt to decrease in severity with the evacuation of any purulent accumulation; which may become thereafter the seat of putrefaction from germ infection. From time to time, however, exacerbations of the symptoms may occur, and new abscesses may form. The symptoms during this, the dying stage, are more chronic in progress when necrosis happens in spongy bone. When the osseous tissue is killed at once the symptoms of this stage are absent.

The stage of separation, as the period occupied in detaching the dead structure may be termed, has characteristic features. Chronic discharge from the cloacæ and overlying sinuses, increased thickness of the bone, and gradual impairment of health, if the disease is extensive, are the most prominent. Symptoms of waxy degeneration of the liver or kidneys may arise. The time occupied in separation varies from a few weeks to many months; being shorter in the upper limb than in the lower and when the necrosis is superficial or circumscribed than under opposite conditions. That separation has been accomplished is known by the motion that can be communicated to the sequestrum by a probe passed into the openings. This is sometimes better determined by introducing two probes, one near each end of the sequestrum. Sometimes the sequestrum is not movable, even when completely detached, because it is imbedded in the granulations on the inner surface of the sheath. If this condition is suspected a strong probe should be used to force the sequestrum down upon the granulations until they are flattened and the cavity enlarged. Motion can probably then be detected.

FIG. 124.

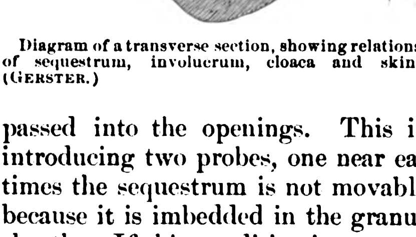


Diagram of a transverse section, showing relations of sequestrum, involucrum, cloaca and skin. (GERSTER.)

Prognosis.—The prognosis in necrosis as to final restoration of the usefulness of the part is generally good, except in acute septic cases. The disease seldom extends beyond the epiphyseal cartilages, and, after removal of the dead bone, the sinuses heal, leaving, however, some deformity in contour. Death at times does occur in the early stages, as, for example, in cases following acute septic osteomyelitis or periostitis; so also exhaustion from prolonged suppuration or pyæmia may lead to a fatal issue. Again, death may result from secondary implication of other structures. This is illustrated by brain disease following necrosis of the skull, arthritis subsequent to disease of the patella and laceration of the femoral artery by necrotic spicules from the femur. Pyæmia from moist necrosis is not uncommon; but fortunately this form of bone disease is quite rare.

Treatment.—The indications in the first stage are to moderate accompanying inflammation, by treating thoroughly the causative osteo-

FIG. 125.

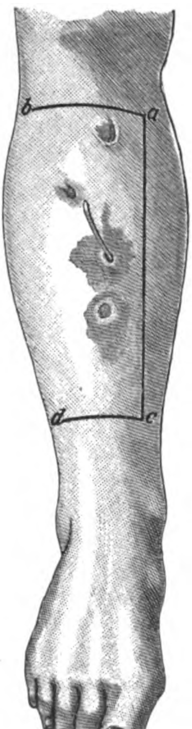
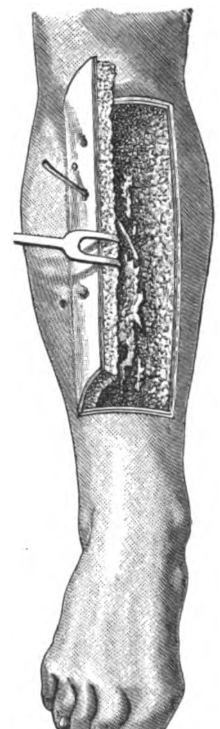


FIG. 126.



Osteoplastic necrotomy. (TILLMANNS.)

myelitis or periostitis, to open abscesses early, and to keep up the general health. Early incision of the periosteum is often valuable, since it relieves pain and tends to prevent extensive destruction of this membrane and the bone by suppuration. So trephining the inflamed bone and scraping away the diseased medullary tissue are valuable operative procedures. Disinfectant solutions should be freely employed to allay fetor; and all cases should be treated with rigid antiseptic measures. As soon as the dead bone is loose, it should be removed by operation. An exfoliation can be lifted away with a chisel after simple incision of the musculo-cutaneous coverings. When the bone has been devitalized by caustics or burning and the dead area is easily determined, there is no objection to cutting it away with the chisel even before detachment has taken place, for it hastens the cure. To effect removal of a sequestrum an opening should be cut in the encasement by means of small sharp chisels and a hammer, or with a saw or trephine, until the sequestrum can be seized with strong forceps and pulled out. Sometimes the cloacæ simply need enlargement; at other times the bridge of new bone between two of them must be cut away. The surgical engine, by which circular saws and burrs can be rotated with great rapidity, may be very useful in these procedures. Sometimes an osteoplastic operation may be done and a trap door of soft parts and bone be raised up.

After application of the Esmarch apparatus an incision should be made in the line of the principal sinuses and cloacæ, and the exposure of the bone will then enable the surgeon to determine upon the proper method of reaching the necrotic piece. The encasement should be freely cut, but in such a manner as not to weaken the bone more than necessary or to fracture it transversely. Occasionally it will be found easier to get the sequestrum out after it has been divided into portions by the bone-cutting forceps. The cavity left is generally lined with granulation tissue, but in tubercular subjects its walls may be carious. Such carious bone should be scraped away with a gouge. In getting access to the sequestrum, the surgeon should not feel compelled to follow the sinuses or cloacæ; any safe path of attack which gives best opportunity for thorough removal is justifiable.

After the operation is completed the wound should be stuffed with dry antiseptic gauze, the limb enveloped in a similar dressing, and a roller bandage firmly applied to the parts before the elastic band of the Esmarch apparatus is removed.

Subsequently to this operation, called sequestrotomy or necrotomy, the encasement contracts, new bone is formed in the cavity of the sheath, as well as under the preserved periosteum, and the sinuses and cloacæ become closed. The medullary cavity, if destroyed, is, as a rule, not reëstablished.

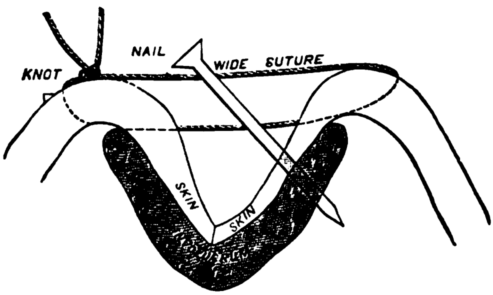
There are some circumstances in which it is probably better to operate before detachment of the sequestrum is complete, notwithstanding the possibility of thus tearing away portions of the living bone. This is the case in acute necrosis from subperiosteal abscess and septic osteomyelitis, and in moist necrosis; for more extensive destruction of the periosteum and septicæmic complications may perhaps be obviated by early excision of the dead structures by means of saws. The periosteum should be peeled off and preserved in these operations so that the flail-like limb, often left, may have an opportunity of becoming solidified and useful.

Small pieces of healthy periosteum or of bone, taken from man or the lower animals and kept aseptic, have been inserted in the gaps left by extensive operations of this kind. Such bone chips act as centers of bone formation, thus hastening and perfecting the regeneration of the removed shaft. It is absolutely essential that the cavity from which the sequestrum has been taken be made perfectly aseptic by the removal of every particle of diseased bone, diseased granulations, and discharge. Herein lie the difficulty and frequent failure of the method. These osteo-plastic operations deserve further trial in cases in which the bone has been extensively destroyed.

The methods of performing sequestrotomy, adopted before the advent of modern antiseptic surgery, gave good results; though the healing of the remaining wound was very prolonged. It was always the seat of protracted suppuration. Septic complications were, however, uncommon; because the dense inflammatory infiltration of the surrounding osseous and other tissues rendered septic absorption difficult, and the open wound with rigid bony walls made drainage thorough and perfect.

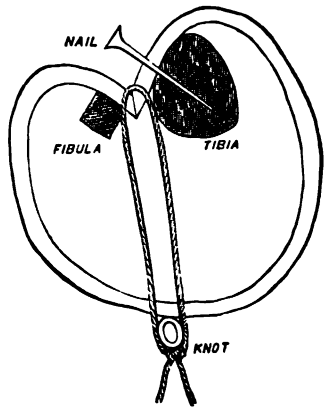
Antiseptic surgery has much shortened the process of healing by making possible the implantation of cellulo-cutaneous flaps and the organization and ossification of aseptic blood clots.

FIG. 127.



Neuber's method. Top of involucrum removed, skin flaps turned into the bottom of the bone cavity. (GERSTER.)

FIG. 128.



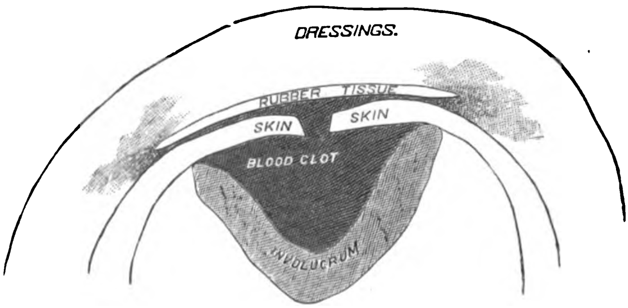
Implantation of cutaneous edges into the defect by transfixing catgut suture. (GERSTER.)

Implantation of cellulo-cutaneous flaps may be done, in order to cover the fresh surface of living bone, left after cutting away all diseased bony structure, and thereby obtain primary union between the bone and the turned in cutaneous flaps. This leaves little or no bony surface to heal by granulation and hastens cicatrization; though, of course, a defect is left in the contour of the part. This defect would also occur, even if the process of implantation was not adopted. The turned in flaps are held in position by sterilized nails driven through the flap and into the bone, and by sutures passed through the skin at the edges of the cavity and carried across the gap; or by sutures carried through the edges of the flaps and then brought out and tied upon the opposite side of the limb. The nail and sutures are removed at the end of three or four weeks; which, if the wound has been made and kept aseptic, will probably be the date of first change of dressing.

The utilization of the blood clot to aid in rapid cicatrization is accomplished by allowing the cavity to fill with blood, which clots and protects the wounded bone and other cut surfaces from septic irritation. The clot must, however, be kept perfectly aseptic. This is done by covering the cavity with its contained clot with a piece of aseptic or antiseptic rubber tissue, just large enough to overlap the borders of the wound. This is in turn covered with a voluminous dressing of dry sublimate gauze. The rubber tissue keeps the blood clot moist, the dry antiseptic dressing absorbs all leakage of blood and serum.

This method of Schede is only possible when the entire mass or all the masses of necrotic bone are removed, when all the pus infected membrane and granulation tissue lining the irregular tracks and cavities have been scraped away with absolute certainty, and when the cavities so made have been thoroughly sterilized by antiseptic solutions and wiped clean with aseptic sponges. Gerster recommends sublimate lotion (1:500) to be used. This is subsequently washed away by a weaker sublimate solution, so that toxic effects may not follow the retention in the wound of small quantities of the strong lotion. Filling the cavity with very hot water or oil has been suggested as a means of sterilizing its walls. The fluid is then mopped out before the wound is dressed.

FIG. 129.



Schede's method. Diagram showing relations of organizing blood clot. (GERSTER.)

If it is impossible to remove a sequestrum, excision of a portion of the bone or of the joint may be demanded. When the destruction of bone has been very great or the patient is already sinking from exhaustion, due to long-continued bone disease, amputation may be the most judicious treatment.

CARIES OR ULCERATION OF BONE.

Pathology.—The disintegration or erosion of bone, called caries, is a process similar to ulceration in soft tissues, for the destroyed structure is removed in small particles, usually in a more or less liquefied form. In this circumstance caries differs from necrosis, in which the devitalized portion of bone is separated from the surrounding living osseous tissue in masses. Caries, therefore, corresponds with ulceration of soft tissues; necrosis with gangrene. Caries is not a disease, but the result of a bone disease; usually tuberculosis, sometimes syphilis. As there is clinically a gangrenous ulceration of the soft parts, in which the two processes are combined, so there may be a necrotic caries of bone. Caries occurring without formation of pus is the so-called rarefying ostitis, or dry caries, which has been mentioned when osteomyelitis was discussed. Pyogenic infection is usually the cause of the moist form of caries, for it is probable that cold abscesses are due to a mixed infection with tubercle and pyogenic organisms. The form of caries most often seen is that in which the inflamed bone softens and disintegrates and causes the so-called cold abscess within or upon the surface of the bone. It is due to tuberculosis, syphilis, and perhaps to other specific diseases, and results from the breaking down of cheesy tubercles and inflamed bone. It is usually a tuberculous affection.

Caries is the result of bone inflammation, and therefore depends upon the causes that induce osteomyelitis. Caries is often associated with inherited or acquired syphilis, but it is possible that syphilis may not be the actual cause of the caries, but simply a cause of lowered resistance which makes tubercular infection easy. The cancellated tissue found in the extremities of the long bones and in the vertebræ, carpus and tarsus is especially subject to the invasion of caries in those predisposed to this disease; but it may occur in any part of the skeleton. In tubercular persons it often follows slight injury. An ulcer of the soft parts may involve the periosteum and bone, and lead to caries.

Caries causes bone to become softened, porous and friable, and of a gray or brownish color before it breaks down into granular semi-liquid

FIG. 130.

Caries of bone.

material. Sometimes the mineral constituents are dissolved out in the early stages of caries leaving the animal matter almost intact, so that the condition resembles that of a bone after maceration in hydrochloric acid. The organic constituents are destroyed subsequently. The removal of the disintegrated area by absorption and liquefaction leaves irregular hollows and cavities, called bone ulcers, which are occupied by the puriform products of the destructive process. The bone around the carious focus is apt to become indurated, because Nature endeavors to construct a barrier to the advance of the diseased action. If, however, the reparative power of the patient is poor, and he, from some inherent constitutional tendency, is especially liable to bone disease, no such induration or sclerosis occurs, and the carious destruction spreads, involves the joints and attacks adjacent bones.

The products of carious destruction consist of oil globules, degenerated cells, blood corpuscles, granular inorganic particles and bone salts, with which are found in most instances the bacillus tuberculosis. The products are the results of cheesy degeneration and emulsification of the osseous tissue. Small masses of necrosed bone will sometimes be found in the liquid, where the two processes, caries and necrosis, have coexisted. Caseous masses, or tubercles, will be found in the interior of the bone tissue, but the surface of the bone is usually involved, either primarily or secondarily, and localized periostitis and inflammation of the overlying soft parts arise. As a rule, a puriform collection, or cold abscess, subsequently occurs in the tissues over the bone; this spontaneously opens and affords an avenue of escape for the liquefied bone material. So long as the carious disintegration continues to furnish a discharge, the sinus, left by the collapsed abscess, will not permanently close. Septic infection frequently occurs secondarily and contributes to this condition. The sinus may cicatrize superficially, because but a small amount of fluid is formed in the depths of the track, but as soon as a few drops collect the tissues inflame and the orifice reopens. Very occasionally, as in some cases of caries of the vertebral bodies, so little discharge is furnished that it is entirely absorbed, leaving no caseous or puriform deposition. These may be called cases of dry caries.

Bone ulcers heal, as do ulcers in soft parts, by granulation and cicatrization. The loss of tissue is partially or entirely replaced by a granulation tissue which undergoes ossification. The attempts of nature to fill up with scar tissue the cavities left after caries may be quite successful, so far as utility of the parts is concerned, if the destruction has not been very great; but depressions, though with rounded margins, are usually left. A great deal of bone is often formed in the endeavor to fill up deep cavities, and remains in the form of protuberances and bridge-like masses. The granulation tissue by which cicatrization is often effected may in turn become infected with the tubercle bacillus, and be, therefore, useless as a reparative agent, because of its continuing indefinitely to undergo cheesy degeneration.

Symptoms.—The early symptoms are necessarily those of osteomyelitis and periostitis or of both, and are followed by those of cold abscess of the soft parts. When this puriform collection has been evacuated, either spontaneously or by incision, the cavity does not promptly heal, but leaves a sinus which discharges thin puriform fluid continuously or intermittently. A probe passed down this sinus will come in contact with the bared and roughened bone, if the track is not too crooked to be followed to its bottom. The carious surface of bone is, as a rule, not tender when touched with the instrument, but it may bleed. If it is impossible to feel the diseased osseous tissue with the probe, the diagnosis may be made by persistent failure to effect permanent healing of the sinus, for which no other cause exists, and by chemical examination of the fluid showing a large amount of calcium phosphate. The discharge is often offensive in odor because of putrefactive infection, and contains gritty particles of bone. If there is much disease, several sinuous tracks with characteristic orifices surrounded by a little elevation of granulations will probably be found converging toward the same region of bone. When the overlying tissue has been ulcerated away, the diseased bone will be exposed to view, though covered in places more or less completely with fungous granulation tissue. Coxitis, angular curvature of the spine, called Pott's disease, and the various forms of joint disease formerly called white swelling are instances of tuberculosis of bone and often go on to caries.

When caries attacks bones near the joints or involves the articular ends of the bone, as it often does, ankylosis is likely to occur, because of inflammatory involvement of the joint structures. On the other hand, a tubercular synovitis may occur first, and lead secondarily to caries of the bone by first involving the articular cartilages.

Treatment.—Iodide of iron, cod-liver oil, combinations containing phosphoric acid, good food, healthy surroundings, sea air and similar therapeutic and hygienic agents are essential factors in the management of caries, whether due to tuberculosis, syphilis or other causes. Even stimulants may be required. Antisyphilitic remedies are often required, in full and long continued doses and combined with tonics.

In the early stages while the disease is active, cleanliness, disinfection of the parts and the prevention of external sources of irritation or infection are the indications for local treatment. Rest of the parts, complete and constant, is imperatively called for, especially when the vicinity of a joint is affected. This is to be obtained by preventing motion by means of gypsum or silicate of sodium splints, permanent extension and similar mechanical appliances. This does not necessarily imply that the patient must be kept in the house or in bed. Confinement is often deleterious while open air exercise is valuable.

When liquefaction of the diseased tissue occurs, free incision should be made for the escape of the fluid and the whole of the diseased and softened bone should be cut away with gouges. This should be done antiseptically and the resulting cavity dusted with iodoform. When the cavity is inaccessible or very large it may be injected with solution of iodoform in ether (1:20) or a sterilized mixture of iodoform and oil of about the same strength. Of this from one to three fluid ounces should be used and then squeezed out after it has been brought in contact with the whole interior of the cavity in the bone and soft parts. The possibility of iodoform poisoning must be recollected, if large quantities are used in cavities, such as those of psoas abscess, where it is difficult to press out the excess of fluid.

Cure can often be hastened by early operative removal, even before liquefaction has occurred, of the soft, devitalized bone and the fungous granulation tissue, which impede repair. Natural processes can effect the removal of this material only after the lapse of many weeks or months; and the protracted discharge necessitated not only debilitates the patient, but has a tendency to cause waxy degeneration of the liver and kidneys. Sulphuric or hydrochloric acid diluted with equal parts of water has been recommended to dissolve away the softened bone. It may be injected into the sinuses or brushed upon the surfaces exposed by a flap incision. A mixture of hydrochloric acid, pepsin and water has been employed for the same purpose, as a digestive of the granulation tissue and diseased bone. This solution has been mentioned in the treatment of sinuses.

If the bone can be reached by incisions not too extensive, scraping away the spongy and devitalized osseous tissue and the fungous granulations is more prompt and sure. To do this effectually Esmarch's apparatus should be applied to prevent hemorrhage obscuring the view. With a gouge, chisel, scraper or the rotating burr of the surgical engine the surgeon removes the unhealthy structures. The operation should be discontinued when healthy bone is reached, which is recognizable by its comparative hardness and the hemorrhage occurring from its surface. When the healthy bone is of nearly the consistency of the diseased parts it can be recognized by the pink color due to its vascularity. The carious bone when washed with water will be white, gray or black.

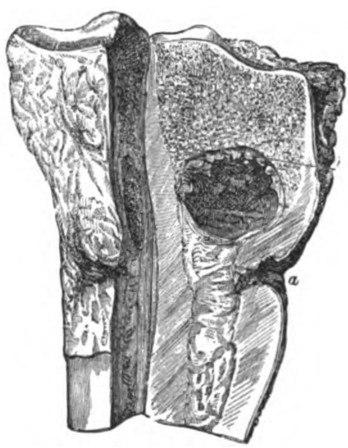
The possibility of general tubercular infection, which may lead to acute tuberculosis and death, arising from a small tuberculous area is a factor strongly pointing to operative removal of the local tuberculous focus when it can be readily and safely done. In extensive caries, excision, arthrectomy, or amputation may become necessary, but these capital operations should not be done hastily, since caries is a disease of chronic type. The lapse of a few months devoted to general constitutional treatment and local measures may change a hopeless looking limb or joint into one that will be much more serviceable than any artificial one. The possibility of fatal exhaustion from the long train of progressive bone disease may lead one to amputate at a rather early date. Passive motion of joints affected with tuberculosis may be cautiously begun, when cure seems to be fully instituted by the absence of heat, pain and discharge; and even when some discharge is present, if it is small in amount.

CENTRAL CARIES OR TUBERCULAR ABSCESS OF BONE.

The process usually called circumscribed suppuration of osseous tissue, or bone abscess, is probably more common than is usually supposed. Such collections of fluid are instances of caries and are usually due to the tubercle bacillus; though syphilis and pyogenic organisms may cause the condition. Bone abscesses are the result of local osteomyelitis. They may occur in any part of a bone, but are more common in the cancellated structure of its extremities. The head of the tibia is the common site. These localized collections within the structure of a bone must not be confused with abscess in the medullary canal and suppurative osteomyelitis, which is a different pathological condition. The cavity may be lined by a soft membrane, or its walls may be roughened carious bone. Sometimes there is a narrow track or sinus leading from the cavity to the exterior of the bone, which in such a case would possibly have a carious surface; but often the pus is completely enclosed in a bony prison. The symptoms are usually very chronic in their progress and are those of osteomyelitis. This would be expected, as the abscess is merely a consequence of bone inflammation. Long continued osseous pain distinctly localized, especially if near the extremity of a long bone and severe, should always suggest abscess. Circumscribed necrosis, and cysts within the bone structure may give somewhat similar symptoms, but the treatment is similar in all these conditions and a differential diagnosis is not very important. Accompanying periostitis may add its symptoms to those of bone abscess.

Treatment affords prompt relief from pain; and consists in dissecting up the soft tissues and periosteum and applying the trephine or chisel to the bone at the most tender spot, so as to open the cavity, give vent to the fluid, and permit curetting of the interior. If the inner surface of the wall is carious, it should be cut away with the gouge or burr; if necrosis exists the sequestrum should be removed. If no pus is found, the trephine may be applied at another spot, or better, perhaps, a drill may be made to perforate the bone in various directions from the bottom of the first trephine hole.

FIG. 131.



Bone abscess in which trephining was done; but the abscess was not discovered at the operation. *a*, trephine wound. (PACKARD.)

Trephining should always be done early, as it is at once followed by relief of symptoms. If no fluid is present, the operation does no harm and will probably ameliorate symptoms by decreasing tension. If no collection of pus-like fluid is found in the body of the bone, it is well to bore into the marrow cavity before desisting, as it is possible that a chronic medullary abscess may be the cause of the symptoms. The wound is to be well drained and dressed antiseptically.

A bone abscess may open spontaneously into a neighboring joint, causing arthritis. This is another reason for early operation. Acute abscess of the medullary canal, or acute infective osteomyelitis, has been discussed in the preceding section.

EPIPHYSITIS.

Inflammation of the cartilage situated between the shaft of a bone and its epiphysis occurs at times in children, especially in those of low vitality. The inflammatory bone conditions already discussed are apt to be associated with epiphysitis, though it is possible that it may be primary in its origin. The symptoms are similar to those of periostitis and arthritis, except when separation of the epiphysis and the preternatural mobility and crepitus there evoked show the loss of the uniting cartilage. Close scrutiny will usually prevent confounding epiphysitis with arthritis. The causes, symptoms, prognosis, complications and treatment are similar to what has been detailed in the consideration of osteomyelitis. Early and free incision, even if no pus is suspected, is good surgery. Even those cases that recover without extensive destruction of tissue are apt to show subsequent arrest in development of the bone, because the osteogenetic function of the cartilage has been impaired. Tonics and nourishing diet are necessary in all cases.

HYPERTROPHY AND ATROPHY OF BONE.

General increase of a bone in length and thickness, to which the name hypertrophy is often applied, is in most cases an inflammatory enlargement due to chronic osteomyelitis, periostitis and epiphysitis. Even after the inflammatory process has subsided the bone retains its increased dimensions. This is not hypertrophy in the true pathological sense, but a productive inflammation. Hypertrophy may occur, however, when unusual functional demands are made upon a bone. An instance is seen in the increased size and strength of the fibula occurring when the tibia has been destroyed by necrosis. The fibula, being gradually called upon to support unaccustomed weight, becomes hypertrophied from increased functional activity. A localized increase in bulk of a bone is more properly called an osteoma or bony tumor. Hypertrophy of bone in itself neither demands treatment nor is amenable to it. Exostoses and other forms of osteoma may be excised, if disfigurement or other reasons make operative treatment desirable.

Atrophy of bone is said to occur in two forms, in both of which there is decreased weight. In one variety the bone becomes smaller in size, with simultaneous absorption of the cancellated and compact tissue and diminution of the calibre of the medullary canal. This change occurs after long disuse, as in stumps after amputation and in joints where ankylosis, dislocation or paralysis has long existed. It is observed most frequently in the long bones, and is a not uncommon senile change, which, when occurring in the neck of the femur, may produce shortening of the limb and lameness and thus simulate fracture at that point. As such localized atrophy, which is frequently associated with fatty degeneration, may happen after injuries, the practical knowledge of this possibility is great. Some cases of so-called atrophy of bone may be imperfect development, due to unrecognized or forgotten injuries or to disease of the epiphyseal cartilages in early life. In the other form of atrophy the bulk of the bone is not altered, but the compact osseous tissue gradually becomes rarefied and changed into cancellated structure, whereby the bone becomes very light and brittle and is easily broken by slight injuries.

The distinction between atrophy on the one hand and interstitial absorption and fatty degeneration of bone on the other hand is perhaps not sufficiently observed. The absorption of bone, or rarefying ostitis, due to pressure of tumors, for example, does not appear to be an instance of atrophy in as true a pathological sense as the disappearance of the alveolar process of the jaw after loss of the teeth. It is true that in the former case the thinning and erosion may be due to interference with circulatory and nervous supply, causing atrophic change; but the diminution of structure following disuse corresponds more nearly with the idea of atrophy.

Treatment is of no avail in curing osseous atrophy. In cases where the function can be restored, as in ankylosis of long duration, the bone may, however, regain some of its lost bulk.

OSTEOMALACIA OR SOFTENING OF BONE.

This very rare affection, also called mollities ossium, seems to be a general disease, though the chief changes are found in the skeleton. Its nature is exceedingly obscure. Some authors have suggested a possible identity with fatty degeneration, malignant degeneration or atrophy of bone. Others have called it rickets of adults, since it resembles rickets, but has been observed only in adults.

The clinical characteristic of the disease is progressive softening of the bones, which become so soft that a knife can readily cut them. At the same time they lose weight and are either flexible or easily broken. Various portions of one bone, and as a rule many parts of the skeleton, are affected. The external compact portion becomes little more than a thin shell, while the cancellated structure becomes more spongy than normal and is filled with a reddish, gelatinous, fatty material. The earthy constituents of the bone are removed by a process of decalcification, and a sort of mucoid degeneration of the animal portion of the osseous structure apparently occurs. The medullary tissue is at the same time very vascular. Lactic acid has been described as found in the bony tissue and in the urine. Osteomalacia is more frequently seen in women than in men and seems to be induced by pregnancy. It is a disease of adult life. The prolonged administration of lactic acid has been mentioned as a possible cause.

The symptoms are pain of a rheumatoid character and a tendency of the bones of the extremities or trunk to bend like softened wax. If the compact outer tissue of the bone is not much decalcified, however, brittleness instead of flexibility will be present and fractures from slight injuries will frequently occur. The urine usually contains a remarkable amount of phosphates, evidently derived from the degenerating bone tissue. Phosphates have been found also, it is said, in the saliva, tears and other fluids. Albuminuria has been observed. The patient finally becomes bedridden, because locomotion is impossible, and dies from exhaustion. Osteomalacia, unlike rickets, is painful, never occurs in children and progresses until death occurs. The softened bones of rickets usually become hard again; such is not the case in osteomalacia. There is no efficient treatment known. Phosphates of lime, sodium and potassium with cod-liver oil and tonics should be given. Bedsores should be expected, and prevented if practicable. If the disease occur in a pregnant woman, the affection may be arrested after delivery. It is well to prohibit nursing the child.

TUMORS IN BONE.

Bones may become the seat of tumors of various kinds, such as sarcoma, osteoma, chondroma, fibroma, angioma, myxoma, and hydatid cysts. It was formerly believed that carcinoma was a not infrequent growth in osseous tissue. Such is not the fact. Except when it occurs secondarily to carcinoma in other structures this form of neoplasm is practically unknown in bone. Sarcoma, however, is common. True cystic tumors are seldom found except in the jaw bones, where they are at times developed from the mucous membrane of the antrum and the structures about the teeth. Tumors containing fluid found in other bones, unless hydatid cysts, are, as a rule, sarcomas, chondromas or myxomas which have undergone cystic degeneration. Vascular tumors, that is to say, angiomas, are occasionally seen; and the pulsating tumors formerly described as aneurisms of the arteries in bone are probably always highly vascular sarcomas.

Tumors of bone may be developed from the lower layer of the periosteum or from the medulla or endosteum. Periosteal growths are usually oval or pyriform in shape, of a smooth surface, and have a capsule derived from the periosteum. The adjacent bone may be normal, hardened, absorbed, eroded, or fractured. The growth, if malignant, may spread to the medulla by the Haversian canals. Endosteal or central tumors are usually spherical, smooth on the surface, and when handled may give rise to a crackling sound. The enlargement of the growth causes disappearance of the bone, but the periosteum becoming inflamed constantly forms new layers of bone tissue. These are absorbed in turn, but new plates of osseous tissue are continually developed. Thus the mass acquires a more or less bony capsule, and when the patient is examined a crackling sound is elicited by the motion imparted to the membrano-osseous encasement. This is the explanation of the apparent dilatation of the bone and the parchment-like crackling elicited by pressure.

Non-malignant growths in bone do no harm, as a rule, other than to act as impediments to motion and to cause deformity. They may be excised with chisels and saws, if such action is demanded by the disability or disfigurement. Sarcomas spread into the surrounding parts and involve distant structures by secondary involvement through the blood current. Amputation, early and at a considerable distance above the disease, is always demanded.

INJURIES OF BONES.

Bone, together with its periosteum and marrow, may receive contused, incised, lacerated and punctured wounds. Such wounds of bone are frequently obtained in war from bullets, balls, sabres and arrows, and occasionally are seen in civil practice. Fractures are lacerated wounds of bone and are common everywhere. Osseous wounds are followed by periostitis and osteomyelitis, which may be localized or diffused. Bone wounds should be treated as similar wounds of soft parts and their sequences, on the principles detailed in the section on diseases of bone. Fractures, which are wounds or solutions of continuity, usually involving the entire thickness of the bone injured, will be discussed in the following chapter of this treatise. Contusions of bone may become of grave import, when a viscus, such as the brain, within the bony case, is simultaneously or secondarily involved, or when atrophy of the bone, as in the neck of the femur, is so induced. The induction of osteomyelitis by contusion is another serious complication of what may seem a trivial injury.

Bending without fracture occurs at times in very young bones or in those softened by rickets or osteomalacia. The treatment is to bend them forcibly into proper shape, or to do so gradually by means of well padded splints or the elastic tension of rubber straps. Muscular action or the elasticity of the bone may correct such deformity in children without much treatment. The surgeon should not hesitate to straighten such bones by making a complete fracture if there is a probability of permanent deformity.

CHAPTER XVII.

FRACTURES.

Definition.—A fracture is a sudden breaking or tearing apart of osseous fibers; in other words, a lacerated wound of bone.

A solution of continuity due to disease or to division by saws or sharp instruments is not a fracture, though in its treatment and mode of repair it may be similar. The term fracture is also applied to breaking of cartilaginous tissue.

Causes.—For the production of a fracture an exciting cause must always be present, but certain characteristics of the patient or of the special bone may act as predisposing causes. The atrophy of bone occurring in old age and the osseous changes of locomotor ataxia, osteomalacia, rickets, and malignant diseases of bones are efficient predisposing causes, for they render the bony tissue less able to resist strain. Syphilis and tuberculosis have been called predisposing causes, but probably on insufficient evidence. General paralysis of the insane seems to be associated with brittleness of bones. This is probably due to atrophic changes in the osseous structure. Stimson states that the greater fragility of bone in the aged is to be attributed to senile atrophy, and not, as is often asserted, to a greater relative proportion of inorganic material. A bone, by reason of its exposed position, its curves, its function as a lever or its small proportion of compact osseous tissue, may be more liable to suffer fracture than the adjacent pieces of the skeleton. On the other hand, a flat, movable bone surrounded by muscles, such as the scapula, is very unlikely to be broken.

The exciting causes of fracture are external violence and muscular action. External violence is said to act directly when the bone is broken at the point of impact. It is a crushing force that causes disruption of the osseous fibers in these cases. Gunshot fractures and fractures caused by kicks and by falling timbers are thus produced. External violence is said to act indirectly when the fracture occurs not at the point struck, but at some distant part of the skeleton. The force is transmitted thither through the intervening bones, and tears the bony fibers apart by leverage, torsion or traction. Muscular action is not a very frequent cause of fracture except in fracture of the patella. That powerful muscular contractions may cause fracture of long bones is proved by instances occurring in athletic persons during efforts of throwing or lifting. Similar injuries have been reported as taking place during tetanic or epileptic spasm of muscles. Fractures of the patella, of the olecranon, of the posterior end of the calcaneum and of the coracoid process of the scapula are usually due to muscular action. Breaking of the patella by contraction of the four-headed extensor of the leg may possibly be at times rendered more easy on account of leverage action exerted upon the bone as it lies in contact with the condyles of the femur. Stimson, however, believes that it is usually a giving way, as of a rope, from direct traction exerted by the muscle. The muscles, by holding the bones in fixed positions, may indirectly assist external violence in causing fractures. This will be understood by considering that a cadaver thrown from a height is less likely to sustain fracture than is a living body.

Fractures occasionally take place in the uterus, due usually to violence inflicted upon the fœtus by injuries received upon the abdomen of the mother. A rachitic fœtus is prone to suffer such osseous lesions from comparatively slight force. It is possible, however, that some supposed intrauterine fractures are really instances of defective ossification.

Varieties.—There are two kinds of fractures, the open and the closed. The open fracture is one in which the broken surfaces are exposed to atmospheric contact by reason of a communication with the surface through a wound of the muscles, fascias and skin. In a closed fracture no such wound exists, and the injury is therefore protected from atmospheric influences. The former are often called compound fractures; the latter simple fractures. As these terms are not self explanatory and are otherwise objectionable, they should be discarded. Closed fractures are sometimes denominated subcutaneous fractures. This use of the word, though convenient, is misleading, because it seemingly implies that the fracture is an open one whenever the skin in the vicinity of the fracture is laid open. Such is not the fact. Communication with the air is the requisite of an open fracture; hence the muscles and fascias, as well as the skin or mucous membrane, must be perforated or divided.

FIG. 132.

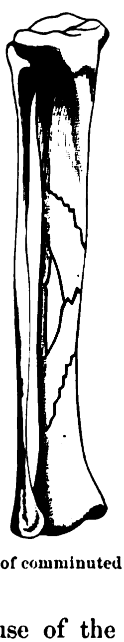
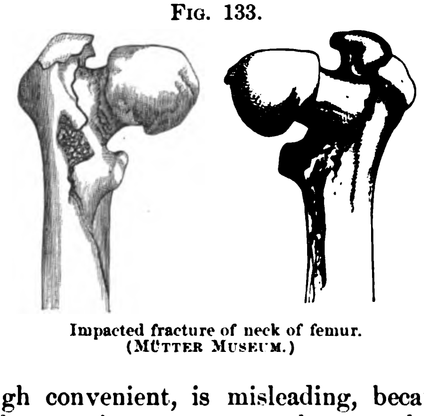


Diagram of comminuted fracture.

FIG. 133.

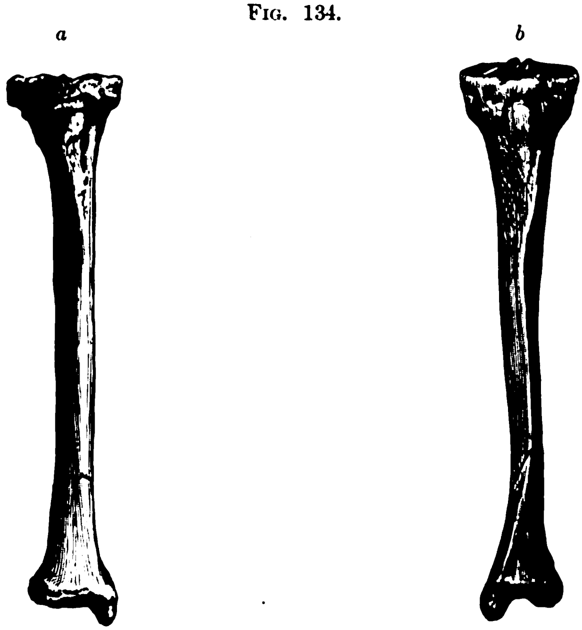


Impacted fracture of neck of femur. (MÜTTER MUSEUM.)

The open character of a fracture may be due to the vulnerating force causing laceration of the soft parts, to its continuance inducing protrusion of the fragments, to the weight of the unsupported limb giving rise to a similar protrusion or to secondary ulceration and suppuration.

Open fractures are liable to be more serious than closed fractures, because pathogenic bacteria may gain admission to the wound and suppuration occur about the ends of the fragments. Union is, therefore, less rapid, and osteomyelitis of a severe type and septicæmia are more likely to arise. The modern or antiseptic methods of surgery have rendered open fractures as little liable to these complications as were closed fractures formerly.

FIG. 134.



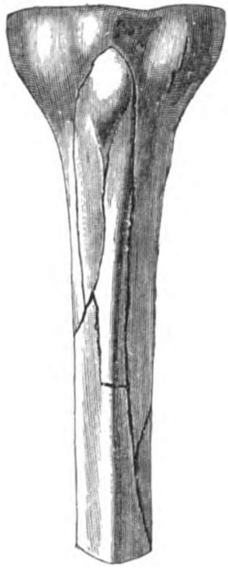
a, transverse fracture and, *b*, oblique fracture. (HAMILTON.)

Various terms are applied to both open and subcutaneous fractures to indicate the characteristics of the broken structure : A comminuted fracture is one in which several inter-communicating lines of fracture split the bone into a number of comparatively small fragments. If a bone is broken at two or more different places and the lines of fracture do not run into each other, the injury is a double or triple fracture, not a comminuted one.

In an impacted fracture one fragment is driven into the cancellated structure of the other and firmly fixed there. It is rather rare, and can only occur, as a rule, at the extremity of bones where there is much cancellated tissue. The lower end of the radius and the neck of the femur are the localities in which it is likely to be seen.

In a transverse fracture the plane of fracture makes a right angle, or at least an angle of not less than 70°, with the long axis of the bone. Transverse fractures are rare, except in the patella and at the lower end of the radius, and when observed are usually caused by either direct violence or muscular contraction. They are probably more common in children and the aged than at other periods of life.

FIG. 135.



Longitudinal fracture. (STIMSON.)

FIG. 136.

Incomplete fracture of femur. (GURLT.)

Longitudinal fractures are those in which the line of fracture is not further from the long axis of the bone than 15° or 20°. They are very rare, except as accompanying such perforating fractures as are caused by gunshot injuries. Oblique fractures are those in which the line of separation is neither transverse nor longitudinal. The majority of fractures are oblique.

A complete fracture of a long bone crosses the long axis of the shaft and divides the bone into two or more pieces. A fracture of a flat bone to be complete must involve its entire thickness. Under the head of incomplete or partial fractures of long bones are included the so-called green-stick fractures, in which some fibers are torn and others bent, fissures, separation of mere splinters, detachment of bony prominences, and perforating fractures, such as are made by bullets. Indentations of flat bones by forces not sufficient to cause fracture through the entire thickness, are instances of incomplete fracture.

Incomplete fractures may become very serious injuries; for example, fissures communicating with the marrow, if open to the external air and infected with putrefactive or pyogenic germs, may be followed by dangerous osteomyelitis. The injury sometimes called sprain fracture, in which a small fragment of bone is torn away at the point where a ligament is attached, is an incomplete fracture. Rupture of the main artery, laceration of the chief nerve, extension of the line of fracture into a joint, dislocation and other lesions may occur simultaneously with a fracture and complicate the treatment.

A diastasis, or forcible separation of an epiphysis from the shaft of a bone, presents the symptoms of a fracture and requires like treatment. Ossification of all the epiphyseal cartilages has usually occurred before the twenty-fifth year; hence epiphyseal fracture, as it is called, can rarely happen at a later period of life than this. The line of separation is of necessity usually transverse; and commonly some scales of bone are torn from the shaft with the layer of cartilage. The innominate bone may be separated by injury into its three primary segments by a similar separation through the cartilages. Arrested growth is not unusual after epiphyseal detachment.

FIG. 137.

Fissure of humerus. (GURLT.)

FIG. 138.

Diastasis, or epiphyseal separation, of the head of humerus. (MOORE.)

Pathology.—When a bone is broken, hemorrhage occurs from the arteries and veins in the Haversian canals and medullary cavity and the periosteum is more or less extensively lacerated. The muscles and fascias about the seat of fracture are usually implicated in the violence, even in closed fractures with little displacement; hence extravasation of blood in and from the surrounding soft parts is common. The blood from the torn soft parts usually shows as a blue discoloration of the skin a few hours after the injury. That effused from the osseous structure itself does not reach the surface for two or three days, because it can only leak through the deep fascial coverings by means of the openings where nerves and blood vessels approach the exterior.

The periosteal laceration may correspond with the line of fracture, but this is uncommon, because the majority of fractures are oblique, and in them the periosteum is apt to be stripped up from the bone in the vicinity of the fracture before it gives way under the tension of the disrupting force. This renders the line of tear irregular. In comminuted fractures some of the fragments may be held in position by untorn periosteum, while others are entirely denuded of this membrane. The latter are not apt to become necrotic unless the wound is infected with micro-organisms. Very occasionally it happens that a bone is broken and the periosteum left intact or nearly so. Little displacement then occurs and rapid cure without deformity is to be expected.

Around the locality of fracture inflammatory processes at once occur, varying in intensity with the severity of the damage done to the bone and the soft parts. The interference with return circulation caused by the pressure of the inflammatory products may give rise to œdema of the distal portion of the limb, even in cases of fractures of very moderate gravity. The fever and other general symptoms depend on the type and degree of the inflammatory action. Albumen, tube casts and fat have been observed in the urine of patients suffering with fractures, apparently as a sequence of the osseous injury.

Angular, rotary, transverse or longitudinal deviation may occur at the seat of fracture. Usually, however, the displacement is a combination of these malpositions. Occasionally, as in some comminuted fractures, the displacement is too complex in its nature to be

FIG. 139.

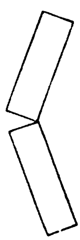


FIG. 140.

FIG. 141.

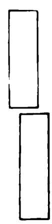


FIG. 142.

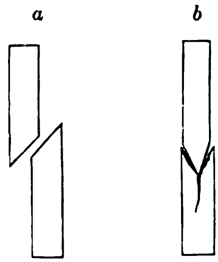


Fig. 139.—Diagram of angular displacement.
Fig. 140.—Diagram of rotary displacement.
Fig. 141.—Diagram of transverse displacement.
Fig. 142.—Diagram of, *a*, longitudinal displacement ; *b*, impaction.

classified under these heads. As a rule, it is the distal fragment that occupies the abnormal position. Transverse fracture of the patella, fracture of the olecranon and similar injuries afford exceptions to this rule. Angular displacement or tilting, in which the axes of the fragments form an obtuse angle, is typically represented in green-stick fractures and bending of bones, in which, indeed, it is the only form of malposition possible. In rotary displacement one fragment is twisted on its long axis. When one fragment is displaced laterally or antero-posteriorly, transverse deviation exists. This form of displacement seldom happens except in combination with one of the other varieties. If the ends of the fragments slip past each other the muscular tonicity causes overlapping, unless an unbroken parallel bone, as in the leg or forearm, prevents its occurrence. Longitudinal displacement is a change made in the long axis of the bone. It consists in overlapping of the fragments, in penetration of a broad fragment by a narrow one (impaction), or in actual crushing of the osseous structure into small pieces. In rare instances, as in fracture of the patella and olecranon, the longitudinal deviation consists in separation of the pieces of bone. This is dependent upon a powerful muscular attachment to one of the fragments. Muscular action in nearly every other fracture causes shortening. It is not always possible to predict the character and extent of displacement that will occur in a fracture at a given locality, for it depends on the direction and nature of the line of fracture as well as on the muscular attachments and other above-mentioned causes of deformity. All the forms of displacement occur in a marked degree in oblique fractures, but little deviation is seen, as a rule, in transverse ones.

Symptoms.—A case of suspected fracture should be examined as soon as practicable after the receipt of the injury, unless the intensity of nervous collapse or some similar circumstance makes such examination more hurtful than a few hours delay in determining the exact character of the injury. When a case is not seen until some days after the accident and very violent inflammation has already supervened, it may be wise to wait a day or two and endeavor to lessen the inflammatory symptoms before undertaking the manipulations necessary to establish an accurate diagnosis. In obscure cases anæsthesia should be induced that a thorough examination may not be prevented by reason of pain. The possibility of deformity from previous injuries and the history of the case should be fully considered. The surgeon should then grasp the parts firmly and examine carefully and thoroughly for deformity, abnormal mobility, crepitus and any other objective symptoms necessary to establish a diagnosis. A wound near the seat of fracture should be cautiously explored with the finger and probe to see whether the fracture is an open or closed one. If oil globules escape from the wound within twelve hours the wound probably connects with the fracture. It is the injured marrow that furnishes this fat. A good deal of venous oozing is suggestive of the fracture being an open one, because the veins of soft tissues cease bleeding sooner than those of bone. The latter cannot collapse so readily.

The symptoms, which, when occurring together, make the evidence of fracture conclusive, are: deformity, abnormal mobility, and crepitus or grating. One is often sufficient to establish the diagnosis, but their coexistence is pathognomonic. In many fractures one or two of these symptoms, as will be shown subsequently, may be absent.

Deformity is principally due to the displacement of the fragments. Extravasation of blood and inflammatory swelling may aid in increasing it. When the periosteum is slightly torn there is no deformity, because this fibrous membrane retains the fragments in apposition.

Mere fissures give rise to no deformity. The recurrence of deformity, when external restraining forces are relaxed, is a characteristic of most fractures, serving to differentiate this class of injury from dislocation of joints. In estimating the degree or existence of deformity, previous fractures and injuries, periosteal nodes, exostoses, and shortening from old joint inflammations or contracted tendons must be eliminated. Sprains and dislocations often give distortions similar to those of fractures near corresponding joints and must be discriminated by other symptoms. The two sides of the body should always be compared, with the bones in exactly the same position. An element of doubt in estimating shortening is the well known normal inequality in length of bones of the two halves of the body. Shortening in very oblique fractures, as of the thigh, may amount to several inches.

Preternatural mobility after injury is absolute proof of a fracture, except in those rare instances where dislocation with very great tearing of the ligaments allows unusual motion at a joint. Increased mobility is sought for by endeavoring to move one part of the bone independently of the other; and so to produce angular, rotary, or transverse deformity at the seat of injury, or shortening or elongation of the bone or entire limb. The best method of developing these features is to hold one extremity of the bone immovable, while an attempt is made with the other hand to move the other extremity. Absence of mobility must not be asserted until endeavors have been successively made to lengthen, shorten, bend and rotate the bone at the seat of supposed fracture, because sometimes the line of fracture is such that only one direction of force will develop the abnormal mobility.

When the injury is near a joint where motion is a normal condition, when the bone is so short or so deeply located that its two ends cannot be firmly grasped and when, as in the case of the ribs, sternum, and fibula, considerable normal elasticity exists, which upon manipulation can simulate mobility, it is difficult to be certain that preternatural motion is present. Fractures, moreover, may exist with little or no increased mobility of parts. Such is the case in impacted, in partial and in interlocked serrated fractures. When one of two parallel bones is broken, the mobility is often slight. When the shaft of a bone is broken near the middle, the unnatural seat of motion may be sufficiently demonstrated by merely placing a hand under the limb and endeavoring to lift it upon this single point of support. Motion and consequent angular distortion are at once evident. When a bone is intimately associated with and held quite fixed by other bones, alternating pressure with the thumbs or fingers applied on each side of the point of injury may develop motion. This method is especially applicable to the fibula and the ribs. In transverse fractures motion will be developed best by force applied laterally, and in oblique fractures by forces tending to elongate or shorten the bone in the direction of its long axis.

Crepitus is the grating sensation felt by the surgeon when he rubs the rough surfaces of the broken bone together. There is often some noise produced by this manœuvre, but the diagnosis rests more on the vibrations conducted along the bone to the hands of the surgeon than on any noise appreciated by his ears. Mobility and grating are usually, though not always, coexisting symptoms. Grating cannot be felt without moving the fragments, but motion may sometimes be produced without making any grating sensation or crepitus perceptible. The development of crepitus requires that the surfaces should be rough, and that they should be sufficiently in contact to render friction of one surface upon the other possible. If the ends are separated, as in fracture of the patella; if they greatly overlap so that the smooth surfaces of the sides of the bone are in contact; if portions of muscle, periosteum, or fascia lie between the pieces; or, if the broken surfaces have by lapse of time become covered with granulation tissue, the surgeon will fail to observe distinct crepitus until he alters these conditions. No grating is possible as a symptom of impacted or green-stick fracture unless the parts are previously rendered movable. Sometimes a certain manipulation will give rise to distinct crepitus, but afterward will utterly fail to produce a similar result. This is because by reason of muscular or external forces a different relation of the fractured surfaces has been assumed in the interval. To elicit grating the surgeon manipulates the parts in such a manner as to produce motion.

When possible, it is best, perhaps, to move the two fragments in opposite directions, as this gives a greater degree of friction. When there is much overlapping, traction must be made before grating can be felt. Placing the palm of one of the hands over the seat of injury is sometimes a good method of feeling grating in bones that are not easily grasped with the fingers. Motion is then produced by the other hand alone. This often avails in fracture of the neck of the femur or great trochanter and in rib fractures. In the last the proper motion may at times only be obtained by deep inspiration or coughing. If the limb is heavy, an assistant may steady or move one portion of the bone while the surgeon has hold of the other. When the presence and character of crepitus have once demonstrated the existence of fracture, no further manipulations should be attempted. The character of grating varies with the character of the fracture.

Fracture crepitus may be confounded with, and, therefore, must be distinguished from, the friction grating of diseased joint surfaces and that of a dislocated bone rubbing on the periosteal surface of another bone. It may also be simulated by the fine crackling of inflamed tendons and bursæ, that felt and heard in subcutaneous emphysema, due to puncture of the air passages or decomposition of cellular tissue, pleuritic or pulmonary sounds, and the crackling of coagulated blood in the tissues. Joint grating is said to be finer and moister than fracture grating, but sometimes it is impossible to assert with positiveness which kind of crepitus is present. Those conditions giving impressions similar to fracture crepitus can usually be eliminated by collateral evidence, if the surgeon merely recollects the possibility of their existence.

The grating produced by motion of the fragments is frequently perceptible to the patient. Occasionally a giving way sensation, accompanied by a sharp crack, is noticed by the patient at the time of the accident. A similar symptom is liable to occur, however, when a tendon is suddenly torn or when a dislocation with great ligamentous laceration takes place. Hence, this snap, even when noticed, has little diagnostic value. It is more often observed by the patient in fractures from muscular contraction than from violence.

The characteristic symptoms of fracture, then, are deformity, preternatural mobility and crepitus. Pain, ecchymosis, loss of function and a variety of other symptoms may be present, but they also exist is such diverse lesions that they have, as a rule, no diagnostic value.

A persistent tenderness after injury limited to a small area of bone is, however, very suggestive of fracture without displacement. The opinion of the laity, that pain in fractures increases when the fragments of bone are becoming united is erroneous. Painful muscular spasms, due chiefly to irritation of the muscles by the sharp points of the broken bone, are frequently experienced in the early stages of fractures.

Swelling deserves little recognition as a symptom of fracture, but is a factor of very great importance in the determination of the best methods of treatment. When the inflammatory swelling is rapid, numerous vesicles may occur on the surface. These may be filled with bloody serum.

Ecchymosis about the seat of lesion is often due to mere contusion of the soft parts. If it first appears after the lapse of several days, and especially if the black and blue discoloration is found at some distance from the seat of injury, a fracture is probably present. This tardy appearance and distant location are due to the difficulty which the blood extravasated from the injured bone, periosteum and marrow has in reaching the surface through the fascial layers. This slowly occurring ecchymosis, particularly when the swelling of the parts results in the formation of blebs on the surface, may be mistaken by the inexperienced for incipient gangrene. Absorption of this extravasation from the deep vessels is always effected in a tardy manner. Indeed, the fracture may be united before all the discoloration has disappeared. Rupture of a large artery as a complication of fracture is of grave import, because it gives rise to great extravasation in the tissues.

Loss of power of the part often occurs after fracture, sometimes from fear of pain, sometimes from loss of continuity in the bony lever. This symptom is absent in many cases of impacted, serrated, or partial fracture, and also in those in which the periosteum is slightly torn. Patients have walked considerable distances with a fracture of the femur or tibia. Motions which do not give pain at the seat of fracture and which do not require rigidity of the particular bone that is broken can be perfectly performed in nearly every case. Movement of the fingers, for example, is often unimpaired in fracture of the radius.

When there are two parallel bones, one may serve as a support to that which is fractured and thus prevent impairment of its ordinary functions.

Intermittent muscular spasms are often an annoying symptom of fracture. They are due to pricking of the muscles by the fragments and to general nervous excitability. Numbness and other nerve symptoms may be present from coincident injury to nerve trunks.

The constitutional symptoms of fracture, after the period of shock, are those of inflammation and its consequences. In an uncomplicated closed fracture there are scarcely any constitutional symptoms. A slight febrile rise is often noticeable, however, during the first three days. In open fractures suppuration is usual, unless care is taken to make the wound aseptic, immediately after its receipt, and to keep it so during cicatrization. Open fractures, managed as described, are usually free from suppuration and cause as little trouble as closed fractures of similar location and extent. Great debility, erysipelas, tetanus, fat embolism, septicæmia and pyæmia may all be seen as sequences of fractures. In old age fractures may prove fatal from the consequent debility that is induced.

Diagnosis.—The symptoms described will usually render the diagnosis of fracture easy; but when deformity, preternatural mobility, and grating are not all found, or, if found, are not well marked, the true nature of the injury may be obscure. Especially is uncertainty apt to arise when the lesion is near a joint, for there a great deal of normal mobility exists, and joint grating may, from some cause, be present. Careful examination under ether, with the corresponding healthy limb uncovered so that comparison can be made, will usually disclose the true nature of the lesion. Severe bruises can be discriminated from fractures in a similar manner.

Dislocations, because of the resulting deformity, may resemble fractures near joints, but in dislocations, unless there is unusual laceration of ligaments, the normal motions of the articulation are impaired; and the surgeon generally finds by manipulation that a sudden and abnormal check to free movement occurs in certain positions of the bones. This is not the case in fracture, for there the motion is almost unlimited. Again, in dislocations there is some resistance when an attempt is made to overcome the deformity by putting the parts in position, but when this has been accomplished there is little tendency to recurrence of distortion. In fractures, on the other hand, the deformity is remedied with ease, but the mere weight of the limb or a slight force will reproduce it. Voluntary motion is, as a rule, not so impaired in dislocations as in fracture, for the long lever is intact, and there is simply a change in the bearing points of the articulation. Fractures have an appearance of helplessness; dislocations that of rigidity. The normal relation of the bony prominences about a joint should be familiar to the surgeon, so that any deviation by dislocation or fracture may be detected. The various test-lines used for determining these relations will be spoken of in discussing fractures near special joints.

The diagnosis between a separated epiphysis and a fracture in the same region is often difficult; but it is not very important, since the treatment is identical. A separated epiphysis gives a smoother and less distinct grating than a fracture. It is apt to be followed by diminished growth in length of the bone.

More difficult than the determination of the simple existence of fracture is the localization of the exact position and line of fracture. This is often of importance, and may be determinable only by careful fingering accurate measurements and close observation of changes in relative position of the prominences. Oftentimes the exact line of break is only to be inferred.

Examination by means of the Röntgen rays and the fluoroscope or by taking skiagraphs with the X-rays will clearly show the line of break and the relations of the fragments. To understand the displacement it is necessary to take views in two or more planes. It must be remembered that cartilage does not cause a shadow like bone; and that, therefore, the unossified epiphyseal cartilage will look like a line of fracture. The epiphyses do not all become united until about the twenty-fifth year. Examination with the X-rays is possible through the splints and other dressings, and, therefore, the surgeon can see the effects of his fracture dressing. It, however, requires some experience to understand the exact value of X-ray pictures.

FIG. 143.

Skiagraph, or x-ray photograph, of a fracture of the lower end of the radius with anterior displacement. Taken a few days after the injury and before reduction, showing the line of fracture and the callus about the bony lesion. (Author's case.)

The conduction of percussion vibrations from one end of a bone to the other will at times prove the non-existence of a line of complete fracture between the two points. Let the examiner grasp or place his fingers on one extremity of the bone, and then give the other several quick, sharp blows with his finger-tips or a small hammer. If the vibrations are distinctly conveyed along the bone, complete fracture is improbable. Perhaps the vibrations might be well transmitted if the fracture was impacted.

Prognosis.—Closed fractures, if uncomplicated, usually do well. Open fractures are more serious than closed fractures of a similar degree of bone injury, only when infected by putrefactive or pyogenic bacteria. Oblique fractures usually leave some shortening of the bone, though this may be very slight and scarcely noticeable. Fractures in children unite more rapidly than those in adults; and fractures of the upper more quickly than those of the lower extremity. Small bones become united sooner than large ones. Some permanent stiffness is not unusual after fractures involving a joint. Fractures will sometimes be followed by imperfect or bad results, notwithstanding the best surgical treatment.

It is a common mistake to suppose that when the bone becomes united the patient will at once have a normal limb. Stiffness of the articulations, a dry and rough skin, œdema and congestion, especially when the limb hangs down, and pain aggravated by changes in the weather are the most frequent sequelæ of fracture. Many months may pass before they all disappear. Sometimes one or more of these symptoms is permanent.

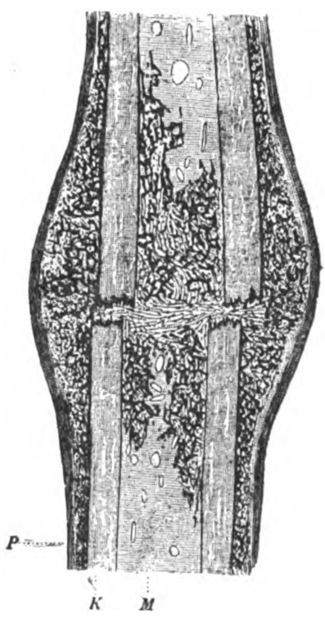
Stiffness, when not due to actual involvement of the articulation in the line of fracture, depends on the simultaneous occurrence of a sprain, hemorrhagic extravasation around or into the synovial sac, the entanglement of tendons in the ossifying callus, or retraction of the ligaments and peri-articular tissues during the period in which the joint was kept immovable by the fracture dressing. This joint stiffness subsequent to fractures is most marked and most persistent in old persons and those of a rheumatic diathesis.

Œdema results from pressure of the fragments or callus upon the deep veins or from phlebitis and coagulation secondary to the injury. The coagula formed in the inflamed veins give rise in very rare instances to embolism. Sudden lividity or pallor, dyspnœa, precordial pain and death occurring from three to six weeks after the receipt of fracture point to venous thrombosis and embolism. Less severe symptoms of the same character, followed by localized lung consolidation and cough, are due to detachment of a smaller embolus, and may terminate in recovery. If phlebitis is suspected, it is wise to keep the patient quiet and the limb at rest until absorption of the internal coagulum has occurred. Its fragmentary detachment from the walls of the vein is to be feared.

Cases of death after fracture have occurred from fat embolism. The crushed marrow furnishes free fat globules, which, taken up by the veins and lymphatics, produce embolic plugging of the lungs, kidneys, brain and other organs. The symptoms are similar to those of shock and of the venous embolism; but occur later than the former, and earlier than the latter. Not immediately after injury, as are symptoms of shock, but after the lapse of one or two days have symptoms attributed to fat embolism been observed. Death may occur very promptly from obstruction of the pulmonary circulation by these fat emboli; or it may be delayed for a week or ten days and be due to inflammation of the lungs, brain or kidneys, secondary to the embolic process. Some observers suggest that traumatic delirium and hypostatic pulmonary congestion after fracture may be the result of fat embolism. Experiments show that disastrous results are only liable to occur when very extensive fat embolism is present. The indication of treatment is to prevent the occurrence of fat embolism by keeping the crushed limb quiet and avoiding further laceration of the marrow. If amputation is demanded by the extent of the injury, it should be done promptly before much fat is absorbed.

Fractures may be complicated with, or followed by, dislocation, synovitis, gangrene, caries, necrosis, injuries to viscera, laceration of arteries, veins or nerves, and delirium. These circumstances greatly affect the prognosis. Whiskey drinkers and the aged seem especially liable to traumatic delirium after fractures.

FIG. 144.



Fracture three weeks old; periosteal and medullary callus partly ossified, partly cartilaginous; *P*, periosteum; *K*, bone; *M*, medulla. (TILLMANNS.)

Repair of Fractures.—As has been shown in the section on healing of wounds, repair of most soft parts results in a cicatricial tissue which is analogous to, but not identical with, the structure wounded. In bones, however, as in nerves, a much more perfect regeneration occurs. Indeed, the uniting bone, if examined sufficiently long after the time of fracture, has the microscropic structure of true bone.

Bones are repaired by the same general process as are other tissues. The cells of the periosteum and marrow and those lining the Haversian canals and the lacunæ of the bone multiply. By this proliferation is formed a mass of granulation tissue, which fills the spaces between the pieces of bone and sometimes infiltrates the parts around the bone. This new germinal material gradually becomes ossified, by the deposition of earthy salts at numerous points and the subsequent coalescence of these ossific centers. The time after fracture at which bony particles are first formed in the bond of union is probably two or three weeks, and ossification is accomplished in from four to eight weeks more. The transition from granulation tissue to bone is usually through the connective-tissue stage; though occasionally the granulation material, at least in some parts, becomes cartilage before it is transformed into bone. Some of the new bone, which is at first spongy in structure, becomes compact; some of it becomes more rarefied, and some is entirely absorbed; until, finally, if the fragments have been kept in correct apposition, the bone is so well restored to its normal condition that, even when the dried bone is sawn open, no line of fracture can with certainty be distinguished.

After the shaft of bone is fractured the periosteum, torn and stripped up from the bone though it may be, often forms a sort of ragged sheath around the seat of fracture. Within the limits of this imperfect periosteal sheath new tissue to unite the bone is principally deposited. The periosteum, the injured marrow, and the broken cylinder of compact bone furnish cellular elements, which, mingling with the blood clots and effused serum, form the reparative material. The periosteum is the most active bone forming agent.

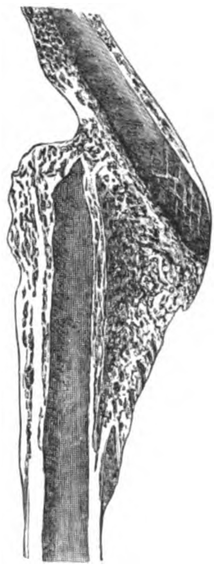
The ends of the bone, in preparation for the process of union by the new material, become riddled with holes as the result of a rarefying ostitis due to giant cells, called osteoclasts, in the Haversian canals and other spaces. Subsequently osteoblasts appear and the bone becomes dense again. The granulation tissue, filling up the space between the ends of the fragments and lying within the confines of the periosteum and other tissues surrounding the seat of fracture, has of course no firmness until ossification begins. During this early period of repair the connective tissue in the structures outside of the periosteum is also filled with proliferating cells, and thus steadies the broken bone by glueing the adjacent muscles, tendons and fascias together. The term callus has been applied to the new tissue about the seat of fracture, and is successively embryonic tissue, granulation tissue, connective tissue or cartilage, and bone. It has no very definite boundary, but gradually loses its identity in the surrounding structures.

The granulation tissue formed in man usually ossifies as connective tissue without showing any cartilaginous stage; but when fractures in man are not kept at rest the granulation tissue which lies between the fragments and around the bone may become cartilaginous before being ossified. In any event it requires weeks for the callus to gain the hardness of bone. Ossification through the cartilaginous stage is the common event in lower animals. During this period the marrow callus, which has occluded the medullary canal like a plug, and the external callus have held the fragments firmly in position. These depositions go by the name of provisional or temporary callus. As the interosseous callus—that is, the callus between the two cylinders of bone and which is called the permanent or definitive callus—becomes hard, the external callus, as well as the internal callus which lies in the medullary canal, is absorbed. Thus the surface of the bone is finally given its normal contour and the medullary canal, which had been completely filled up in both fragments for some distance from the break, is reëstablished.

Small pieces of comminuted bone may be imbedded in the callus and assist in increasing its bulk. These fragments, even if entirely denuded of periosteum, do not die, unless the fracture is infected with pyogenic germs or other septic organisms. Sometimes such pieces become necrotic and remain in the callus as foreign bodies, giving little trouble; though they are apt to cause prolonged irritation and interfere with union.

If there is much displacement, union is effected between the nearest lateral surfaces of the bone, the open medullary cavity is covered in by new osseous structure, and the displaced ends of the fragments become round and smooth as in a stump left after an amputation.

FIG. 145.



Fracture healed with deformity (callus luxurians). (TILLMANNS.)

Fractures of short and flat bones and of the ends of long bones are not accompanied by injury of marrow in a medullary canal. The process of union is, with the exceptions due to this fact, identical with that in the shaft of long bones. Unless there be much motion during the time of union, very little callus is found around the seat of fracture, and, therefore, the prominent oval mass felt in the form of fracture just described is absent. This absence is probably due to the fact that the periosteum in these locations is less easily stripped up by the injury. Less laceration and less displacement therefore occur. Union is favored, moreover, by the broad surfaces of spongy and vascular bone which are in contact and by the less liability to motion from involuntary muscular spasm. Hence less callus is formed; for a large amount of callus usually means difficult repair because of great displacement or much motion.

When the line of fracture invades the articular surface of a bone, the deposition of callus differs from that described in fractures not involving a joint. The bony surface covered with cartilage and bathed in synovial fluid does not usually furnish granulation tissue and callus, as do the parts of the bone which are covered with periosteum and surrounded by muscles and fascias. Hence when union occurs it is by callus furnished by the envelope of the extra-articular portion of the bone and by the fracture surfaces themselves. There is no ensheathing callus on the articular surface to aid in repairing the edge of the fracture there.

The articular cartilage which is split by the same line of fracture does not unite; or if so, the normal structure is replaced by cicatricial fibrous tissue only. As a result there is shown on the joint surface a groove in the cartilage or a line of uncovered bone to mark the position of the former fracture. Sometimes in injuries of this sort, as for example in fracture of the patella, where correct apposition has not been obtained, the bond of union is very imperfect, being mostly fibrous instead of osseous.

Open fractures, if aseptic, unite in a manner identical with that which has been described in closed fractures. If suppuration occurs, the repair is slower, because the warfare between the cells and the micro-organisms is followed by death of much new tissue as well as destruction of the surrounding bone, muscle and fascia. Violent inflammation of a mycotic kind is added, therefore, to the simple traumatic inflammation of aseptic fractures. Repair, therefore, is antagonized, and open fractures, unless they are early converted into closed fractures by primary healing of the soft parts next the bone, require a long time to unite. Superficial areas of bone or detached splinters may become necrotic and greatly retard healing of the soft parts and union of the main fragments. If much bone is lost by necrosis or by the shattering force causing fracture, bony union across the wide gap may be impossible, because the ossific influence is not great enough. Fibrous union then occurs.

Epiphyseal separations, or fractures, seem to unite as readily as true fractures. The union is said to be at once a bony one instead of by the normal epiphyseal cartilage as previously. The growth in length of the bone is retarded by this precocious union between the shaft and epiphysis. In some cases the epiphyseal cartilage at the other end of the bone may act in a compensatory manner by allowing an unusual lengthening there. Very little is known of the peculiarities of union in this form of injury.

Fractures of cartilages, such as the costal and laryngeal, which tend to ossify with advancing age, unites as bones by a material resembling callus.

Treatment.—The essential points in the treatment of fractures are the replacing of the displaced fragments as soon as possible, the prevention of recurrence of displacement, attention to the condition of the soft parts around the seat of fracture and due consideration of the patient's general health. The surgeon's object is to obtain prompt union with as little deformity as possible. At times, unfortunately, more or less deformity is unavoidable, because of the situation and direction of the line of fracture.

After receiving a fracture of the upper extremity the patient can usually walk to the place of treatment, if the injured limb is supported by his other hand or a sling. If the lower extremity is the seat of suspected fracture, walking should be prohibited and the patient carried by four men on a stretcher, settee or wide board. It is recommended by some writers that these carriers should not keep step, because keeping step has, it is said, a tendency to impart a painful swinging motion to the litter. Other writers advise them to step simultaneously. It matters little which precept is followed, if the litter is held steadily and given no sudden jars ; especially is this so, if the patient lies immobile and does not try to move his body and limbs so as to neutralize the vibratory movements of the stretcher. The patient must also be carried in severe fractures of the upper limbs if shock is great. A crude splint of board, twigs, straw, pasteboard, or any other material of sufficient rigidity to steady the fragments during transportation should be bound to the limb. This may be done outside the clothing. In fractures of the leg or thigh the opposite limb makes a good splint to which to bind temporarily the broken one. Hay, rags or small pillows may be placed between the limbs before they are tied together.

The bed for the permanent treatment of a patient with a fracture of a leg or thigh should preferably be a narrow one, so that the attendants can conveniently reach each side of his body. A firm mattress that will not sag down under the buttocks is necessary. One made of hair and laid upon slats is probably the best. The old fashioned sacking bottom for supporting the mattress is undesirable. Patients accustomed to sleeping upon feather beds may be very uncomfortable unless they have softer mattresses than hair. In such cases a thin feather bed may be used, if it is thoroughly supported by the framework beneath it. Good springs under a hair mattress are not objectionable, if they do not permit the upper surface of the mattress to become uneven. There is no necessity for a specially made fracture bed, if the bed pan and urinal are carefully and intelligently placed, when the contents of the rectum and bladder are to be voided. A large soup plate makes a serviceable bed pan. The sheet under the patient should be kept smooth; its edges may be tacked or tied to the sides of the bed. When a clean sheet is to be put under him it should first be folded or rolled up longitudinally for half its width. This doubled up portion is to be carefully pushed under the right side of the patient, while he is very slightly turned on his left side; then he is to be carefully turned on his back and slightly on his right side until a second person standing on the left side of the bed draws from under him the folded up edge of the sheet. Very little movement of the patient is made when this method is adopted.

During long confinements to bed the sacrum, heels and other points subjected to pressure should be washed freely with equal parts of alcohol and water, and every precaution taken to avoid the occurrence of bedsores. Air mattresses may be demanded on this account in cases of fracture of the spinal column, where the accompanying paralysis greatly increases the tendency to bedsores.

Replacing the fragments in their normal relation, technically called reduction or setting, should be attempted as soon as the patient has been conveyed to a convenient place. Early reduction—that is, reduction before the advent of inflammatory swelling—is nearly always demanded. It is less painful to the patient, and adjustment can thereby be more easily and accurately accomplished than if the necessary manipulations are delayed. Moreover, the subsequent inflammation and clonic muscular spasms will probably be less severe, if the sharp points of displaced bone are prevented by reduction from continually irritating and wounding the soft tissues. When the case has not been seen until severe inflammatory action has stiffened the muscles and greatly distended the fascias and integument by interstitial swelling, it may occasionally be proper to delay reduction until this condition has been relieved. Absolute rest of the part with the fragments in moderately good position should be adopted ; and accompanied, perhaps, by local antiphlogistic treatment and sometimes even by incision through the constricting skin or fascia. After the lapse of a few days accurate reduction may be effected.

When subcutaneous hemorrhage or inflammatory swelling endangers the safety of the limb by arresting circulation, as shown by coldness and numbness of the fingers or toes, free incisions should be made through the tense integument and deep fascia, to permit the fluids to drain away and thus relieve the pressure upon the vessels and nerves. Great stress is laid upon this measure, as threatening gangrene may often be averted by several deep incisions of two, three or four inches in length.

Reduction of displacement should be attempted even if the case is first seen several days or weeks after injury. More force will be required under such circumstances ; but of this more will be said under the discussion of treatment of Deformed or Vicious Union of Fractures.

Reduction is sometimes readily effected by merely relaxing the muscles tending to cause displacement, whereupon the fragments fall into place. At other times some additional pressure and manipulation with the fingers are necessary before the more or less numerous pieces of bone are pressed into correct apposition. In still other cases an extending force or traction must be applied to the limb on the distal side of the fracture, while counter-traction is exerted upon the other side of the seat of injury. The extension or traction should be steady, continuous and moderate, and exerted in the axis of the limb. No greater force than can be obtained by the firm grasp and strength of the surgeon or assistants should be applied to the reduction of a recent fracture. What is required is a firm, steady pull of moderate force that will tire out the contracted muscles. Anæsthesia is often desirable, as it relaxes spasm and prevents pain. The traction overcomes shortening due to overlapping of fragments, but if there is lateral and rotary displacement, coaptation with the fingers and rotation of the limb should be added to the extension. These combined manipulations will usually correct the deformity. When a portion of bone into which a muscle is inserted is broken off it is to be put and held in position by traction exerted against the muscle. Fractures of the olecranon and patella illustrate this point.

Sometimes difficulty is experienced in properly and completely reducing the fragments. This may be due to impaction, to a fragment being entangled in or thrust through muscles or fascias, to one fragment being locked behind another and held there by muscular tension, or to actual crushing and powdering of portions of spongy bone. Inability to obtain a firm hold on one fragment may also be a cause of imperfect reduction. If muscles or fascias prevent reduction, an incision should be made to enable the surgeon to properly adjust the fragments and prevent permanent deformity from this cause.

An incision of skin and muscles is not infrequently required in open fractures before reduction can be obtained and also to permit thorough disinfection of the wound cavity and to make provision for free drainage.

After reduction has been obtained the limb should be compared with the sound side and the test lines verified, to establish the correctness of the replacement. Swelling may make appearances deceptive. Great care in this respect is necessary in fractures near joints. Continuous traction by means of weights is often employed to overcome overlapping. It acts by gradually tiring out the displacing muscles, and thus effecting reduction. It is the usual method in fractures of the femur.

Closed fractures seldom require any lotions or other external medicinal applications. Lead water and laudanum and similar remedies, applied to the skin, can avail little in relieving inflammation of broken bones and torn muscle, and may, by macerating the skin, increase the tendency to the formation of blisters on the surface. Immobility and freedom from muscular spasm are therapeutic agents of far more value than external lotions. A rubber bag filled with cracked ice laid over the seat of fracture with some linen or muslin between it and the skin is unobjectionable and may ease pain.

After reduction has been satisfactorily accomplished, displacement may recur through the action of gravity, muscular contraction or restlessness of the patient. The surgeon must guard against such recurrence by applying some form of fracture dressing, which will retain the fragments in proper position. The best form of dressing will be that which corrects the tendency to displacement in the individual case, and, at the same time, steadies and immobilizes the limb. The special tendency to displacement varies in each case with the line and position of fracture, and should be recognized before the form of dressing is decided upon.

There are occasions in which no retention apparatus is needed, but these instances are rare. The confidence of the patient and greater safety against displacement are usually best obtained by adopting some mode of fracture dressing.

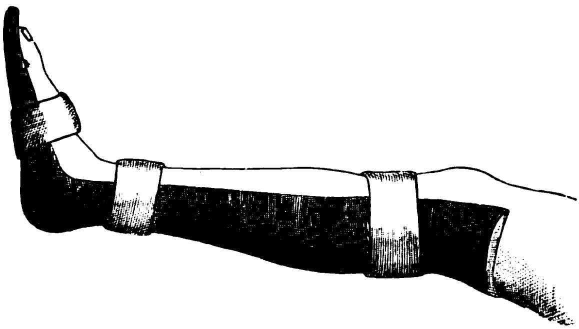
Fracture dressings may be grouped under three heads: (1) Those which give moderate continuous traction, or maintain extension which was applied when the fracture was first adjusted; (2) those which, by virtue of their rigidity or fixedness, resist retraction; (3) those which, by virtue of their inflexibility, prevent angular or lateral displacement by giving lateral support to the fracture. These forms may be combined in the treatment of a given fracture. The simplest apparatus is the best. The articles employed in dressing fractures are: roller bandages; padding, such as cotton or oakum; adhesive plaster; splints of any rigid material, such as wood, felt, pasteboard; cotton fabrics stiffened with gypsum, silicate of sodium, or starch; fracture boxes; and weights for making continuous traction. As a rule, no roller bandage should be applied to the limb under the splint, for the inelastic constriction thus made may lead to gangrene, if unexpected inflammatory swelling occur, and is, at any rate, of no service.

In dressing fractures of the shaft of bones, the nearest joint above and that below should, as a rule, be made immovable by the splint, because motion allowed at such articulations may cause displacement of the approximated fragments. Splints, if not moulded to the patient's person, should be padded with a thin layer of cotton so as to make equable and elastic pressure, and thus accurately conform to the contour of the limb. The splints after adjustment are to be held in place by spiral and reverse turns of a roller bandage, applied with sufficient firmness to maintain the apparatus in position, and thus make the limb rigid so that no motion can occur at the seat of fracture. The fingers or toes should usually be left uncovered that lividity, coolness or œdema, due to improper constriction, may be noticed. The turns of the bandage can be kept from slipping by painting a broad line of mucilage or silicate of sodium down the outside of the completed dressing, or by applying a narrow strip of adhesive plaster down its exterior so as to hold the folds of the bandage. Another method is to stitch the bandage to the covering of the splint.

Before applying the fracture apparatus, the skin should be washed with soap and water and shaved. In open fractures this is exceedingly important. Antiseptic lotions are to be used in these cases freely, to destroy any germs which may have gained access to the wound. Sublimate solution (1: 500 or 1: 1000) is probably the best; and can subsequently be washed out of the wound with sterile water. All recesses must be made aseptic, and drainage tubes used to drain all dangerous pockets. Incisions and counter-incisions are often demanded, and all devitalized parts should be trimmed away. In truth, the injury must be treated and dressed exactly as any other lacerated infected wound, and then have fracture appliances adjusted. Conformable splints of metal, felt or pasteboard, or moulded splints, such as will be described below, are far better than any form of carved wooden splint.

Moulded splints are a most desirable form. They are at first sufficiently soft to be accurately fitted to the inequalities of the limb, but subsequently become hard. Felt, guttapercha and pasteboard may be thus moulded after being made soft by heat or moisture. Strips of gauze or any woven fabric with wide meshes can be converted into excellent splints by saturating them with a watery mixture of gypsum, the so-called plaster of Paris. Ten to twelve of these pasty strips, one over the other, are applied to the limb while it is held in proper position. They soon become rigid by the setting or hardening of the gypsum. Lateral or anterior and posterior splints of any shape may thus be made and held in position by roller bandages. If it is preferred, the limb may be encased in sheets or bandages of gauze saturated with gypsum. This method is that used in making the so-called immovable dressings, which are often very valuable after the primary inflammation of injury has subsided. These hardened encasements, if made with silicate of sodium, glue or any material with elasticity, may be split open on one side, so that they can be sprung open, somewhat as a book, and thus become movable splints. They may be furnished with eyelets, and laced like a shoe when re-applied.

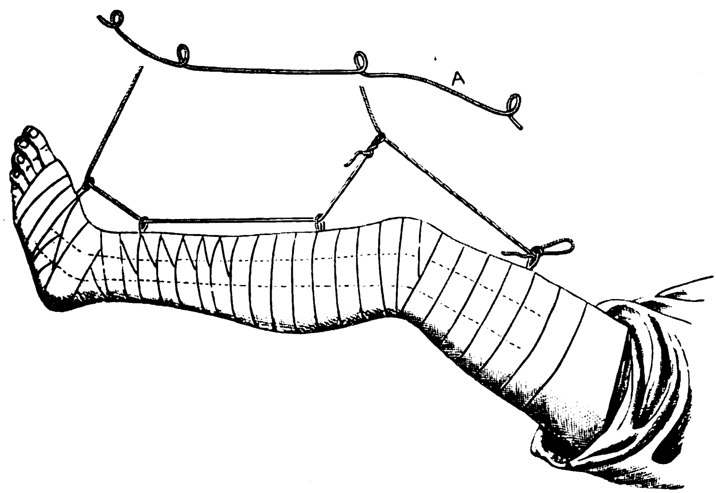
FIG. 146.



Posterior gypsum splint for fracture of the leg. (STIMSON.)

The gypsum powder for this purpose must be kept dry, for, if it absorbs moisture, it will not set. It may be mixed with enough water to make a paste of the consistence of cream, which is rubbed into the gauze at the time of dressing the fracture, or the dry powder may first be rubbed into the meshes of the gauze and the gauze strips

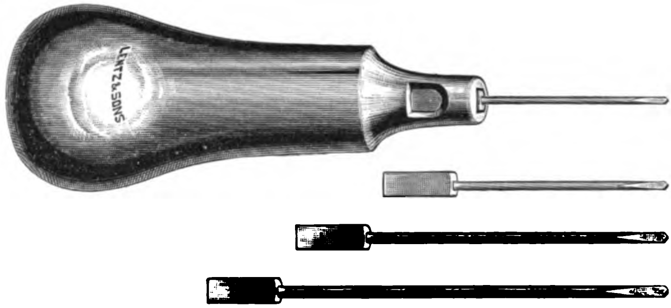
FIG. 147.



Anterior and posterior gypsum splints with wire rings applied for suspension in fracture of leg. (STIMSON.)

or bandages dipped into water as needed. If gypsum gauze is not used at once, it should be preserved in a dry place. The setting can be retarded by the addition of a little dissolved glue, of borax or cream of tartar to the water, and hastened by using hot water or adding salt. A little skill, in cutting out V-shaped pieces of the sheets of gauze and in overlapping the edges thus made when corners are to be turned, will enable the surgeon to make moulded splints to suit fractures in all regions. Such splints may be varnished to pre-

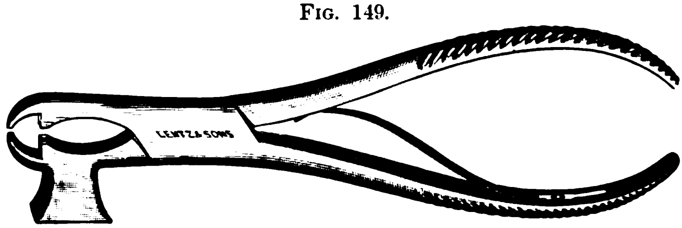
FIG. 148.



Author's fracture-nails with drill point and handle. The nails are easily started through the bone by means of the handle. They are then driven with a hammer.

vent absorption of fluids. In open fractures which have become infected, and are therefore suppurating, openings may be made in the splints, so that the wound may be dressed without displacing the

FIG. 149.

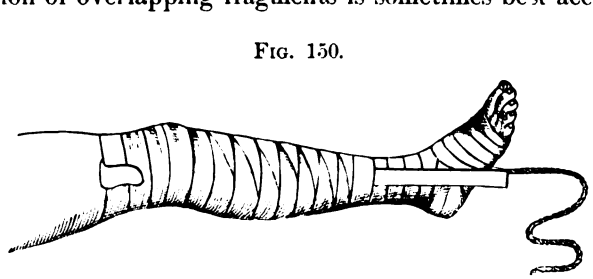


Author's hammer-forceps for driving and withdrawing fracture-nails.

fracture apparatus. Strips of metal to strengthen the dressings, or wire rings for suspension, may be incorporated within the layers.

Reduction of overlapping fragments is sometimes best accomplished

FIG. 150.



Adhesive plaster and foot-board applied for continuous extension.

by continuous traction by weights. The displacing muscles are thus tired out, and their tendency to either tonic or clonic spasm overcome. The cord carrying the weight passes over a pulley and is attached to the limb by strips of adhesive plaster. The tendency to lateral displacement is then obviated by coaptation splints at the seat of fracture. This method is most employed in fractures of the femur, but is at times useful elsewhere. Subcutaneous nailing of fractures with sterilized nails will sometimes be found an efficacious way of preventing recurrence of displacement. In other cases it may seem wiser to freely expose the seat of fracture by an incision and then nail or suture the bones in position. For bone suture, iron or silver wire or chromicized catgut is usually employed.

It is a safe plan to always remove the splints within twenty-four hours after the first dressing. Bad fractures should be visited within a few hours after the original dressing, lest unusual swelling may have occurred and rendered the dressing too tight. If, after the second dressing, no undesirable symptom has occurred and the limb feels comfortable, removal of the apparatus is not called for oftener than two or three times a week. Daily inspection of the patient should, however, be enforced for ten days or so, even if no change is made in the dressing. When the surgeon takes off the splints the limb should be held by an assistant, who should firmly grasp it above and below the fracture and allow no motion or displacement. After the skin has been washed with soap and water or with alcohol, the limb should be dried and carefully examined for abrasions or bedsores, due to pressure, and for any renewal of deformity. It should ever be recollected that absence of discomfort is not a token of absence of deformity.

If no untoward symptom occurs within two weeks, change of dressing once or twice a week is sufficiently often; but the possibility of angular displacement, even so late as four or five weeks, must be remembered. Loosening of bandages or sinking in the bed may cause lateral or rotary movement at the seat of fracture.

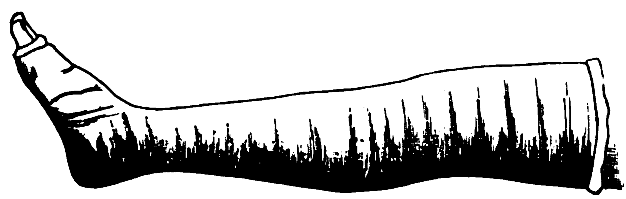
Massage of the muscles of the limb for a few minutes at each change of dressing is very beneficial. It hastens absorption of inflammatory exudate, prevents stiffness and atrophy of muscles and maintains a more normal condition of the circulation. The limb will be in much better condition when the splints are discarded, if massage has been employed during the time of treatment. Daily removal of dressings and moderate massage, if judiciously employed, will be thus beneficial. There is no objection to careful passive motion of the joints; provided that no strain is put upon the callus at the seat of fracture.

Retention apparatus may, as a rule, be discarded in uncomplicated fractures of the upper extremity at the end of from four to six weeks, and of the lower extremity at from six to eight weeks. The bones should be subjected to no muscular strain for two or three weeks subsequently. During this time, and often longer, slings or crutches are needed. The union becomes firm in children sooner than in adults.

Persistent pressure of the splint or bed upon any bony protuberance is liable to cause a localized chronic sloughing of the skin and subcutaneous cellular tissue, technically called a decubitus or bedsore. This result must be avoided by careful padding, frequent change of the points of pressure and bathing the cutaneous surface with water or alcohol. A patient can often change his posture in bed without detriment if a rope, attached to the ceiling over his head, is allowed to hang within reach. Bedsores often occur without any sensation of pain or burning. The surgeon must look for them and not be satisfied with a reply that there is no pain. If a dark spot is seen on the heel, elbow, sacrum or other prominence, a bedsore already exists. The slough must be detached before the sore will get well. Hence, moist antiseptic dressings should be applied for a time. The ulcer remaining after the detachment of the slough is to be treated by antiseptic dressings to prevent suppuration, and possibly by applications, such as chloral in solution or ointment (gr. x to ℥j), nitrate of silver and bismuth subnitrate.

The inflammatory symptoms at the seat of injury in closed fractures usually need no treatment. Correct apposition and prevention of motion are the essential factors. The blebs that sometimes form on the surface may be let alone, unless they are large; then they may be punctured with a sterile needle to allow the bloody or straw colored serum to escape. Wrapping the limb in cloths saturated with lead water and laudanum, before applying the splints, is improper. Such measures do no good, and the dressings, acting as poultices, may cause blebs to arise which otherwise would not have appeared. Muscular spasm about fractures is best combated by morphia given by the mouth or hypodermically, traction apparatus or section of the tendons of the displacing muscles. Tenotomy is not usually demanded. It is valu-

FIG. 151.

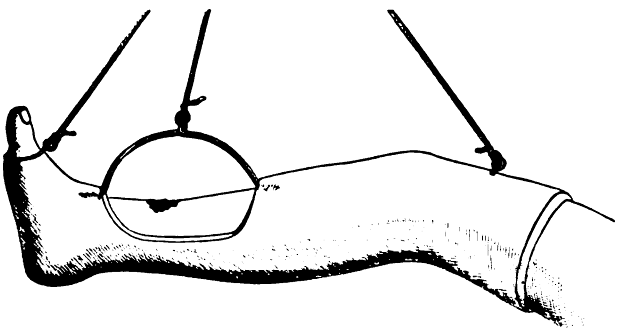


Encasement with gypsum dressing for fracture of leg. (STIMSON.)

able, however, when the calf muscles cause displacement of the fragments in fractures of the leg. Retention of urine requiring catheterization is not infrequent after fracture of the thigh. Abscesses, traumatic fever, delirium, tetanus, erysipelas and other complications must be treated on general principles. Gangrene due to arterial rupture or thrombosis simultaneous with the fracture occurs at times; it may also follow constrictive pressure from excessive inflammatory swelling beneath the skin and fascia. When the last condition is feared, free cutaneous and fascial incisions, as previously described, will relieve the tension by allowing gaping, and thus often avert the calamity. Injudicious bandaging has often caused gangrene. In gangrene from any of these causes it is usually well to wait for the line of demarcation before amputating. If, however, the destructive process is rapidly spreading, immediate amputation at a high point may be judicious.

Immovable or fixed dressings, which, however, allow no inspection of the fractures, are often used when the fracture has been reduced and there is no fear of swelling. They should, as a rule, not be employed in the early days of a fracture. It is much safer to wait until inflammatory swelling has subsided. The end of the first or second week is usually early enough for their employment. Encasements are made from bandages or cloths saturated with gypsum, silicate of sodium or glue, as has been mentioned above in describing moulded splints. Before the immovable apparatus is applied the limb should be smoothly enveloped in soft flannel or a layer of cotton wadding. Then the roller bandage soaked in gypsum should be applied circularly to the limb, without being drawn at all tightly. Silicate of sodium solution may be used instead of gypsum. It dries more slowly than gypsum, but makes a more elastic encasement, which, when split, can rather more readily be pulled apart, so that the limb may be lifted out and examined. Such a split encasement then becomes a movable splint. As the limb shrinks because of absorption of inflammatory deposits, the splint will become too loose and allow displacement of the fracture. It should then be removed and replaced by a new one, unless it is elastic enough to be opened, padded and reapplied. Eyelets and laces may be inserted for the purpose of regulat-

FIG. 152.

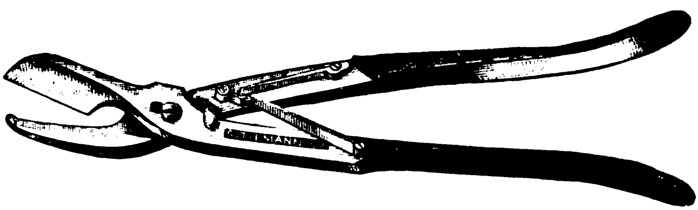


Suspended and fenestrated gypsum encasement for fracture of leg.

ing the degree of constriction. The seat of fracture or wound may be left open to inspection by an opening in the encasement. Powerful shears, a saw or a pocket-knife are the best instruments for dividing fixed dressings which are to be removed. Gypsum encasements may be softened before using the knife by applying muriatic acid along the line of proposed division.

Fractures running into joints may be followed by ankylosis, because of imperfect coaptation of the fragments; and sometimes, though more rarely, from the arthritis that arises secondarily to the bone injury. The joints adjacent to a fracture are usually kept immovable by the splints in order to prevent motion at the point of fracture. Hence, when the apparatus is finally removed these joints often show considerable stiffness, due to disuse and to the inflammatory exudate among the muscles and fascias. Passive motion of these joints and massage of the muscles of the limb by the surgeon at the time of rearranging splints during the treatment of the broken bone will, to a great extent, prevent this stiffness. Care must be taken not to displace the fragments, which must be supported during the slight movements of the joints. If arthritis has occurred as a complication, absolute rest is indicated and such passive motion will do harm. If no arthritis has occurred, the stiffness due to disuse can readily be overcome by passive motion at a later date. In cases of doubt as to the propriety of passive movements, they had better be omitted. When passive motion and massage can be properly employed, they are a valuable aid in the rapid restoration of function. Later the patient can supplement the passive motion employed by the surgeon by rubbing and moving the limb with his own hands or pulling against a resisting force. Passive motion which is followed by pain and tenderness of the joint is deleterious, for it means that arthritis exists.

FIG. 153.



Shears for cutting through gypsum dressing.

When a fracture is complicated by dislocation of a neighboring joint, the surgeon should endeavor to reduce the dislocation at once. The necessary leverage may be obtained by applying such temporary splints as will steady the broken bone. If success does not attend the efforts at reduction, the injured bone should be exposed by a free incision, the dilocated joint be restored to its normal relations and the wound closed. The fracture is then to be managed as a fracture accompanied by an aseptic wound.

Treatment of Open Fractures.—The treatment of open fractures —that is, of fractures complicated by a wound leading to the seat of fracture which thus communicates with the air—varies with the character of the injury. The indications are to replace and retain the fragments in apposition and obtain rapid healing of the wound. The last indication is usually, though not always, possible of fulfillment if the wound is promptly made aseptic and kept so. When a portion of the bone protrudes through the skin, manipulation, relaxation of muscles, enlargement of the wound, tenotomy and resection of the ends of the fragments may be practised to accomplish replacement. When the fragments constantly slip out of apposition, resort should be had to wiring them together by means of holes drilled obliquely or transversely through the extremities, or to fixing them by driving sterilized steel nails into the osseous tissue. Chromicized or formaldehyde catgut may be used instead of the silver or iron wire. Loose splinters and all foreign bodies should be picked out of the wounds. Portions of bone still maintaining periosteal attachments should be permitted to remain. Fractures complicated with wounds should be thoroughly washed out by antiseptic lotions (corrosive sublimate 1:500 or 1:1000) after the surrounding parts have been scrubbed with soap and water under anæsthesia, and only closed after provision for free drainage has been made. All dirt and foreign material must be removed. When washing out an open fracture with the antiseptic solution, provision should be made for the outflow of the blood stained fluid, so as not to leave poisonous solutions in the cavity or to fail to get rid of the septic bacteria. Counter-openings or enlargement of the original wound may be demanded for this object. Intramuscular or subcutaneous lacerations often extend up and down the limb a long distance from the seat of fracture. These may require long incisions in order that efficient disinfection may be accomplished. After thorough irrigation, the wound is to be dressed on general principles with a voluminous sterile gauze dressing. Ordinary fracture apparatus, to maintain proper position of the fragments, must next be applied outside of the gauze dressings. If the attempt to get primary union fail, the first indication of suppuration is to be followed by immediate opening, sterilization and drainage of the wound.

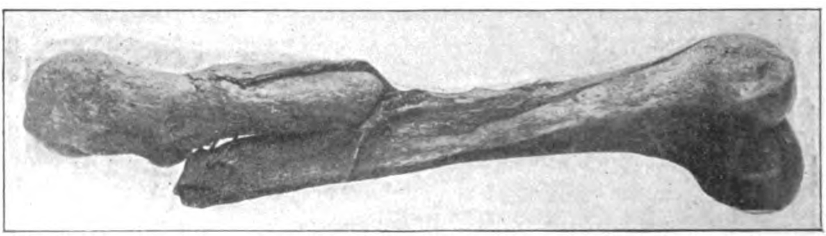
When a simple fracture shows signs of becoming open because of cutaneous sloughing, an effort should be made to prevent as long as possible the separation of the eschar by keeping it aseptic.

Some open fractures demand immediate amputation, because the injury is so severe that the sloughing sure to follow will probably prove fatal. Antiseptic methods have enabled surgeons to save many limbs the seat of open fractures, that under previous methods of treatment would have required immediate amputation to save life. Almost any open fracture in which the tissues are not absolutely devitalized can be successfully treated, if made perfectly sterile and kept so. In the upper extremity conservative surgery is attended with less risk to life than in the lower limb. Moreover, the fact that artificial legs are very serviceable, while artificial hands and arms are practically useless, argues something in favor of not taking too much risk by trying to preserve a doubtful leg. Open fractures involving large joints may often be treated successfully by antiseptic methods or by primary or secondary excision of the joint instead of amputation. Gunshot fractures involving joints are an exceedingly serious form of open fractures. If in open fractures running into joints the limb is to be saved, antiseptic cleansing, free drainage, antiseptic irrigation, and in extensive fracturing, excision must be the resorts of the surgeon. Excision may sometimes be delayed and performed as a secondary operation when it can be better determined how much bone must be sacrificed. Rigid and thorough provision for escape of all wound fluids must be insisted upon in all these injuries.

Ununited Fracture or Pseudarthrosis.

Pathology.—It is occasionally found that some degree of mobility and pain on motion persist after the lapse of what ordinarily would be sufficient time to cause consolidation of a given fracture. Such instances are denominated cases of delayed union. If successive weeks or months pass without union occurring at the seat of fracture, the condition is ununited fracture, false joint or pseudarthrosis. Delayed union is usually the result of deteriorated general health, while false joint in almost all instances depends upon some local condition pertaining to the fragments themselves. Many cases of delayed union finally terminate in complete consolidation without any special treatment beyond building up the patient's health. False joints, however, whether sequences of delayed union or cases showing from the beginning no tendency to union, persist and require either the adaptation of apparatus to supply the normal rigidity of the limb or active and judicious surgical treatment. Efficient apparatus is more easily obtained for non-union in the upper than in the lower limb, because of the weight sustaining function of the latter.

FIG. 154.



Ununited fracture of the femur with great overlapping of the fragments. (DENNIS.)

It is not customary to apply the term ununited fracture to the fibrous union that frequently occurs when short, spongy bones and the spongy ends of long bones are broken, or when prominences for muscular attachment are torn loose. These fractures would probably unite by ossific deposition, as other fractures do, if correct apposition was obtained and maintained. They actually, therefore, are cases of ununited fracture, though not called so. The bond of union holding the fragments together after healed fracture occasionally undergoes softening and absorption during the progress of phlegmonous inflammation of the limb, scurvy or other grave disorder. It is manifestly improper to apply the term ununited fracture to this condition when it occurs subsequent to complete union of the osseous lesion. Atrophy of the bone itself sometimes occurs after fracture.

Ununited fracture is a comparatively rare condition. The cases may be divided into three classes: 1, those in which there is no bond whatever; 2, those in which there is a more or less successful attempt at union by means of bands of fibrous tissue and nodules of bone; 3, those in which a crude joint is formed, as exhibited by cartilaginous material on the apposing surfaces of bone, synovial fluid and an imperfect capsule. The first and third varieties are unusual. The second form is that usually found when ununited fractures are dissected. The length and disposition of the fibrous bands vary in accordance with the relation of the fragments. There may be a mass of callus partially ossified and little fibrous tissue; or little callus with bands of fibrous tissue uniting the fragments somewhat like interosseous ligaments. This kind of non-union gives a flail-like limb, if the bands of fibrous tissue are long. It is more movable than the form described as having a joint-like structure.

Causes.—Syphilis, pregnancy, advanced age, acute diseases and other sources of physical deterioration and malnutrition have been described as causes of ununited fracture. They apparently, however, have little influence in giving rise to non-union, though delayed union may perhaps be due to them. Non-union is nearly always the result of a local cause, and this local cause is usually mechanical. The most frequent agencies are: (1) unfavorable relation of parts, such as great separation of the fractured surfaces by reason of displacement, actual loss of substance, or necrosis; (2) defective treatment, by which immobility of the fragments is not secured; (3) portions of fascia or muscle, and bullets or other foreign bodies lying between the fragments; malignant and other growths in the same location. Destruction of the nerves coming from the trophic centers, in the lower part of the spinal cord, or of the centers themselves has been with apparent reason assigned as a cause of ununited fracture or pseudarthrosis. Perhaps rupture of the nutrient artery at the time of the fracture may be a cause of ununited fracture. It is also stated that softening or absorption of callus may follow the too early use of a broken limb. This occurrence is doubtless the result of motion at the seat of a partially ossified union and comes under the head of defective treatment mentioned above.

Diagnosis.—The diagnosis of ununited fracture is made by preternatural, and, in most cases, painless mobility existing long after the time for consolidation has passed. Near a joint such mobility may simulate the normal articular movement; or, a joint, with relaxed ligaments, may simulate ununited fracture. The character of the defective union is often obscure. If it is simply delayed, an elastic mass of callus, which is the seat of pain on strong passive motion, will probably be discerned by palpation. If a crude joint has been developed, no callus and no pain will be found; nor will the flail-like mobility of long fibrous attachment exist. Careful palpation and puncture with long needles will at times determine the position and shape of the fragments. The employment of the Röntgen rays and the fluoroscope or the use of these rays to make skiagraphs will be of service in the diagnosis of some cases.

Treatment.—The treatment of delayed union consists in friction of the limb, change of air, nourishing diet and the administration of alkaline phosphates and carbonates and of tonics. A few additional weeks under good hygienic circumstances is all that is usually demanded.

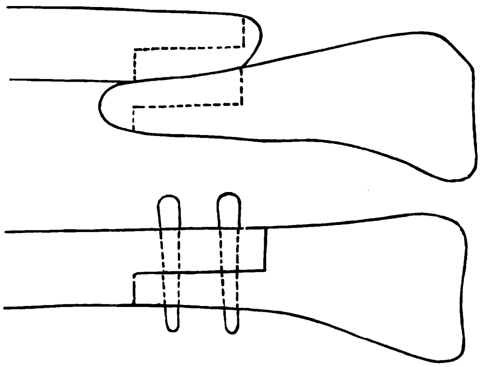
Ununited fractures, whether fibrous or articular, demand much more active measures. Rectification of any displacement that seems to interfere with union should be accomplished, after which the immovable gypsum dressing should be applied and worn for a month. If any increase of consolidation is observed, this dressing should be continued for several months, during which time the patient may go about on crutches if it is the lower limb which is the seat of injury. If the part becomes painful from excoriation, the encasement may be split and laced or removed, and a new one applied. During this period the hygienic measures noted above for delayed union should be adopted. The application of the descending constant electric current has been recommended, but is probably valueless.

Failure to accomplish anything by these plans necessitates the adoption of operative measures, unless mere support, by apparatus to give rigidity, is acceptable to the patient and surgeon.

The operative plans aim either at setting up inflammatory action at the seat of non-union, and thus stimulating functional activity; or, at converting the old ununited fracture into a recent one with freshly sawed surfaces in apposition. Violent bending and rotation, such as will tear apart the fibrous connections and cause the ends of the fragments to be rubbed upon each other, will often be followed by consolidation. These manipulations may be repeated daily until tenderness and swelling follow. Upon the appearance of these symptoms the limb should be immobilized in splints and treated as a recent fracture. As a rule, the fibrous union can at one sitting be torn up and the ends rubbed with sufficient degree of force to cause the advent of tenderness on the following day. The bones may be bent at right angles and extensively rotated and extended without endangering the safety of vessels or other tissues. To be of service the manipulation must be thoroughly done; usually under anæsthesia. When this operation does not succeed in causing deposition of callus and consequent union, subcutaneous drilling of the fragments may be tried. A bone drill is introduced through a small puncture in the skin and the ends of the fragments perforated in various directions. Afterward retentive apparatus is applied. Ostitis is the result of this treatment, and may be followed by union. A similar productive ostitis has been induced by driving an ivory peg through or into each fragment, in which a hole has been previously made by means of a drill. The fibrous bands should previously be ruptured by passive motion. The pegs, which do not pin the bones together, are withdrawn in a few days when pain is felt in the osseous tissue. A better plan, when practicable, is to bore holes into the fragments and pin them together by means of nails, metal screws, or pegs of ivory or bone. These may be cut or broken off close to the surface of the bone, and the tissue allowed to heal over them. The ivory and bone pegs will become absorbed, the steel screws encysted. If the surgeon prefers, the screws or pegs may be allowed to project from the wounds of entrance and be withdrawn in two or three weeks, when consolidation is partly accomplished.

The most radical operation for ununited fracture is resection of the rounded ends of bone. It makes an open fracture, but it is often the only method that will lead to a cure. This is especially so in cases where the non-union has caused the formation of a joint-like structure, and where the failure of union is due to dead bone or portions of muscle between the ends of the fragments. A longitudinal incision is made, the ends of bone turned out and sawed off after saving as much as possible of the periosteum, the limb put up in splints, and the wound treated antiseptically as in open fractures. The chisel, bone cutters or saw may be used to remove the pieces of bone. Sometimes the ends may with advantage be fastened together by wire, sterilized bone pegs, screws, nails, bone ferules or a metal plate held in position by several screws. The plate may be removed some weeks or months after union has occurred. The pegs, screws or nails may be cut off short and left in the wound, or be taken out in about three weeks. As little as possible of the bone should be sacrificed, only enough to give a broad, fresh surface of contact. Sometimes shoulders are cut so that the fragments may be interlocked or mortised together. Transplantation into the gap of small portions of bone from the human subject or from lower animals has been practised with apparent success. Decalcified bone chips might perhaps be used, if sterilized. It may happen that the excision of the ends of the fragments with pegging or wiring them together will, if done antiseptically, produce so little irritation that there is not enough productive inflammation to cause union. When this is feared, it is best to leave the wound in the soft parts open and plug it with antiseptic gauze, so that more irritation will be induced and union occur only by second intention.

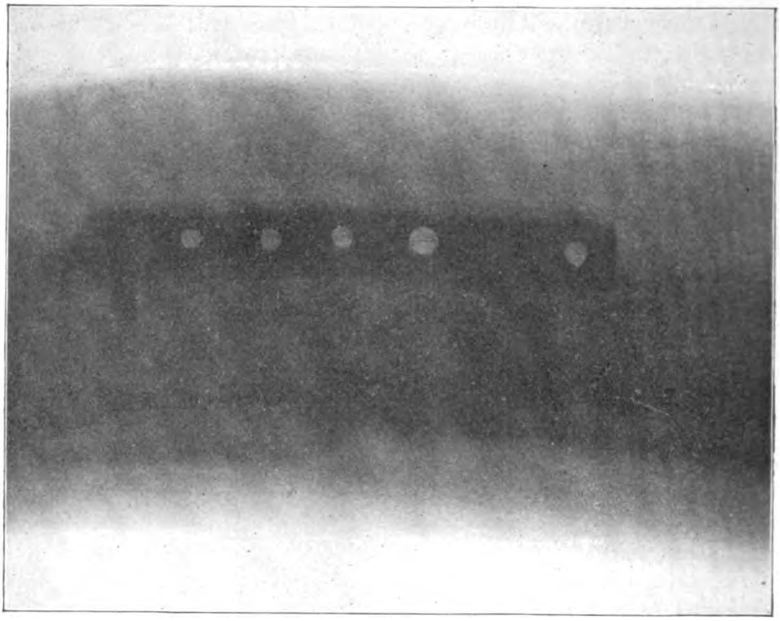
FIG. 155.



Volkmann's operation for pseudarthrosis.

Perhaps continuous passive congestion of the bone ends and the surrounding soft parts, induced by the moderately firm application of

FIG. 156.



Skiagraph of Dr. L. W. Steinbach's case of ununited fracture treated by metal plates.

a rubber bandage on the proximal side of the limb, might induce the deposition of bony material. I have tried this, but the result was not conclusive.

Deformed or Vicious Union of Fractures.

Pathology.—Absence of proper treatment in cases of fracture often gives rise to deformed union, because callus will be furnished and consolidation of the bony structures usually occurs, even when the fragments have not been placed in correct apposition. Great disability may thus result, especially in the lower limb. Angular deformity or overlapping will cause shortening; the presence of an abnormal projection near a joint may interfere with flexion and other articular movements. Change in the long axis of the fragments and rotation may cause the weight of the body to throw unusual strain on the lateral ligaments of the knee and ankle, and produce secondary deformity in these situations. Vicious union may also give trouble by causing painful pressure upon nerves or by inducing ulceration of the skin over projecting portions of bone. In the forearm pronation and supination may be obstructed by bridges or masses of callus attached to the radius and ulna. Deformed union sometimes allows muscles and tendons to become entangled in the callus, and thus, if not remedied at an early day, gives rise to permanent impairment of muscular action.

Treatment.—There are two methods of treatment: subcutaneous refracture, and division of the deformed union. These operations are practically devoid of danger, because they merely create fractures, which unite promptly; and there is naturally much less disturbance of the soft parts than in similar fractures of accidental origin. Hence little reaction follows. Experience shows that refracture or rupture can be done as late as six and twelve months after consolidation has occurred, and that with proper precautions the bone need never be broken at other than the seat of original injury. Gradual bending and attempts to soften the callus by applications or medication are a useless waste of time.

Angular deformity is the variety that most frequently demands correction. Fortunately it is also the most amenable to improvement. Refracture of malunion a few weeks old can usually be accomplished by seizing the limb firmly with the hands and forcibly bending the bone at the seat of the old fracture. The bending is generally made in such a way as to attempt at once straightening the bone. Sometimes it is better to bend first in the direction of the flexion, as in done in breaking up an ankylosed knee. It may be necessary to place a fulcrum, such as the operator's knee or a block of wood, against the convex surface of the angular deformity. Another method is to have the limb projecting over the edge of the table and steadied upon the table by an assistant, while the operator takes the distal end and suddenly throws his weight upon it. A sudden force is much more effectual than gradual bending, which will be found unavailable in all but recent cases. It is often well to bind a straight splint to the limb below the seat of proposed refracture and another above it, but neither of them should overlap the mass of callus. These splints prevent motion and strain of the joints, give the operator more leverage and avoid the remote possibility of fracturing at any other than the desired point.

When the deformity depends upon lateral application of the two bony cylinders, rupture must be attempted by flexion across the bond of union, combined with rotation in the axis of the limb and strong traction and counter-traction. These cases are not as amenable to treatment as angular malunion.

Osteotomy of the deformed union should be employed when correction by refracture is impossible. An incision in the soft parts is made, and through this a small chisel or saw is introduced. The callus is then divided, the deformity corrected and dressings applied as in open fractures. If simple division of the bony tissue will not permit adjustment or if the soft tissues of the concavity are very tense, a wedge shaped piece of bone with its base at the convex surface may be excised.

Projecting spurs of bone, acting deleteriously because of pressure or their position near joints, may be removed with the saw or cutting forceps, very much as an exostosis, and usually with as little risk. The operative treatment of malunion in the forearm interfering with pronation and supination is surrounded with a good deal of difficulty. In some cases, division or excision of callus is justifiable.

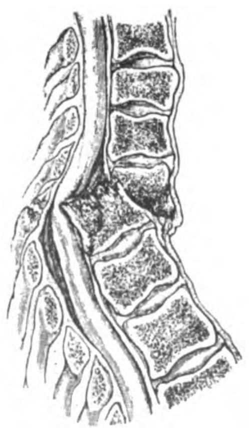
SPECIAL FRACTURES.

Fractures of the Vertebræ.

Fractures of the vertebral column derive their chief importance from the damage to spinal cord and nerve trunks, which so often accompanies them. The spine requires solidity and flexibility in order to give support and movement to the head, trunk and limbs; but its protective function, as regards the spinal cord, is even more essential to life and health.

The vertebral column quite frequently sustains fracture from an indirect violence which tends to produce over-extension or over-flexion of its normal curvatures. For example, a man falling from a height on his head or buttocks or being crushed under a weight falling from above, upon his head or shoulders, sustains a fracture of the spine, because the limit of flexion or extension has been exceeded and the bony segments are crushed or lacerated by the force. The fracture in such instances usually occurs where a movable portion of the column joins a more rigid portion, because here the sudden check to movement occurs. Hence, clinical experience shows spinal fractures from this form of injury to be more frequent near the dorso-lumbar junction and in the vicinity of the fifth and sixth cervical vertebræ.

FIG. 157.



Fracture of the fourth and fifth dorsal vertebræ with marked compression of the spinal cord caused by a fall from a great height.

Pathology.—The bodies of the vertebræ seem to suffer from fracturing forces oftener in the lower than the upper region; while the arches are more frequently broken in the neck than elsewhere. Fracture of the spinous process occurs most often in the dorsal region. The lines of fracture and the number of vertebræ involved depend upon the direction and degree of the force. Dislocation often accompanies the fracture. Indeed, the two conditions are frequently indistinguishable except by post-mortem examination.

Contusion, compression and laceration of the spinal cord may be caused by displacement of the fragments. It requires considerable displacement to pinch the cord, for the canal is much wider than the spinal cord and its membranes. As the cord ends at the level of the first or second lumbar vertebra, fracture below this point can only compress the leash of nerve roots and branches called the cauda equina, and the symptoms will be less marked than if the cord was injured. Hemorrhage from the venous plexuses between the bony wall and the dura mater may be a result of the fracture. Such hemorrhage and inflammatory products may exert pressure on the nervous structures. Extravasations of blood into the cellular tissue in front of and around the spinal column often occur, and after a time may appear upon the surface of the face, chin, neck and other regions.

Symptoms.—There is often in vertebral fractures no noticeable deformity, preternatural mobility or crepitation. The diagnosis must then depend upon the rational symptoms, which are, for the most part, referable to lesion, either primary or secondary, of the spinal marrow. The palsy of muscles, the areas of insensibility and the absence or accentuation of the reflexes will point to the character and the situation of the concomitant spinal lesion. Depression may sometimes be discovered over a fractured spinous process or vertebral arch, or an angular prominence may be perceptible posteriorly after crushing fractures of one or more vertebral bodies. Unusual mobility may be observed at times, especially in fractures of the cervical region, and occasionally movable regions may become more or less immobile, because of spasmodic contraction of the muscles about the fracture or because of interlocking of the fragments. Crepitation may be present, absent, or discernible only by the patient.

In spinal fractures intelligence is unimpaired, except, perhaps, during the stage of shock. Paralysis of the parts supplied by the nerve branches, leaving the cord at or below the seat of injury, is a common symptom. In locating a fracture by this symptom it must be recollected that the nerve roots and branches run obliquely downward within the vertebral canal, and do not escape at the inter-vertebral openings corresponding to their points of origin from the medulla. The paralysis is usually both motor and sensory and is partial or complete, according to the character of lesion in the cord. Complete transverse lesions destroying the functions of the cord give complete motor palsy below the level of the injury, total anæsthesia below the level of the injured spinal nerve and complete abolition of the knee-jerk and deep reflexes. If the transverse lesion is partial, the palsy of motion and sensation will be incomplete. When the cord sustains damage on one side only, hemiplegia of the same side occurs; when the injury is bilateral, paraplegia takes place; when nerve roots only are involved, the palsy is a local one. Pricking the surface with the point of a pin is an easy method of determining the paralyzed area, and of estimating its increase, as the cord becomes involved in secondary degenerative processes extending upwards or its diminution as the pathological condition of the cords improves. The lower limbs alone will be motionless, if the fracture is below the origin of the brachial plexus. Otherwise the arms will be paralyzed also. There is usually no reflex contraction upon pricking or pinching the paralyzed limbs, and electrical contractility is soon lost. If the paralysis is incomplete, hot and cold sensations may be distinguished. Sometimes cutaneous hyperæsthesia exists. Darting pains may be felt in the limbs when the partially paralyzed extremities are moved, though spinal pressure elicits no such symptoms. The occurrence of such pains is under some circumstances a sign of returning innervation, and, therefore, a symptom of beginning improvement. Tonic or clonic spasms of the muscles are occasionally observed, and may be excited by manipulation, drafts of cold air and similar irritants. The paralysis may not be present immediately after injury, but may supervene upon movement causing displacement, or arise from an intraspinal hemorrhage or the development of inflammation of the cord or its membranes. The superficial branches of nerves coming from the medulla above the lesion may supply the integument for a considerable distance below the injury, and thus deceive the surgeon as to the location of the fracture.

Tympanitic distention of the abdomen takes place. In fracture of the upper regions the respiratory distress due to paralysis of the abdominal and other muscles of respiration is increased by this tympanitic distention, which prevents full descent of the diaphragm. Bedsores appear, often within two or three days, because the insensitive and motionless limbs do not change the points of pressure. The probable occurrence of bedsores is increased by the difficulty of keeping the sheets free from urine and feces, which are evacuated unconsciously.

Persistent vomiting and marked elevation of temperature of the palsied region have been observed in fractures of the upper part of the spine.

The sphincters of the rectum and bladder are controlled by centers in the portion of the cord contained in the third, fourth and fifth sacral vertebræ; hence severe cord injury in this region gives rectal and bladder incontinence. The finger introduced into the rectum will find a relaxed anus, if the sphincter muscle is palsied; and the feces will escape as soon as they descend from the sigmoid flexure into the rectum. The relaxation of the sphincter of the bladder is not permanent in these spinal injuries, but the dribbling occurs whenever a few ounces of urine have accumulated in the bladder. Urinary retention is apt to occur when the lesion is higher up in the cord.

Priapism, more or less marked, is a common accompaniment of spinal fracture. It seems to diminish in frequency as the injury occurs lower in the vertebral column. Seminal emissions sometimes take place. Introduction of the catheter to relieve the distended bladder, though not felt by the patient, may increase the erection or cause a partial erection if none was previously present. Alkaline fermentation and cystitis are very prone to occur. Catheters used to relieve retention should be sterilized with great care.

Fractures of the atlas and axis are very dangerous because they are apt to involve the integrity of the medulla oblongata, with its numerous nerve centers, and are above the roots of the phrenic nerves which, going to the diaphragm, are the chief respiratory nerves. If cord injury occurs and death is not immediate, the paralysis will almost certainly involve the trunk, arms, and legs. Fractures below the axis and not lower than the second dorsal vertebra are of unfavorable prognosis, because this region includes the roots of origin of the phrenic nerves and brachial plexuses. The phrenic nerves emerge between the third and fourth cervical vertebræ, coming from the fourth cervical pair alone or having accessory roots from the third and fifth cervical nerves. The brachial plexuses are derived from the fifth, sixth, seventh and eighth cervical and first dorsal nerves. Hence injury at, or no higher than, the fourth cervical vertebra will involve the innervation of the arms, but will allow the functions of the phrenic nerves to go on unless intraspinal hemorrhage or inflammation extends above the level of the fracture. Lesion of the cord above the fourth,

FIG. 158.

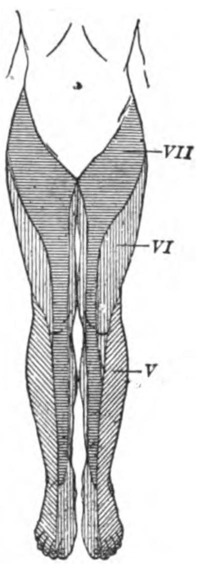
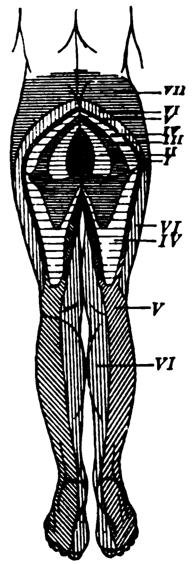


FIG. 159.



Areas of anæsthesia at various levels of the spinal cord, from sacral V to lumbar II; *I*, sacral V; *II*, sacral IV; *III*, sacral III; *IV*, sacral I; *V*, lumbar V; *VI*, lumbar III; *VII*, lumbar II. (STARR.)

sufficient to induce paralysis, will probably involve the phrenics and cause death promptly by respiratory failure due to paralysis of the diaphragm. When the other muscles of respiration, but not the diaphragm, are paralyzed, the character of breathing is peculiar. Inspiration occurs from diaphragmatic action alone and expiration from the abdominal walls and viscera pressing the diaphragm up. Expiration is consequently passive and feeble; hence the patient is unable to talk, cough or sneeze forcibly and the lungs become clogged with mucus. Change of posture, by changing the pressure, may alter the complexus of symptoms.

The study of the localizing symptoms will be of much service in fixing the site of a fracture causing compression, inflammation or secondary degeneration of the cord. The following table from Keen will be very serviceable :

Localization of the Functions of the Segments of the Spinal Cord.

Segment.	Muscles.	Reflex.	Sensation.
Second and third cervical.	Sterno-mastoid. Trapezius. Scaleni and neck. Diaphragm.	Hypochondrium (?) (third to fourth cervical). Sudden inspiration produced by sudden pressure beneath the lower border of ribs.	Back of neck and of head to vertex. (Occipitalis major, occipitalis minor, auricularis magnus, superficialis colli, and supraclavicular.)
Fourth cervical.	Diaphragm. Deltoid. Biceps. Coraco-brachialis. Supinator longus. Rhomboid. Supra- and infraspinatus.	Pupillary (fourth cervical to second dorsal). Dilatation of the pupil produced by irritation of neck.	Neck. Shoulder, anterior surface. Outer arm. (Supraclavicular, circumflex, musculo-cutaneous or external cutaneous).
Fifth cervical.	Deltoid. Biceps. Coraco-brachialis. Brachialis anticus. Supinator longus. Supinator brevis. Deep muscles of shoulder blade. Rhomboid. Teres minor. Pectoralis (clavicular part). Serratus magnus.	Scapular (fifth cervical to first dorsal). Irritation of skin over the scapula produces contraction of scapular muscles. Supinator longus (fourth to fifth cervical). Tapping the tendon of the supinator longus produces flexion of forearm.	Back of shoulder and arm. Outer side of arm and forearm to wrist. (Supraclavicular, circumflex, musculo-cutaneous or external cutaneous, internal cutaneous, radial.)
Sixth Cervical.	Biceps. Brachialis anticus. Subscapular. Pectoralis (clavicular part). Serratus magnus. Triceps. Extensors of wrist and fingers. Pronators.	Triceps (sixth to seventh cervical). Tapping elbow tendon produces extension of forearm. Posterior wrist (sixth to eight cervical). Tapping tendons causes extension of hand.	Outer side and front of forearm. Back of hand, radial distribution. (Chiefly musculo-cutaneous or external cutaneous, internal cutaneous.)
Seventh Cervical.	Triceps (long head). Extensors of wrist and fingers. Pronators of wrist. Flexors of wrist. Subscapular. Pectoralis (costal part). Serratus magnus. Latissimus dorsi. Teres major.	Anterior wrist (seventh to eighth cervical). Tapping anterior tendon causes flexion of hand. Palmar (seventh cervical to first dorsal). Stroking palm causes closure of fingers.	Radial distribution in the hand. Median distribution in the palm, thumb, index, and one-half middle finger. (Musculo-cutaneous or external cutaneous, internal cutaneous, radial, median.)
Eighth Cervical.	Triceps (long head). Flexors of wrist and fingers. Intrinsic hand-muscles.	....	Ulnar area of hand, back, and palm, inner border of forearm. (Internal cutaneous, ulnar.)
First Dorsal.	Extensors of thumb. Intrinsic hand-muscles. Thenar and hypothenar muscles.	....	Chiefly inner side of forearm and arm to near the axilla. (Chiefly internal cutaneous and nerve of Wrisberg or lesser internal cutaneous.)

SEGMENT.	MUSCLES.	REFLEX.	SENSATION.
Second Dorsal.	....	....	Inner side of arm near axilla. (Intercosto-humeral.)
Second to Twelfth Dorsal.	Muscles of back and abdomen. Erectores spinæ.	Epigastric (fourth to seventh dorsal). Tickling mammary region causes retraction of the epigastrium. Abdominal (seventh to eleventh dorsal). Stroking side of abdomen causes retraction of belly.	Skin of chest and abdomen, in bands running around and downward, corresponding to spinal nerves. Upper gluteal region. (Intercostals and dorsal posterior nerves.)
First Lumbar.	Ilio-psoas. Rectus. Sartorius.	Cremasteric (first to third lumbar). Stroking inner thigh causes retraction of testicle.	Skin over groin and front of scrotum. (Ilio-hypogastric, ilio-inguinal.)
Second Lumbar.	Ilio-psoas. Sartorius. Quadriceps femoris.	....	Outer side of thigh. (Genito-crural, external cutaneous.)
Third Lumbar.	Quadriceps femoris. Anterior part of biceps. Inward rotators of thigh. Abductors of thigh.	Patellar (third to fourth lumbar). Striking patellar tendon causes extension of leg.	Front of thigh. (Middle cutaneous, internal cutaneous, long saphenous, obturator.)
Fourth Lumbar.	Abductors of thigh. Adductors of thigh. Flexors of knee. Tibialis anticus. Peroneus longus.	Gluteal (fourth to fifth lumbar). Stroking buttock causes dimpling in fold of buttock.	Inner side of thigh, leg, and foot. (Internal cutaneous, long saphenous, obturator.)
Fifth Lumbar.	Outward rotators of thigh. Flexors of knee. Flexors of ankle. Peronei. Extensors of toes.	Achilles tendon (fifth lumbar to first sacral). Over extension causes rapid flexion of ankle, called ankle-clonus.	Back and outer side of leg; sole, dorsum of foot. (External popliteal, external saphenous, musculo-cutaneous, plantar.)
SEGMENT.	MUSCLES.	REFLEX.	SENSATION.
First and second sacral.	Flexors of ankle. Extensors of ankle. Long flexor of toes. Intrinsic foot-muscles	Plantar (fifth lumbar to second sacral). Tickling sole of foot causes flexion of toes and retraction of leg.	Back and outer side of leg; sole; dorsum of foot. (Same as fifth lumbar.)
Third, fourth and Fifth sacral.	Gluteus maximus. Perineal. Muscles of bladder, rectum and external genitals.	Vesical centers. Anal centers.	Back of thigh, anus, perineum, external genitals. (Small sciatic, pudic, inferior hemorrhoidal, inferior pudendal.)
Fifth sacral and coccygeal.	Coccygeus muscle.	....	Skin about the anus and coccyx. (Coccygeal.)

Prognosis.—In spinal fracture accompanied by paralysis the prognosis is unfavorable. Many cases die from spinal meningitis and myelitis and from the exhaustion of bedsores and cystitis. Cases do at times recover, but usually with considerable disability from loss of power in the legs and imperfect control of the bladder and rectum. The lower the seat of fracture the better the chance of recovery both as to life and to function. In cases which finally prove fatal, life is the more prolonged as the site of fracture descends the spinal column. In patients who finally recover more or less completely, sensation usually returns in the palsied region before motion.

Treatment.—The management of spinal fracture comprises attempts at reduction, catheterizing the bladder, preventing the occurrence of bedsores and treating the spinal inflammation. The patient should be transported and turned when in bed with great care. Especially in cervical fracture is this caution important, for there unexpected displacement from movement is more liable to happen. Sudden death from pressure upon the medulla oblongata or cord may be thus induced. It has been suggested in fracture of the neck to keep the patient lying on his back with his head supported in a hollow made in a bag of sand. In fracture lower down gypsum jackets have been applied, after suspending the patient or laying him in a horizontal position with a table under the hips and another under the shoulders. The suspension gives an opportunity to reduce the fragments by traction and direct pressure, and the jacket prevents subsequent displacement. The jacket is best made by soaking at one time several sheets of gauze, cut in the proper shape, in a paste of gypsum and water and applying these layers around the trunk.

If displacement is discoverable and paralysis present, reduction of the displaced fragments by means of traction, rotation and pressure is justifiable. Especially is this so because of the frequent impossibility of diagnosticating dislocation from fracture.

The urine should be drawn with a soft rubber catheter three times in the twenty four hours, beginning as soon as retention occurs, which is usually at once. The surgeon must look to this, for the patient will feel no pain from the distended bladder. The dribbling that takes place from overflow when the bladder is distended to its utmost may deceive the nurse, who will think the urine is being passed incontinently. This incontinence of retention calls for catheterization. Proper and early use of the catheter delays the advent of cystitis. When true incontinence occurs the catheter is no longer demanded. When cystitis has supervened, the bladder should be washed out daily or every other day with warm water passed through a rubber catheter from a reservoir held a foot above the patient's abdomen. The water may be medicated as is detailed in the section on Cystitis. Spinal fracture rarely gives rise to pericystitis, pelvic abscess or sloughing of the bladder wall, but may do so.

Bedsores are to be avoided by using an air or water bed and keeping the patient clean. Careful turning to change the points of pressure is often essential. A cheap water bed can be made by filling a trough with water and tacking a rubber blanket over the top.

Bromide of potassium, cupping and ice to the spine, belladonna, ergot, iodide of potassium, strychnia, massage, counter-irritation and electricity are therapeutic resources to be employed.

Sawing or cutting away the arches of the vertebræ, called laminectomy, for the purpose of removing pressure on the spinal marrow has been attended with some success and should be adopted at once in most cases. To a great extent the want of success is owing to the fact that the injurious pressure is often caused by the displacement of the vertebral bodies, which, being in front, are not easily reached; and to the circumstance that operative interference is delayed. Reduction by traction applied to the patient's shoulders and legs and operative relief of spinal cord pressure should be undertaken immediately after the receipt of injury. Perhaps the cord may at times suffer pinching by a temporary displacement of the fragments at the moment of accident. In such cases operation would be of no service, because the bones have resumed their normal relations. Operation is always justifiable, if the fracture is definitely located and there is no reason to suspect irrelievable displacement. It must be attempted under most rigid asepsis or antisepsis.

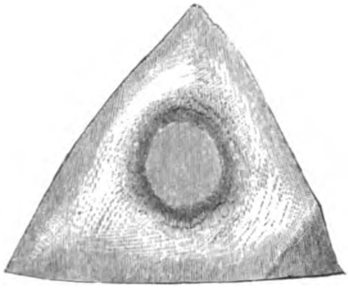
Fractures of the Cranium.

Pathology.—Cranial fractures differ from those of other regions in not being subject to displacement from muscular action; in requiring no retentive apparatus to maintain apposition of fragments and in having no tendency to non-union. Their importance and interest, moreover, center, not in the damage done to bone but in the associated injury sustained by the brain and its membranes. The cerebral injury may be contusion or laceration due to the same force that broke the bone; or it may be inflammation and irritation occurring secondarily to depression and splintering of the bone and to bacterial infection through the fissures in the bone, or to overgrowth of callus at the time of repair.

It should be remembered that the walls of the cranium consist of two tables, separated by a greater or less amount of soft and vascular cancellated bony structure called the diploë. The inner table is nearly always more extensively broken than the outer, because the fracturing force, as a rule, is supplied from without inward. The greater shattering of the inner table is especially marked in comminuted fractures. The thinnest parts of the cranial wall are in the orbital, ethmoid, squamous and inferior occipital regions. The frontal region is remarkable, after the age of infancy, for the existence in it of large cavities, the frontal sinuses, between the two tables of bone.

Prognosis.—The prognosis in cranial fracture is favorable, provided the brain sustains no primary or secondary damage. Under opposite conditions death often occurs. Epilepsy and insanity sometimes follow as remote results, especially in fractures during childhood. Union is rather slow because the callus is furnished by the osseous tissue rather than the external periosteum and dura mater. As the bony tissue is not very spongy and vascular, the amount of callus is small; hence openings left by removal of fragments or after trephining are usually closed principally by fibrous tissue. The button of bone, if kept aseptic, may be replaced. It will usually unite with the surrounding bone and cause bony closure of the opening. The fracture may be a single fissure or a series of fissures traversing the cranium for a great distance, even running across several sutures. There is in such cases little or no separation or displacement of the edges. Separation of the sutures is sometimes caused by head injuries. This condition is practically the same as a fracture. Localized violence, if sufficient to cause fracture, gives rise, as a rule, to comminution of bone and very often to displacement, usually inwards. A few cases of fracture of the inner table without fracture of the outer have been recorded. The diagnosis of such cases during life must be obscure, unless the symptoms of brain disturbance are sufficiently localized to justify trephining. Fractures of the outer table without breaking the inner may be produced where the bone is thick, by a force only sufficient to drive the fragment into the soft diploic structure between the two tables. In children permanent depression of the bone without actual fracture may occur after injury. This is identical with what has been described as bending of bones and as green-stick fracture. It is probable that some osseous fibers at least are torn.

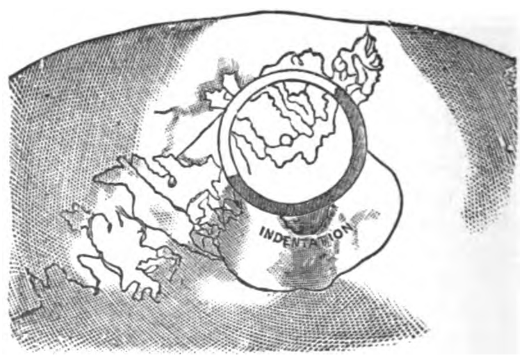
FIG. 160.



Repair by fibrous tissue after trephining.

Symptoms.—Fractures of the cranium, whether of the vault or base, show no special rational symptoms that may not arise from cerebral contusion, laceration or hemorrhage, without fracture. Marked depression of the fragments, however, can be perceived through an untorn scalp by palpation, as can the area of a greatly comminuted fracture which feels soft and is easily depressed by the finger and perhaps shows crepitus. Local subcutaneous emphysema in the mastoid region is diagnostic of fracture into the mastoid cells. A translucent, pulsatile swelling of the scalp is indicative of escape of cerebro-spinal fluid from the ventricles or subarachnoid space, and is conclusive evidence of solution of continuity in the cranial wall. It is, however, a rare phenomenon. Laceration of arteries may give rise to large fluctuating tumors under the scalp without any bone injury; but these are not translucent, nor as a rule pulsatile. Depressed fracture is often stimulated by the swollen and infiltrated tissues forming a hard ridge alongside of a softened

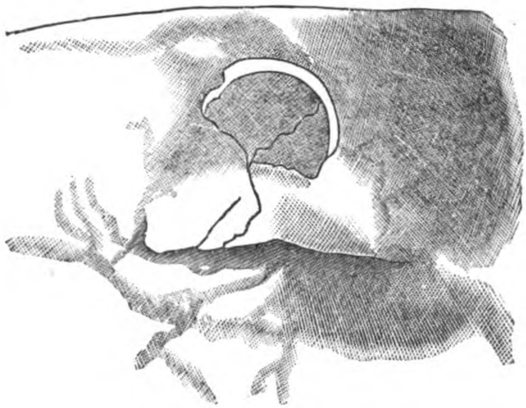
FIG. 161.



Portion of skull showing fracture with small external indentation, marks of trephining and numerous Wormian sutures. (Author's case.)

and less elevated area of scalp. To the surgeon's finger this condition at times feels identical with a ledge of bone at the side of a depressed fragment. It must also be recollected that congenital depressions and irregularities from old injuries, periostitis, and senile changes may exist. When a wound is present the diagnosis is easy, for the fissure in the bone is easily recognized by a red line due to the blood staining the crack. This must not be confounded with the serrated lines shown by the great sutures and the sutures around occasional Wormian bones. If the outer table is broken the inner one seldom escapes similar lesion. Brain tissue, cerebro-spinal fluid and blood escaping from the interior of the skull may aid in establishing a diagnosis of fracture. Quite profuse venous bleeding, increasing in volume during expiration, does not prove that a meningeal vessel or sinus has been torn, for it may come from the vascular diploic bone tissue. Fractures of the base of the cranium can rarely be seen or felt by the surgeon's finger. There may be no special sign of the injury. At times, however, the escape of brain substance, blood or fluid from the ear, nose, mouth or orbit, or the occurrence of paralysis of some of the cranial nerves may serve to confirm the diagnosis.

Fig. 162.

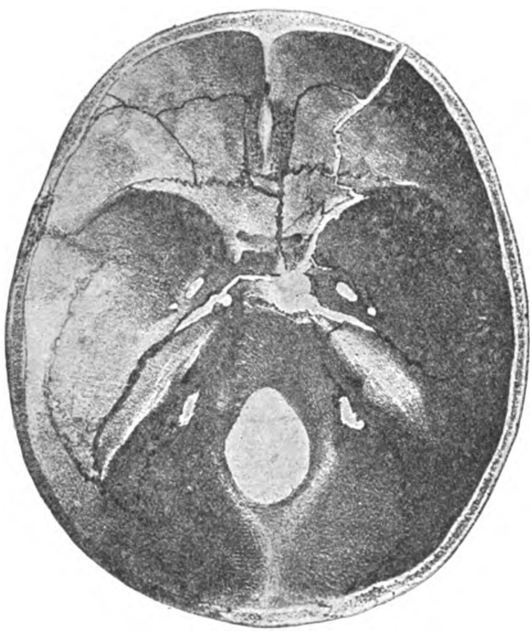


Internal surface of same portion of skull as in previous figure, showing extensive depression of inner table. (Author's case.)

Bleeding from the ear, nose or mouth to be of diagnostic value must be profuse and continuous ; since limited bleeding occurs from damage to the soft parts in these regions. The appearance of blood at the external orifices of the head after laceration of an intracranial sinus, artery or vein, is due to fracture of the bony walls of these cavities and rupture of the mucous membrane. In escape of blood from the ear the drum membrane is usually ruptured. Sometimes, when the petrous portion of the temporal bone is broken and the drum membrane not injured, the blood passes into the pharynx by way of the Eustachian tube, to escape by the mouth or nose or to be swallowed and subsequently vomited. Marked extravasation of blood under the conjunctiva covering the eyeball, especially if it occur a day or more after the head injury and if it does not appear in the eyelids till some hours later, is very suggestive of fracture of the orbital plate of the frontal or sphenoid bone. Direct external injury to the eyeball and violent vomiting or coughing may, however, give rise to subconjunctival ecchymosis. So, also, may fracture of the malar or upper maxillary bone. Signs of orbital aneurism, such as protrusion of the eyeball, pulsation and murmur, suggest the occurrence of damage to the internal carotid artery or the cavernous sinus and make fracture of the cranial base probable. The late occurrence, after injury, of ecchymotic spots in the suboccipital region or below the mastoid process tends to confirm the diagnosis of basal fracture.

Discharge from the ear of an abundant, colorless, watery fluid, with little accompanying hemorrhage, especially if it occurs promptly after receipt of injury and if the flow is modified by the position of the head and by coughing, is characteristic of fracture of the petrous bone and laceration of the tympanic membrane. It is cerebro-spinal fluid which will be found highly saline and almost destitute of albumin. The escape of watery liquid from the ear under other circumstances is of limited diagnostic value. It may be the liquid of Cotunnius from the internal ear or blood serum escaping from a clot in the aural passages. Cerebro-spinal fluid, in rare instances, may escape from the nose or mouth, because of fracture of the spheno-ethmoidal portion of the base or of petrous fracture without rupture of the tympanic membrane. In the latter event the intact membrane prevents escape from the auditory meatus and the fluid passes into the pharynx by the Eustachian tube. Escape of cerebro-spinal fluid or abundant hemorrhage in basal fractures is an evidence of serious, but not necessarily fatal, injury.

Fig. 163.



Fracture of base of skull. (Bruns.)

Paralysis of a cranial nerve occurring immediately after the receipt of a head injury may be due to laceration of the brain near the origin of the nerve or to hemorrhage within the nerve sheath. It is very suggestive, however, of fracture of the base with synchronous rupture, contusion or compression of the nerve trunk. The pressure may arise from the existence of displaced bone or a large clot. The nerves most frequently subjected to such conditions in basal fracture are the facial, auditory, optic and olfactory.

Treatment.—Death from the associated or induced brain lesion is common in fractures of the cranium, but the mortality has recently been greatly decreased by early and more frequent antiseptic operations. Elevation and removal of bone with extraction of splinters of the inner table, removal of large clots, and incision even of the dura mater would avail nothing in cases where there has been serious contusion or laceration of the interior of the brain substance; but many cases have undoubtedly died because peripheral lesions immediately adjacent to the site of fracture were untreated by mechanical means until the pathological process had advanced too far to be remediable. Fractures of the base are amenable to but little operative treatment, except that the nasal cavities and ears should be made aseptic and plugged with gauze impregnated with carbolic acid or iodoform. The general treatment is identical with that proper in fractures of the vault, as is the operative treatment when the lesion is accessible.

The shock following head injuries is to be met by recumbency and the measures spoken of in the section discussing Contusion and Laceration of the Brain. Care must be taken not to continue a stimulating line of treatment after reaction has fairly begun, because the danger in these cases pertains to encephalitis, which is a possible sequence of the injury. As soon as the condition of shock will permit, therefore, elevation of the head, cold to the scalp, low diet, perfect quiet, purgatives and bromide of potassium (ʒij to ʒiv in twenty-four hours) should be insisted upon. Alcoholic stimulants should not be given unless the primary shock is profound, and then should be speedily discontinued. Shaving the entire scalp is a wise measure, since it permits more accurate examination for scalp wounds and cranial depressions, and, in addition, renders the application of cold to the head more effective. A rubber bag or bladder filled with cracked ice, a coiled tube with cold water circulating in it or cloths wet with ice water are easy methods of applying cold to the scalp. If ice is used, a degree of cold sufficient to freeze the skin might be obtained in careless hands. Retention of urine often occurs and requires the use of the catheter. General bloodletting or cupping at the back of the neck may be necessary in the stage of inflammation.

In many instances the uncertainty as to the cranial lesion is more dangerous to the patient's life or future health than the conversion of a closed into an open fracture or the exposure of the encephalon by perforation of its bony wall. Improved methods of wound treatment have greatly lessened the risk from such operative procedures, but encephalitis is as fatal as ever. The symptoms denominated compression of the brain are probably the evidences of encephalic inflammation rather than of brain compression. As this inflammation is frequently due to injury from spicules of the inner table of the bone, to irritation from intracranial bleeding or to septic infection, it is preferable to eliminate by operation the possibility of this inflammation being due to local causes under the seat of fracture.

In punctured fractures immediate trephining, to remove the depressed and splintered bone, to sterilize the wound and thus to avert encephalitis, is advised by all authorities. This should be the line of treatment, even when no cerebral symptoms have developed. Punctured fractures are those open fractures with accentuated depression that result from blows inflicted by the corner of a brick, the point of a spike or any very localized force that produces a puncture of the cranial wall with extensive splintering and driving in of the inner table. Gunshot fractures of the cranium are to be treated as punctured fractures.

The following tabulated statement gives my views concerning the proper treatment of cranial fractures. It is more heroic than that sometimes taught, but it has been written only after careful consideration of the reasoning of those who hold the opposite opinion to my own. Every case must be individually studied, and the patient's chances of death, of return to perfect health and of life with subsequent epilepsy or insanity carefully weighed; but for a working rule to guide the student and practitioner, experience will show the indications given in the table to be correct. Trephining, properly performed, is in itself so free of danger that in a doubtful case the patient had better be trephined than allowed to run the risk of death, epilepsy or insanity.

Syllabus of Treatment of Cranial Fractures.

Closed fissured fractures.	1. Without evident depression.	Without brain symptoms.	No operation.
	2. " " "	With " "	Incise scalp and trephine.
	3. With " "	Without " "	Incise scalp and probably trephine.
	4. " " "	With " "	Incise scalp and trephine.
Closed comminuted fractures.	5. Without " "	Without " "	Incise scalp and probably trephine.
	6. " " "	With " "	Incise scalp and trephine.
	7. With " "	Without " "	Incise scalp and trephine.
	8. " " "	With " "	Incise scalp and trephine.
Open fissured fractures.	9. Without " "	Without " "	No operation, and treat wound.
	10. " " "	With " "	Trephine.
	11. With " "	Without " "	Trephine.
	12. " " "	With " "	Trephine.
Open comminuted fractures.	13. Without " "	Without " "	Probably trephine.
	14. " " "	With " "	Trephine.
	15. With " "	Without " "	Trephine.
	16. " " "	With " "	Trephine.
Punctured and gunshot fractures.	17. In all cases.	. . . .	Trephine.

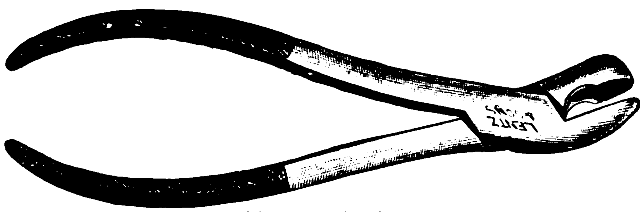
Operation, when decided upon, should be performed at once or certainly not delayed more than a few hours. All cases, whether trephined or not, should be treated as cases of incipient encephalitis.

When careful study of the paralytic and other symptoms accompanying head injuries localizes the cerebral lesion near the seat of contusion of the scalp, incision is to be resorted to promptly, even if there is only a suspected fracture. If no fracture is found trephining should, as a rule, be performed, because it is probable that a hemorrhage has occurred either between the bone and dura mater or under the dura mater. Trephining will permit the surgeon to remove this source of trouble, if outside the dura mater; if absence of pulsation or change in color of the dura mater is observed, he should incise that membrane in the expectation of finding a clot beneath it.

The study of cerebral localization should be cultivated by all surgeons, for many cases of head injury would be treated much more successfully than is usually the case, if the neurologist and surgeon employed their skill in combination. The symptoms and cranial lines by which neurologists locate brain lesions have been referred to in the section on Encephalitis, which should be read in this connection. Incision of the dura mater, aspiration of the brain substance and the excision of brain tumors will become less unusual when all surgeons are familiar with the principles of cerebral localization.[1] In fracture of the cranium trephining is sometimes demanded by the paralytic and other symptoms localizing the lesion under the seat of fracture, when the amount of damage seen in the skull would lead one to abstain from operation. Hence cognizance of the significance of local palsies and spasms is demanded of the skilled surgeon.

TREPHINING.—The term trephining is employed to designate operative perforation of the cranium, whether done by means of a trephine, hammer and chisel, surgical engine or ribbon saw. After the initial perforation is made, the opening may be enlarged by gnawing forceps, saw or chisel. Osteoplastic resection, by which a trap door of soft tissues and bone is raised and then restored to its original position after the intracranial manipulation is concluded, gives a good exposure and a satisfactory reconstruction of the cranial wall.

FIG. 164.



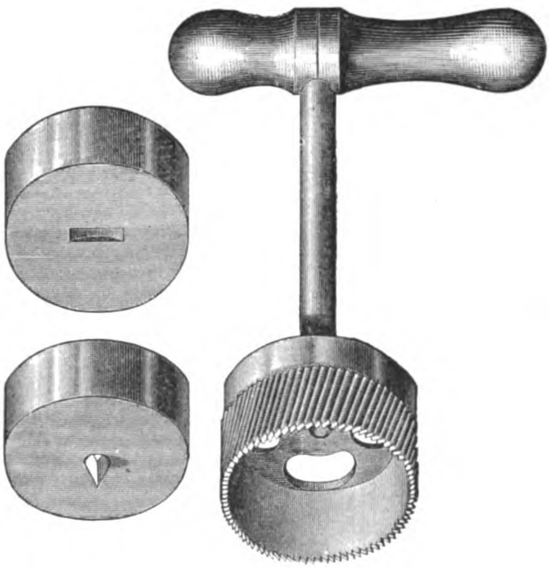
Hopkins's gnawing forceps.

Since the usual object in cases of fracture is to get an opening through which to insert an elevator to pry up the depressed fragments, a small trephine should be employed. One not over three-eighths of an inch in outside diameter at the cutting edge is large enough. In operations for removing brain tumors a trephine of one and a half to two inches in diameter may be used. After the induction of anæsthesia, the incision in the scalp should be made of a horseshoe shape, with its convexity downward when the patient is recumbent, so that during the after-treatment the drainage may be

[1] See Operative Surgery of the Human Brain, by John B. Roberts. P. Blakiston, Son & Co., 1885.

free. If a wound previously exists it may be enlarged. The knife should divide the scalp and periosteum at the same time in order that all the soft structures may be raised in one layer. If any periosteum remains attached at the seat of operation, it should be pushed back with the knife handle. In trephining for epilepsy, cerebral abscess or tumor the periosteum need not be removed except at the point where the crown of the trephine is applied. Indeed a circular incision in it the size of the disk to be removed is all that is needed. When the aseptic button of bone is to be replaced in the gap, the periosteum upon its upper surface may be utilized for holding sutures passed through it and then through the periosteum at the margin of the opening.

FIG. 165.



Author's conical aseptic trephine with solid stem and disk with center-pin, instead of the usual center-pin sliding in hollow stem.

In fractures the trephine crown must be placed on solid and undepressed bone with about one third of the crown overlapping the portion to be elevated. If the latter precaution is not observed, a bridge of solid bone will be left, which will prevent the application of the elevating lever. Elevation and extraction are often facilitated by removing a disk at the least depressed edge of the depressed fragment. The trephine should be semi-rotated from left to right and right to left, with moderate pressure against the bone. As soon as the groove is made sufficiently deep to maintain the cutting edge in position, the center pin is retracted or the center pin disk removed lest it should perforate the inner table and membranes. The trephine is then reapplied and the groove cautiously deepened. After a few more half-turns have been made the trephine is removed, and the depth of the groove ascertained by carrying along it the end of a probe or pin. If the skull is of uneven thickness, as shown by the cranial wall being completely divided in one segment of the circle and not in the remainder, the trephine must be tilted toward the uncut side and cautiously rotated. Very soon the disk is cut loose and is to be picked or tilted out with forceps. The point of an elevator is then pushed under the depressed fragment, and used as a lever to raise the bone into place. Loose pieces and spicules of bone are removed by the elevator or forceps; but care must be observed not to twist during extraction a large and interlocked fragment so as to lacerate the dura mater. It is better to saw away the ledge or point of bone interfering, or even to make a second trephine hole. There is usually in comminuted fractures one piece that acts as a keystone; when this is removed or elevated, the other fragments are readily managed. The Hey's saw and gnawing forceps do good service in cutting away corners of bone. Spicules driven into the membranes or brain should be searched for with the finger and at once removed. Finally, all sharp edges of bone should be trimmed away, the wound washed with sublimate solution, a drain of catgut or rubber tube inserted, the scalp flaps sutured in position and the gauze dressing applied. The bone wound closes usually by fibrous tissue; the scalp wound heals as do other wounds of the soft parts. It is common now to replace all or some of the fragments of bone, in order that they may aid in closing the gap in the skull, by forming osseous tissue and inducing ossific deposition in the granulation tissue. To accomplish this successfully, it is necessary that the fragments taken out be thoroughly cleaned in an antiseptic solution, of a temperature of about 105° F., and then kept warm in a similar antiseptic lotion, or between warm aseptic cloths until the moment before the flaps are to be sutured. The bony fragments are then laid loosely upon the dura mater and covered by the scalp tissues. This procedure is most successful in exploratory operations, because then there is less probability of the grafts being septic.

Occasionally gold foil, rubber tissue and other foreign substances have been sterilized and laid upon the dura mater before closing the wound. This step has for its object the prevention of adhesions between the dura and scar tissue in the opening in the cranium. Some success has seemed to attend these methods. They have not been generally employed.

Incision of the dura mater, hypodermic puncture of the brain or even incision of abscess in the brain does not alter the method of procedure, so far as the preliminary trephining and after-dressing are concerned. The dura should, however, be sutured with catgut if large incisions have been made in it. The bone grafts can then be laid upon it; but provision should be made for removal of serous exudations and blood by drainage. The drainage tube or threads may be removed in thirty six hours, if the wound is aseptic.

If it is possible to avoid doing so, the trephine opening should never be made over the superior longitudinal sinus, the lateral sinus, the torcular Herophili or the middle meningeal artery where it grooves the anterior inferior angle of the parietal bone. Hemorrhage from wounding these structures may prove very serious.

The removal of comminuted bone, however, may lay open these vessels. Bleeding from the artery may be arrested by ligation, by forcing a piece of wood into the bony canal, if there is one, by seizing the vessel and the bone in a pair of spring forceps, which can be left in position for several hours, or by crushing the edge of the bone and the contained vessel with strong forceps. Hemorrhage from the venous sinuses may at times be controlled by forcing a little pad of absorbent gauze or sponge between the vessel and the overlying solid bone. Ligatures or a suture carried around the bleeding vessel by means of a needle should be tried when the hemorrhage persists. Trephining over the sinus, at a point a little distance from the wound, might be required to enable the surgeon to apply such a suture; but this event must be exceedingly rare. Hemostatic forceps may be left in the wound until the first dressing is changed. In trephining over the air-cells in the frontal bone, called the frontal sinuses, a large trephine should be used to perforate the outer table and a smaller one to bore through the inner.

Fractures of the Bones of the Face.

Fractures of the facial bones are usually the result of great direct violence; hence several of the bony components of the face may be broken by the same injury. Owing to the great vascularity of the parts, union takes place quickly and with the formation of but little callus. It is improper to remove splinters of bone which seem to have but slight attachment, for necrosis of such pieces is uncommon.

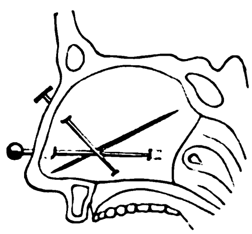
Fracture of the Nasal Bones and Cartilages.

Injuries of the nose producing fracture may involve, in addition to the nasal bones, the nasal processes of the superior maxilla, the frontal spine and the perpendicular plate of the ethmoid upon which the nasal bones are supported. The cartilaginous septum is often bent or broken, and the lateral cartilages may sustain similar lesions or be torn loose from the lower end of the nasal bones. The vomer likewise may be broken. It is said that fracture of the cribriform plate of the ethmoid may accompany fracture of the nasal bones. In young children the arch made by the juncture of the two nasal bones, may, it is said, be flattened from the suture opening on the posterior aspect.

Fractures of the nose are often comminuted and attended with much swelling. The swelling, which rapidly appears, is liable to conceal the displacement, interfere with accurate diagnosis and obstruct nasal respiration. Congenital deviations of the septum may deceive the surgeon. Emphysema of the face may occur from air escaping into the subcutaneous cellular tissue during efforts at blowing the nose soon after the injury. This symptom needs no treatment. Caries and necrosis are rather unusual, but may occur. Union generally takes place rapidly and is complete within two or three weeks. If the fracture extends into the nasal processes of the superior maxilla, the lachrymal duct may become occluded by the displacement or by callus.

The risk of permanent disfigurement is so great and union occurs so soon that careful examination and replacement should be instituted promptly, and, if necessary, under an anæsthetic. If the nasal bones are depressed, a narrow and rigid instrument, such as a grooved director, passed into the nostril will probably enable the surgeon to elevate the fragment. When there is a tendency for the depression to recur, a steel pin or needle may be thrust through the nose from right to left underneath the broken bone. The pin should remain in position for about five days. When a tendency to displacement of the cartilaginous portion of the nose is present, the proper conformation should be maintained by transfixing the cartilages with pins, and, by a sort of leverage action, pinning them in place. I have found this method effectual, after incising the deformed cartilage in cases of nasal deformity from fractures received many years previous to operation.[1] Plugs and canulas in the nostrils are uncomfortable, unnecessary and often inefficient. Patients should be cautioned against violently blowing the nose or snuffling, for displacement may thus be caused.

FIG. 166.



Author's method of pinning nasal septum.

If profuse hemorrhage occurs, the nostril on the bleeding side should be plugged. To the end of a strong string, about eight inches long, a disk of moistened sponge, about three fourths of an inch in diameter and three eighths of an inch in thickness, is firmly tied. This sponge is oiled, and, by forceps, pushed into the nostril and along its floor till it reaches the posterior nares. Upon the string hanging from the anterior nostril four or five similar disks of sponge are strung like beads and consecutively crowded into the nose until the cavity is filled. After the lapse of twenty four hours the disks are removed one by one.

Fractures of the Malar Bone and Zygoma.

These rare injuries are readily recognized by the deformity and the irregular outline, which can be felt by the fingers. If fracture of the malar bone extends into the floor of the orbit, the superior maxillary nerve may be injured, subconjunctival ecchymosis appear or protrusion of the eyeball from intra-orbital hemorrhage take place. In fracture of the zygomatic arch the mouth may not open freely, because the displaced fragments obstruct the movement of the coronoid process of the lower jaw. Pain and swelling sometimes stimulate or increase this disability.

The treatment consists in replacement by pressure of the fingers upon the cheek or within the mouth. If necessary, an incision may

[1] See Cure of Crooked and otherwise Deformed Noses, by John B. Roberts, Phila., 1889.

be made for the introduction of a lever under the displaced bone, which is easily pried into place.

Fractures of the Superior Maxillary Bone.

The alveolar, nasal and other processes of the upper jaw bone are the parts that most frequently sustain fracture. Even these injuries are uncommon, except fracture of the alveolar process during the extraction of teeth. The lachrymal canal, the orbit and the superior maxillary nerve may be involved in the injury, with results similar to those described above under nasal and malar fractures. Union occurs in three or four weeks. Separation of the suture between the two superior maxillaries has been observed.

Examination of the surface of the face and of the interior of the mouth will disclose the nature of the lesion. In treating such fractures loose teeth should be left in place, for they frequently become firmly fixed again. Apposition can sometimes be maintained by keeping the teeth of the lower jaw firmly closed against those of the upper by means of Barton's bandage or a band of adhesive plaster passed under the chin with its ends crossed at the top of the forehead. Wiring the teeth adjoining the line of fracture is sometimes a good means of preventing motion.

FIG. 167.

Gunning's inter-dental splint, with opening for introducing food.

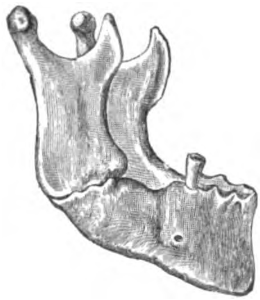
The inter-dental splint, which is a mould of gutta percha or similar plastic material made to fit the grinding surface of the teeth of both jaws, will in most instances act sufficiently. It is placed in position, and the mouth kept shut by bandaging or adhesive plaster. Cork cut to fit the teeth in the same manner will answer a good purpose if no dentist is at hand to make the more complicated apparatus. During the three weeks that closure of the mouth is enforced, liquid food is introduced through the crevices between the teeth or by a tube passed between the alveolar arch and cheek as far back as the last molar. Inter-dental splints may be made thick enough to have a perforation for this purpose.

Fracture of the Inferior Maxillary Bone.

Pathology.—The mandible is more frequently broken than any other bone of the face. The seat of fracture is generally toward the anterior part of the body of the bone. Fracture of the ramus is comparatively rare, and fracture of the condyle and coronoid process even more unusual. The body of the bone is said to be weaker and more easily broken near the root of the canine tooth and the mental foramen than elsewhere. Loss of teeth and consequent atrophy of the alveolar process may reduce the normal strength of the bone in other situations and be the predisposing cause of fracture. The most frequent seat of fracture, according to Gurlt's statistics, is near the middle line in front. These statements exclude from consideration mere splintering of the alveolar process often produced by pulling teeth and by other causes. Double fracture of the lower jaw is not uncommon.

When the body of the bone is broken the fracture often communicates with the mouth through a tear of the gum. The fracture becomes in such cases, therefore, an open one, and is accompanied by suppuration because it cannot be kept aseptic. Suppuration is usually not very great, for drainage is free. The close attachment of the fibrous tissue of the gum to the alveolus is a sufficient explanation of this frequent complication. The inferior dental nerve may be torn or bruised when its canal is involved in the fracture. Anæsthesia of the corresponding half of the lower lip and chin is the result of this nerve lesion.

FIG. 168.



Fracture of lower jaw behind teeth.

Symptoms.—The displacement and unnatural mobility in fracture of the body are easily detected, but the surgeon must bear in mind the possibility of malpositions of the teeth from irregular development and irruption. In single fracture of the body away from the median line, the anterior fragment is apt to be displaced inward toward the mouth. In double or bilateral fracture of the body, the middle or chin portion may be drawn downward by muscular action. The displacement in fracture of the ramus may be most easily recognized by the finger in the mouth.

Pain, often increased by motion or deglutition, and excessive secretion from the mouth are observed in fracture of the lower jaw. Perhaps the increase of saliva and mucus is largely apparent, the excess observed being really due to a want of proper control of these fluids within the mouth. Fetor from decomposing food, pus and other secretions is often marked. Abscesses about necrosed pieces of bone, fistulous tracts and ulceration of the mucous membrane may add to the discomfort of the patient, who perhaps becomes greatly debilitated by swallowing foul secretions and being deprived of a fully nutritious diet.

Union of ordinary fracture of the jaw takes place in about five weeks. The prognosis, even in bad cases, is ultimately good. Even if teeth are lost the solid union which occurs gives a good basis for the adaptation of artificial teeth.

Treatment.—Reduction of the fracture by pressure of the fingers on the teeth is usually easy, though occasionally comminuted fragments or displaced teeth may cause interlocking and require removal before correct apposition is obtainable. Teeth which are simply loosened should not be pulled unless they impede reduction. The normal relation of the upper and lower teeth in most mouths is that the upper incisors come in front of the lower when the mouth is quietly closed. This should be recollected. Generally there is little tendency to displacement after ten days have passed. Hence after the lapse of about two weeks the dressings may be removed, and the patient given an opportunity to attempt mastication cautiously in order to demonstrate whether the fragments have been adjusted in a manner to give the best use of the teeth in chewing. Any slight change in adjustment is then possible, for consolidation will not be complete. After reduction, uncomplicated fractures of the jaw are to be treated by keeping the upper and lower teeth in contact by means of the Barton figure-of-eight bandage of the occiput and chin. The mouth must be cleansed with disinfectant washes of carbolic acid, tincture of myrrh (♏xv to f℥j of water) and similar drugs. Feeding, as in fracture of the upper jaw, is accomplished by introducing milk and soups through the crevices between the teeth, or through a tube passed behind the last molar or through the nostril. The hair and beard of men should be closely cut before the bandages are applied; otherwise they are apt to slip or be very uncomfortable.

FIG. 169.

Barton's bandage for fracture of jaw.

When the simple bandage does not give sufficient firmness to cause maintenance of correct apposition or when the lateral pressure of the bandage causes overriding, it is well to adapt a moulded splint to the outside of the chin. Pasteboard, felt, leather, gutta percha or gauze stiffened with gypsum are the proper materials from which to construct a hollow cap to fit the front and lower surface of the chin. The splint should extend on each side nearly as far back as the angle of the jaw; it may need a crescentic portion of its posterior edge cut away in order to avoid pressure on the throat above the larynx. The splint is padded and placed over the chin and held in position by the bandage. Before applying the bandage the splint may be fixed in position by carrying a band of rubber adhesive plaster over the splint and as high up on the cheeks as the zygoma.

If the tendency to displacement is persistent, wiring the fragments together or some form of inter-dental splint becomes necessary. A strong silver or iron wire may be fastened around several teeth on each side of the fracture; or in open fractures the ends of the bone may be drilled and wire sutures passed through. Inter-dental splints are splints worn inside the mouth and so fitted to the teeth and alveolus that motion at the seat of fracture is prevented. An impression of the teeth and alveolus is taken while the fragments are held in position. By means of this impression a splint of metal or vulcanized rubber is constructed which contains indentations into which the teeth accurately fit. If such a splint is applied to the teeth of the broken jaw and fixed so that the jaw bone is kept continually in close contact with it, motion at the seat of fracture is impossible, because the crowns of the teeth are buried in indentations on the surface of the splint. There are several methods of securing the splint to the jaw. Probably the best is to have the upper surface of the splint fitted to the upper teeth. The jaws are then closed upon the splint and kept in that position by a Barton bandage. Lateral motion is prevented by the depressions into which the teeth fit. Such an inter-dental splint can be made thick enough to permit openings for feeding between the upper and lower surfaces of the splint. An illustration of this splint is shown above under Fractures of the Upper Jaw. Instead of using the upper jaw for immobilization the splints may be fitted to the lower jaw alone and attached by rods coming out of the corners of the mouth to a splint under the chin. A simple splint is made by softening a guttapercha strip in hot water, moulding it to the crowns of the lower teeth so as to overlap the adjacent gum and hardening it by cold water. Such a splint may be fixed in position by wires carried by means of needles through the muscles and skin of the chin and twisted under the chin over small rolls of plaster or pieces of cork. In subjects who have lost all or nearly all their teeth inter-dental splints moulded to the atrophied gums present about the only efficient means of maintaining immobility. In all forms of splints greater immobility will as a rule be obtained by bandaging the jaws together. If desirable, guttapercha wedges may be placed between the jaws on each side of the mouth in order to have a space in the middle for introduction of food. A crude form of inter-dental splint may be made of cork cut to fit the teeth of the two jaws.

Fractures of the Hyoid Bone.

The hyoid bone is rarely broken, and when such a lesion is sustained the bone usually gives way near the junction of the great horn and the body of the bone. Fracture of the hyoid bone is at times associated with fracture of the laryngeal cartilages and is due to similar causes, namely, pressure of the rope in hanging, grasping the throat by the fingers as in homicidal assaults, and direct blows upon the bone. The symptoms of hyoid fracture are sharp pain, increased by pressure, speaking or swallowing; swelling, displacement and motion of the fragments and crepitus. If the mucous membrane of the pharynx has been perforated blood will appear in the mouth. Sometimes the surgeon's finger in the pharynx will detect the displacement with ease. Coughing with paroxysms of choking or asphyxia may follow attempts at swallowing food or protruding the tongue. The treatment consists in replacing the fragments, keeping the parts quiet by prohibiting talking and feeding the patient on liquids by means of a tube. Bandaging the throat is of no service.

Fracture of the Cartilages of the Larynx.

Pathology.—These injuries, owing to the exposed position of the larynx, are more frequent than fracture of the hyoid bone. They are at the same time more dangerous, because the intralaryngeal swelling is very liable to cause fatal asphyxia. Blows, falls, hanging and homicidal throttling are the causes likely to produce laryngeal fracture. The mucous membrane is frequently torn, leading to extravasation of blood within the larynx and emphysema of the cellular tissue of the throat and neighboring regions. The upper horn of the thyroid cartilage is sometimes developed as a sort of epiphysis. Epiphyseal separation may then occur.

Symptoms.—The symptoms are deformity, motion and crepitation, accompanied by convulsive cough, alteration or loss of voice, dyspnœa, painful deglutition and in many instances frothy, bloody expectoration. The emphysema that is seen in many cases may spread over a large portion of the neck, face and trunk.

In severe fractures death is common from suffocation due to subcutaneous hemorrhage, to free bleeding into the larynx or to inflammatory or emphysematous swelling. The fatal issue may suddenly occur several days after the receipt of injury.

Repair occurs most probably by osseo-cartilaginous material.

Treatment.—The treatment consists in remedies to allay inflammation, and cautionary tracheotomy, lest fatal obstructive swelling occur unexpectedly in the larynx. The opening thus made may be of value in giving the surgeon an opportunity to replace the broken fragments by the introduction of instruments into the air passages. It is unwise to postpone tracheotomy until dyspnœa becomes extreme, since asphyxia may be sudden. The operation had better be done in all cases of severe fracture before the patient is left by the surgeon. A permanent tracheal opening is sometimes demanded after fracture of the larynx.

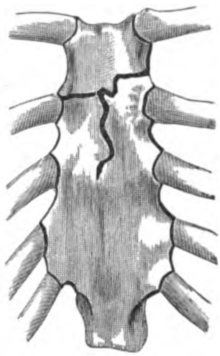
The tracheal rings occasionally sustain fracture. The diagnosis is often difficult, but if such injury is discovered it should be treated as fracture of the larynx by antiphlogistic measures and tracheotomy below the seat of injury.

Fractures of the Sternum.

Pathology.—This is a rare injury, probably because the sternum is protected from indirect violence by being connected with the elastic costal cartilages and ribs. When fracture occurs it is usually due to such great violence that associated injury to the ribs or thoracic viscera exists; but a direct blow of moderate force may, if limited to a small area, break the sternum. Violence which forcibly bends the spinal column backward or forward may give rise to sternal fracture in some cases, as it may cause vertebral fracture in others. Great muscular efforts, such as occur in lifting heavy weights or in parturition, have been followed by disruption of this bone.

The first portion of the sternum, or manubrium, and the last portion, or ensiform appendix, often become united in adult life to the gladiolus, or central segment, by osseous material. In early life, and sometimes until much later, more or less perfect joints exist at these points. Therefore it is difficult and often impossible to say whether a given traumatic displacement is a fracture or a dislocation. Displacement between the first and second segments, the result of direct violence, may be diagnosticated as diastasis or dislocation rather than fracture when the patient is young. The symptoms confirmatory of this diagnosis are the half facets for the second ribs or a smooth upper facet being felt through the skin, the cartilages of the second rib being out of place and easily reduced to position, and no crepitus being discoverable.

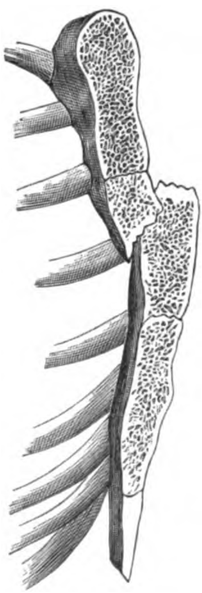
FIG. 170.



Fracture of sternum.

Sternal fractures are generally more or less transverse. Congenital fissure may be mistaken for longitudinal fracture, which is a very rare lesion. The frequent irregularites of the ensiform appendix must not be forgotten. Union usually occurs promptly, and little annoyance arises from uncomplicated fracture even if some deformity persists. Cases associated with rupture of the lungs or pericardium or with profuse bleeding or consecutive suppuration in the mediastinum are of grave prognosis.

FIG. 171.



Transverse fracture of body of sternum. (STIMSON.)

Symptoms.—The symptoms of fracture of the sternum are displacement, mobility, crepitus, pain on motion, deep breathing or coughing, bloody expectoration, dyspnœa, and sometimes a stooping position of shoulders because of the shortening of the breast bone.

Treatment.—Replacement can best be accomplished by traction and pressure. If a hard pillow is placed under the patient's back and his trunk bent backward over it, the fragments can often be easily pressed into position. A deep inspiratory effort may assist the reduction. Recurrence of the deformity is not unusual. It has been proposed to screw a gimlet into the depressed portion of the bone and thus pull it upward, or to insert an elevator or hook under it. These means increase the severity of the injury, but are justified by symptoms arising from pressure on the heart and lungs. After reduction, if there is a tendency to displacement or if much pain is present, the chest should be immobilized by a broad bandage of flannel or adhesive plaster firmly applied, while the lungs are emptied by forced expiration. If intrathoracic symptoms arise, they should be treated on general principles. Pus behind the sternum should be promptly evacuated by incision along the side of the sternum or by trephining the bone.

Fractures of the Ribs and Costal Cartilages.

Pathology.—Fractures of the ribs are frequently met with in adults, but quite rarely in children. The greater elasticity of the bones and costal cartilages in childhood sufficiently accounts for this difference. The occurrence of green-stick fracture may, perhaps, be often overlooked in chest injuries among children, and even in adults the periosteum at times remains almost intact and thus obscures the symptoms of fracture. The protected situation of the first and second ribs behind the clavicle and the mobility of the last two ribs render fracture of these bones unusual. The ribs most commonly broken are the fourth, fifth, sixth and seventh. Unless several ribs are simultaneously broken over-riding is impossible, for the adjoining ribs and the intercostal structures act as splints. Angular deformity is in the same way a good deal limited. Comminution, when great, changes the rigid thoracic wall into a flaccid membrane moving in and out with respiration.

Direct violence, by driving the rib inward, causes fracture at the point of impact and generally with inward displacement. Indirect violence by depressing the chest, has a tendency to bend the rib and cause fracture beginning on the external surface. Outward displacement is probably the more common deformity in these cases. Erichsen thinks that in indirect fractures the bone usually gives way near its angle, which is the point of greatest convexity. Direct violence is more apt to cause splintering of the inner surface in the bone and inward displacement; consequently there is, under such causation, more likelihood of puncture of the viscera. Contraction of the extra-thoracic muscles during violent respiratory efforts, as in coughing or sneezing, may cause fracture of a rib. The rather frequent occurrence of broken ribs in connection with general paralysis of the insane is said to be due to trophic changes in the bones making them more brittle.

Injury to the thoracic or abdominal contents is not an infrequent associate of rib fractures. The most common indication of such injury is subcutaneous emphysema about the seat of fracture due to puncture or rupture of the pleura and lung. This is probably more frequent when the rib is broken at the situation of an old inflammatory adhesion of the pulmonary and costal pleura than when no such adhesion exists. When the wounded lung is previously non-adherent, the air from the bronchioles and vesicles sometimes escapes into the pleural cavity, giving rise to pneumothorax instead of distending the subcutaneous cellular tissue and causing emphysema. The lung may actually become compressed and collapsed by large quantities of air and blood in the pleural sac. When the emphysematous condition spreads into the mediastinum and the interlobular cellular tissue of the lung the patient's condition becomes critical. Pericardial and heart injuries are infrequent except after very great violence. It is to be recollected that laceration of the viscera may occur without fracture of the ribs.

Laceration of an intercostal artery may happen even in fracture of a not very serious kind. If the fracture is open so that such injury and the consequent hemorrhage are detected, efforts should be made to secure the bleeding artery by passing a ligature around it. This can perhaps be done with a curved needle carrying a thread through the tissues in the intercostal groove on the lower margin of the rib, or by drilling the bone and passing a ligature through it and around the vessel. The vessel may be seized with hemostatic forceps, which are then used to apply torsion or are allowed to remain in the wound for twenty-four hours. In closed fractures an incision should be made and similar treatment adopted, if the diagnosis of dangerous hemorrhage from a torn intercostal artery is made.

Symptoms.—The symptoms of uncomplicated fracture of the ribs may be so obscure that certainty of diagnosis is impossible. Green-stick fractures are scarcely recognizable except when a nodule of callus is developed at the seat of pain during recovery. Local pain induced or increased by pressure, motion, full inspiration or coughing is suggestive of fracture, but may be due to mere contusion of the soft parts. Shallow or catching respiration is a common accompaniment of broken ribs and is due to the pain inflicted by deep inspiratory efforts. Cough is often present and has been attributed to reflex irritation from injury to the intercostal nerve lying in the groove of the bone.

Pain or ecchymosis at a distance from the part of the chest upon which the violence was received is indicative of fracture. If the patient lie upon his back and the surgeon make strong pressure upon the sternum and anterior part of the chest, pain will often be experienced at the point of fracture. This is due to the elasticity of the ribs and cartilages causing motion at the seat of fracture even when it exists at the lateral or dorsal aspect of the chest. If no fracture is present, sternal pressure cannot give rise to pain at a distant part of the chest wall. Preternatural motion may be difficult to obtain and recognize, because of the normal mobility and elasticity of the thoracic parietes. Crepitation may be elicited by applying the finger-tips to the ribs on both sides of the suspected fracture and making alternating pressure. Motion also may be thus detected. Sometimes crepitation is more readily detected by laying the palm over the painful spot while the patient coughs or the surgeon makes firm pressure in the neighborhood of the injury with the other hand. Auscultation may detect crepitus when other means fail. Subcutaneous emphysema, which is shown by crackling when pressure is made upon the skin, is an unmistakable sign of fractured rib and puncture of the lung. The development of a pleuritic friction sound or of a local pneumonia, a day or two after injury, is very fair evidence of a broken rib. Bloody expectoration, pneumothorax and serous effusion or hemorrhage into the pleural sac are suggestive of fracture and simultaneous injury of the thoracic contents, but they may also occur from violence that does not break the elastic ribs.

The prognosis is good in ordinary uncomplicated fractures of the ribs. Union occurs in about three weeks by interosseous and ensheathing callus which often leaves an irregularity, even when no displacement existed, because perfect immobilization is impossible. Sometimes when several bones have been broken bridges of callus unite the upper and lower borders. Hernia of the lung may occur, if much displacement or comminution exists after severe fractures. The cellular emphysema is in the great majority of cases unimportant and soon disappears spontaneously. Great dyspnœa from sudden congestion of the lungs or pneumothorax is an important and at times a fatal symptom. Pleurisy, pneumonia and pericarditis occurring as complications add greatly to the seriousness of the injury and should always be looked for by percussion and auscultation. Recovery, however, is not uncommon after severe injury to the lungs and other viscera.

Treatment.—Fractures of the ribs should be treated by reduction of displacement and immobilization. At the same time the surgeon should be on the alert to avert or relieve intra-thoracic inflammation. Doubtful cases are to be treated as fractures. Pressure upon the ends of the fragments or upon the sternum may correct deformity and at the same time relieve the existing pain. Deep inspiration on the part of the patient may be of assistance. Occasionally, when overlapping exists the outer fragment may, by pressure, be sprung under the inner one, and its resiliency used to lift the latter outward into proper relation. If inward displacement were causing important symptoms, it would be proper to introduce a hook or elevator under the depressed bone and thus bring it into position. In gunshot or other open fractures, comminuted and detached pieces may at times be extracted with propriety.

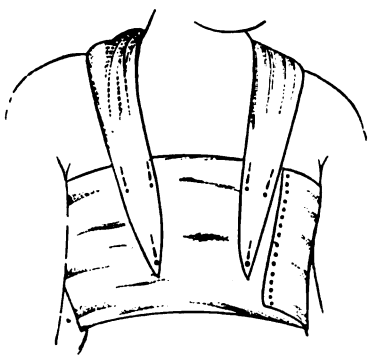
Fig. 172.

Fracture of ribs; synostosis. (Park.)

Immobilization is to be effected by encircling the chest with a broad bandage so that thoracic breathing is restricted. The ribs are thus kept quiet and the patient required to breathe by the diaphragm and abdominal muscles. The bandage should be made of a piece of flannel or muslin about eight inches wide and a yard and a half long; it should be applied and firmly fastened with pins during full expiration in order to be sufficiently tight. If the patient is ordered to raise his arms over his head and to breathe out as much as possible, the girth-like bandage can be firmly adjusted. The gypsum dressing may be thus employed. If the patient has pain from the circular constriction, it may be made looser or entirely dispensed with, since in order to avert pain the muscles will immobilize the parts pretty well without external assistance.

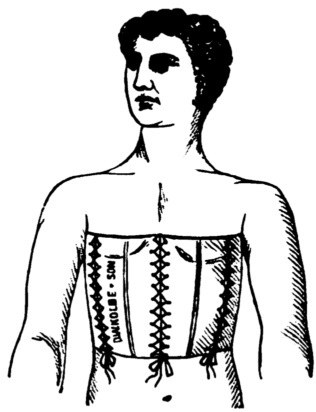
The bandage must never be carried much below the ensiform cartilage, lest it interfere with the play of the abdominal respiratory muscles. It may be prevented from slipping downward by bands carried over the shoulder. The arm of the affected side should be bound to the chest or carried in a sling, if the motion of the pectoral muscles gives pain. If displacement inward is caused by the bandage, it is not to be employed. A laced jacket of stout linen, such as has been used in the Pennsylvania Hospital, is an efficient dressing for broken ribs. The dressing may be discarded in about three weeks. A broad sheet of rubber adhesive plaster or several overlapping strips of plaster may be used instead of the bandage. Before applying adhesive plaster all hair on the chest should be removed with the razor. In some cases constriction of the entire chest is very uncomfortable; this is especially so when the patient has asthma or chronic bronchitis. The adhesive plaster is then a preferable dressing, for it is easy to apply it to the injured side only, with the ends merely crossing the median line in front and behind.

FIG. 173.



Bandage for fracture of ribs.

FIG. 174.



Morton's jacket for fracture of the ribs.

The intra-thoracic inflammations require treatment similar to that indicated in similar lesions from non-traumatic causes. The cellular emphysema accompanying many fractures needs no special treatment, as the air is soon absorbed. The pressure of the bandage perhaps aids in its disappearance. Even when great extension of the emphysema occurs no danger is to be apprehended, except when it gets into the mediastinum and interlobular tissue of the lungs. Extreme congestion of the lungs, giving rise to grave dyspnœa, should be treated by venesection. Pneumothorax, hemorrhage into the pleural sac or large pleuritic effusion may demand aspiration or incision.

Fractures of the Costal Cartilages.

These injuries are said to happen most frequently near the junction of the cartilage and rib and to occur in the seventh and eighth cartilages oftener than elsewhere. The partially ossified cartilages of the old are more susceptible of fracture than the cartilages of youth. Chondral fractures are usually transverse or nearly so and are seldom complicated. Deformity is the most constant diagnostic symptom, though at times crepitus and mobility may be distinguishable. When it is impossible to determine whether fracture or dislocation of the cartilage has taken place the termination of the rib may be made out by acupuncture, for the needle will enter the substance of the cartilage. Union is accomplished not by cartilage, but by osseous or fibro-osseous tissue in much the same manner as in fracture of the ribs. The perichondrium seems to furnish the ensheathing callus. The treatment is the same as that for fractured ribs.

Fractures of the Pelvic Bones.

Pathology.—Fractures of the pelvis are rare and require for their production a great degree of violence, except in instances where mere projecting processes are split or torn off. Falling embankments, railroad accidents and the passage of loaded vehicles across the trunk are the kind of injuries liable to produce fracture of the pelvis. The fracture lines are apt to be multiple, because the crushing force which breaks the pelvic girdle brings strain at the same time on various parts. Separation of the pubic and sacro-iliac synchondroses or joints is not an unusual result of traumatism, and in young persons the epiphyseal lines of the innominate bone may be forced asunder by violence that in older persons would cause fracture. The pubic, iliac and ischiatic elements unite between the years of fifteen and twenty; the secondary centers at about twenty five years.

The usual severity of the causative violence and the relation of the pelvis to the viscera render the prognosis as to life unfavorable. Laceration of the urethra, usually in its membranous portion; rupture of the bladder, rectum, colon or small intestines; injury to the uterus; rupture of the iliac artery or vein, and contusion or laceration of the solid viscera are not at all infrequent complications. Death from secondary affections, such as suppuration in the cellular tissue of the pelvis or necrosis, must be recollected as a possibility. If no such complications occur, cure of even severe fractures takes place. Union may be expected in from six to eight weeks, but lameness is usual from more or less permanent disability of the muscles injured by the accident or restricted in their function by the process of union or cicatrization. Deformities narrowing the pelvic canal may occasion serious difficulty in subsequent parturition.

The character of fracture varies with the direction of application of the fracturing force. Sometimes the fracture lines are vertical, one or more passing through the rami of the pubes and ischium on one or both sides of the middle line and another through the iliac portion of the innominate bone into the sacro-sciatic notch. In the posterior segment of the circle, the sacrum may be split vertically or the sacro-iliac joint torn open. Lateral crushing may drive the head of the femur through the acetabulum into the pelvic cavity; or, if less severe, may produce lines of fracture radiating from the acetabular region. Parturition, forced abduction of the thighs and direct external violence have produced separation of the symphysis of the pubes. The separation is said to occur between one of the pubic bones and its attached cartilage rather than between the two cartilages which the joint contains. The gap felt through the integument may be as much as two inches wide. Occasionally the symphysis of the pubes and one of the sacro-iliac articulations have been torn open so that half of the pelvis and the corresponding leg have been markedly displaced upward. Of the fractures which involve the continuity of the pelvic ring, that in the pubic region is most common, for here the bony constituents of the pelvis are most fragile. Transverse or nearly transverse fractures of the sacrum or the coccyx are occasional lesions. In both the tendency is for the lower fragment to be bent inward with its lower extremity pointing toward the interior of the pelvis. Dislocation of the coccygeal articulations is practically identical with fracture of the ankylosed bone.

Symptoms.—Displacement is not very great in the majority of pelvic fractures; but palpation will, if the parts are accessible, usually show either deformity, mobility or crepitus. Vaginal and rectal exploration will be serviceable in a few cases. Shortening of the lower extremity, from upward displacement of the pelvis, and inability or indisposition to move the limb will at times aid in the diagnosis. Loss of support, fear of pain and laceration of the muscles attached to the pelvis may all have part in the production of this disability. A good deal of subcutaneous extravasation of blood is frequently a feature of these injuries.

Careful observation of the relative position of the anterior spinous processes of the ilium will at times serve to strengthen or weaken an obscure diagnosis. Crepitus may be elicited and correction of deformity secured by traction on the lower limb. Escape of blood from the urinary meatus or rectum, retention of urine, bloody urine and the rapid supervention of tympanites or peritonitis suggest the probability of fracture of the pelvis in cases with appropriate history. The use of the Roentgen rays may aid in demonstrating lines of fracture.

In sacral fracture, paralysis of rectum, bladder and legs, from complicating lesions of the sacral nerves, is said to be not unusual; and pain on coughing or defecation may be expected. Seizing the bone between a finger in the rectum and the thumb on the dorsum will probably demonstrate motion and crepitus and perhaps correct the displacement. Coccygeal fracture occurs probably more frequently from parturient efforts and manipulations than from other traumatism. Rectal examination will often establish the correct diagnosis and reduce the displaced fragments. Fractures of the crest or processes of the ilium are probably the least important of the fractures of the pelvic bones, for they have as a rule no serious complications and confine the patient to bed for only a couple of weeks or perhaps not at all. Mere fissure of the cavity of the acetabulum has no characteristic symptom.

Fracture of the rim of the acetabulum is worthy of consideration. It usually occurs as the result of great violence applied to the hip and as an accompaniment of dislocation of the femur. Dislocation backward of the head, with breaking of the posterior and upper margin of the acetabular rim, is the ordinary form of the lesion. The symptoms are those of dislocation of the head of the thigh bone with crepitus, and a ready recurrence of the dislocation after its reduction. Fracture of the neck of the femur may be mistaken for dislocation and fracture of the acetabular margin, because crepitus and recurrence of deformity are essentially marked symptoms in the former injury. In fracture, however, unless it is impacted, the limb assumes a position of outward rotation and extension, while in the posterior dislocations, which are the varieties likely to be seen here, the limb takes the position of inward rotation and flexion on the pelvis. Again, in fracture the trochanter is relatively nearer the anterior superior spine of the ilium than in dislocation. It is well in all cases of doubt to make sure of the actual position of the head; and also to remember that dislocation of the femoral head complicated with fracture of the neck of the bone is not impossible, and that the crepitus attributed to fracture of the acetabulum may exist really between the fragments of the broken femoral neck.

Treatment.—The treatment of fractures of the pelvic bones varies with the location of the injury; but in all the severer forms of fracture the surgeon should at once introduce a catheter, in order that laceration of the urethra may be discovered, if it exist, before extensive extravasation of the urine has occurred. Shock must also be treated. If the end of the catheter will not pass beyond the torn portion of the urethra into the bladder, a perineal incision should immediately be made. This incision should be made in the middle line and should open the tissues down to the seat of rupture, to which the end of the catheter left in place is a guide. Exit is thus given for the urine to pass from the opening in the urethra to the exterior and disastrous extravasation into the perineal structures is averted. It is not proper to open the neck of the bladder unless the bladder itself is ruptured. The incision down to and into the urethra at the point of its rupture is all that is required to conduct the urine to the surface. The case should then be managed, so far as this feature is concerned, as one of external urethrotomy for stricture, by the occasional passage of a bougie. If a catheter can be introduced through the torn urethra into the bladder, no incision is demanded and the instrument, preferably a rubber one, should be retained in the bladder for a few days until danger of urinary infiltration has passed.

Violent manipulation may increase visceral damage in pelvic fractures and should be avoided, though careful efforts at correcting marked displacements are proper. Rest in bed in the dorsal, prone or lateral position, according to the comfort of the patient, and support to the pelvis by encircling bands of adhesive plaster or by a broad girdle of muslin or flannel will usually meet the indications. All pressure liable to cause displacement or pain must be avoided by pads. A gypsum dressing may sometimes be serviceable. Continuous traction by weights attached to the leg and thigh, as in fracture of the femur, may be the only means of preventing upward displacement in double vertical fractures on the same side of the median line. Fractures of the ischium may require pressure to be applied within the rectum in order to effect coaptation of fragments. The finger or a wooden lever may be employed. A few cases have been treated efficiently by means of packing kept in the rectum for a series of days to prevent recurrence of displacement. The packing, which should be enclosed in a rubber bag, must be occasionally removed to allow defecation and escape of flatus, unless a canula be placed through the center of the distending apparatus. A rubber bag distended with air or water and well oiled, when inserted, would seem to be the most judicious means for effecting this seldom required intra-rectal pressure. In fractures of the iliac wings the encircling bandage must be omitted, if it tends to press the fragments abnormally inward. In fractures of the tuberosity of the ischium the hamstring muscles should be relaxed by flexing the leg on the thigh, while the thigh should be extended or semi-extended at the hip. In instances of great comminution followed by extensive suppuration, provision for free drainage should be made and detached splinters of bone removed early.

The neuralgic affection, coccygodynia, whose symptoms are not unlike fissure of the anus, may be a secondary result of fracture of the coccyx. If subcutaneous division of the soft structures attached to the coccyx fails to relieve the pain, removal of the bone, by means of the cutting forceps or saw or with the burr of the surgical engine, may be performed.

Fractures of the Clavicle.

Pathology.—Direct violence and muscular strain, as in lifting heavy weights, may cause fracture of the clavicle. By far the most common cause, however, is indirect violence, for in falls upon the shoulder, elbow or hand the force of impact is transmitted to the clavicle, which constitutes the only bony connection of the arm with the trunk. A tendency to exaggerate the curves of this doubly curved and doubly twisted bone is thus produced and the bone gives way as soon as the strain becomes too great.

The outer part of the middle third is the most common site of fracture, but from its obliquity the line may extend into the outer or inner third. The small diameter of the bone and the sharpness of the curve at this point, associated with the frequent causation from indirect violence, are satisfactory reasons for the lesion showing this preference.

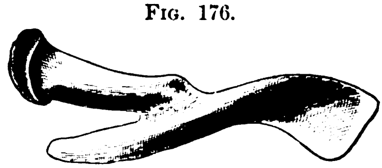
Comminuted, multiple or open fractures of the clavicle are rare. Green-stick fractures are common, and transverse breaks with little displacement or laceration of periosteum by no means unusual.

Fig. 175.

Deformity from fracture of clavicle united with displacement. (Hamilton.)

Symptoms.—The usual deformity after the ordinary fracture of the middle portion of the clavicle is produced by tilting upward of the outer end of the sternal fragment and displacement inward, forward and downward of the inner end of the acromial fragment. The projection upward of the former has been attributed to the lifting force

Fig. 176.



Fracture of clavicle.

exerted by the outer fragment being thrust under it and also to contraction of the sterno-cleido-mastoid muscle. The displacement inward, forward and downward of the acromial fragment is due to the fact that the clavicle is the support or stay which holds the scapula and its attached arm in proper relation to the thorax. When the clavicle is broken, the scapula, partly by reason of the weight of the arm and partly by the action of the great serrated and the lesser pectoral muscles assisted perhaps by the rhomboids, is rotated forward around the dorso-lateral aspect of the chest in such a way as to depress the acromion and carry it toward the anterior middle line of the trunk. This displacement of the point of the shoulder and the consequent relation of the clavicular fragments are well shown in the diagram adapted from Stimson. It represents in a schematic way the intact as well as the broken shoulder girdle as the claviculo-scapular combination has been called. The inward and forward displacement of the acromion is seen at a glance. The downward deformity, being in another plane, is of course not exhibited. Shortening of the clavicle is great in oblique fractures with over-riding and may amount to one and a half or two inches. Sometimes, in transverse fractures, interlocking of fragments gives upward and backward angular deformity. In all fractures the continuance of the fracturing force, after rupture of bone has occurred, and the line of break have influence in determining the amount and direction of the displacement.

Fractures of the outer third of the clavicle are often transverse and, in reference to frequency, come next to fractures of the middle third. The deformity is usually angular, with the acromial fragment thrown forward. In fractures of the inner third the most usual deformity is due to displacement downward and forward of the inner end of the acromial portion of the bone or angular distortion of both fragments in the same direction.

FIG. 177.

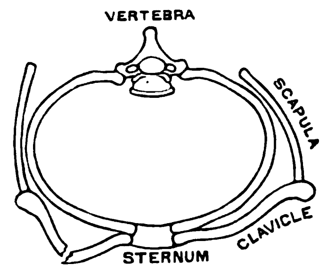


Diagram showing sliding forward of scapula and tilting out of its posterior border in fracture of clavicle.

The local deformity arising in fractured clavicle has been discussed; but in addition there is falling inward and forward of the shoulder and projection of the inferior angle and posterior border of the scapula. This is an especially prominent feature of the injury when great overlapping occurs in lesions in the middle third of the bone. On account of the usually indirect causation of the injury, contusion, if existent, will be found on the shoulder, elbow or hand, and not at the seat of fracture. Crepitus may not be perceptible until the shoulder is pressed outward and backward, so as to bring the ends of the overlapping fragments together. A loss of function, due to pain induced by movements and not to mechanical obstruction, is shown in inability to place the hand on the head while the latter is held erect or to raise the arm so as to hold it out at a right angle with the trunk. In green-stick fractures fixed local pain may be the single symptom, until, in the course of a fortnight, a small nodule of callus is perceptible. This condition must be discriminated from the localized pain and subsequent nodular deformity of syphilitic periostitis. Fractures near the acromial end of the clavicle simulate dislocation.

The vascularity of the collar bone enables union to become quite firm by the end of the third week. Non-union is rare, and, when occurring, produces a very moderate degree of disability. Impairment of function from pressure of exuberant callus on the vessels and nerves behind the clavicle is a remote possibility. The paralysis sometimes attributed to such cause is oftener, perhaps, the result of injurious pressure of a large axillary pad used in treating the fracture.

Treatment.—Cure, without deformity, of clavicular fractures presenting much primary displacement seems, with our present appliances, to be almost impossible. Fortunately the permanent distortion so often left is a cosmetic defect rather than a disability.

The probability of permanent deformity after complete fracture renders it wise to desist from too active attempts to straighten the bone in the green-stick fracture, for if complete separation is caused by the manipulation greater disfigurement is liable to occur. Straightening should, therefore, be attempted only with a moderate degree of force, especially as the bent bone may even regain something of its normal shape during the after-growth of the patient.

In complete fractures correction of deformity is to be attempted by grasping the scapula and swinging it around the posterior chest wall toward the median line of the back and holding its lower angle against the ribs. This procedure tends to carry the acromion and head of the humerus outward and backward and thus to restore the position of the shoulder, which has been changed by the loss of the support given by the unbroken clavicle. At the same time moulding of the fragments at the seat of fracture should be practiced. A similar effect may sometimes be produced by standing behind the patient and pulling the shoulder backward with one hand, while coaptation is secured by pressure with the other hand at the seat of lesion. Good position is usually obtainable by these manœuvres. The difficulty in treatment arises from the impossibility of retaining correct apposition for two or three weeks by apparatus that can be tolerated by the patient and worn during walking.

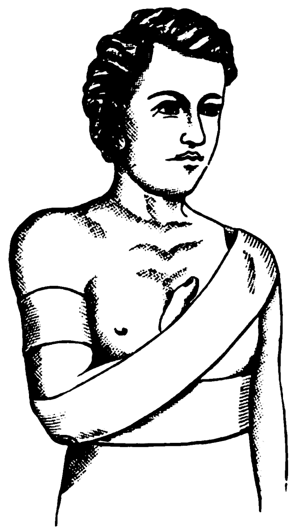
Dorsal recumbency on a firm, level mattress, with the head bent a little forward by a small pillow and the injured arm laid and fixed by a bandage or adhesive strip across the chest with the elbow close to the ribs, is the best method of treatment. In this posture the weight of the body keeps the scapula pressed against the chest and prevents it rotating forward. A bag of shot or sand may, if necessary, be laid upon the acromion to hold the shoulder more firmly outward and backward. The position of the arm also aids in maintaining coaptation and preventing over-riding. Few persons, except perhaps women who occasionally dress so as to expose the neck, care to maintain this irksome posture for several weeks, especially when informed of the fact that deformity, though unsightly, is not prejudicial to good use of the arm. Experience, however, seems to show that if this line of treatment is continued for ten days or two weeks the solidification of the fracture becomes such that the erect posture may be assumed, in conjunction with the ordinary fracture dressing, without any great tendency to reproduction of displacement. The best treatment for fractured clavicle, therefore, is the recumbent posture for about ten days, followed by the ordinary dressings, when the patient is released from his confinement in bed, for about two weeks more. When the least possible deformity is especially desirable, the recumbent posture should be retained for three or four weeks. Continuous coaptating digital pressure could be maintained for several weeks, if necessary, to insure more absolute perfection in the result. The free administration of chloral and bromide of potassium will overcome the nervous restlessness which the requisite immobility of the trunk engenders.

When confinement to bed is objected to by the patient, the dressing of Bryant, Sayre, or Velpeau should be adopted. Bryant reduces the fracture and then places a pad over the scapula below its spine and binds the bone firmly to the chest by strips of adhesive plaster, extending from the vertebral spines to the sternum. The arm of the injured side is then supported in a sling, with the hand drawn upward toward the opposite shoulder. Sayre uses two strips of adhesive plaster about three inches wide and one and a half to two yards long. At the end of one strip a large loop, with the back of the plaster inward, is made by stitching with a needle and thread. After the skin of the chest has been shaved, the injured arm is passed through this loop, which must be loose enough not to constrict the vessels. The elbow is then drawn well backward and fixed in that position by the free end of the plaster being carried around the entire chest from back to front, as shown in the illustration. This end should also be se-

FIG. 178.

First stage of Sayre's dressing for fractured clavicle.

FIG. 179.



Sayre's dressing for fractured clavicle completed.

cured by stitching, if there is any probability of the plaster slipping. The flexed forearm is now laid across the chest and the elbow carried forward, so that the loop of the first strip is made to act as a fulcrum. The middle of the second strip is then applied under the olecranon and the elbow forced upward by carrying the ends of the plaster along the forearm and across the back to the opposite shoulder. A slit should be made in this strip at the elbow, to relieve the olecranon of painful pressure, and pieces of lint should be placed under the forearm and in the axilla to prevent irritation from sweating. In cool weather this dressing may require no renewal during the time necessary to maintain immobility. If the fragments project upward notwithstanding the dressing, a compress may be placed upon the seat of fracture and held there by a short strip carried down the back and front of the chest. A pad of cloth, covered with plaster with the adhesive side outward, will stick to the skin and not easily slip out of position. The hand may be left free, if desired, by passing the second strip along the ulnar side of the wrist. This lessens the discomfort of the dressing.

A good dressing in some cases is that of Velpeau. After placing the hand of the injured side on the opposite shoulder, a roller bandage is carried from the scapula of the well side obliquely over the back to the injured shoulder, over this, down the outside of the arm, under the elbow, across the chest to the opposite axilla and to the point of starting. When the arm has been well supported by several turns of this kind, the bandage is carried around the thorax and arm by circular turns from elbow upward. This dressing can be made more secure by coating it with silicate of sodium or gypsum or by applying several narrow strips of adhesive plaster, about a foot in length, vertically over its folds.

FIG. 180.

Velpeau's dressing for fracture of clavicle.

If displacement cannot be obviated by these methods, subcutaneous nailing of the fragments or incision followed by suture of the bone may be employed.

In children the dressing for fractured clavicle should be continued for two or three weeks, in adults three or four weeks.

Fractures of the Scapula.

The mobility of the scapula and its environment by muscular masses protect it quite efficiently from fracture under ordinary forms of accidental injury. Fracture, when it does occur, is usually of the body, acromion or surgical neck. The spine and the coracoid process also suffer fracture, but these lesions are of great rarity. The rim of the glenoid cavity is occasionally chipped off in dislocations of the head of the humerus and the cavity itself may at times be fissured, but the obscurity of the symptoms renders diagnosis almost impossible.

In suspected fracture of the body, placing the forearm across the chest or behind the back will render the posterior border of the bone sufficiently prominent to enable the surgeon to detect deformity from displacement. Crepitus is best obtained, perhaps, by placing the palm of one hand over the scapula while the patient's arm is moved in various directions, or by the examiner insinuating his fingers under the inferior angle of the bone and endeavoring to obtain motion while he steadies the upper part of the bone with the other hand on the shoulder. The ridges sometimes so well marked along the borders and spinous process of the bone must not be mistaken for fracture with displacement.

Reduction of the fragments may be difficult but should be attempted by pressure while the patient's arm is moved in various directions. Broad adhesive strips carried across the scapula and partly around the thorax and a bandage applied to raise the elbow and keep the arm against the side in a more or less vertical position furnish an appropriate dressing. Union takes place in about three weeks and good use of the limb is to be expected, even if some deformity persists. In open fractures suppuration may occur from bacterial infection and pus burrow under the scapula. This should be averted by furnishing facilities for drainage as soon as needed.

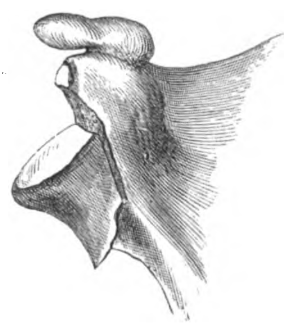
Fracture of the acromion and separation of the acromial epiphysis are lesions often indistinguishable. The two centers of ossification for the acromion appear about the sixteenth year, and ossification is complete between the twenty second and twenty fifth year. Hence, direct violence falling upon the elbow or muscular contraction may easily cause epiphyseal separation even in adults.

The line in acromial fracture is usually either in front of the articulation with the clavicle or at the root of the acromion process. Absence of deformity and contusion of the soft parts may obscure the recognition of the lesion. When the process is broken at its base much flattening of the shoulder is produced by the weight of the arm pulling the fragment downward and inward. Less deformity results when the mere tip is broken off. Inability to abduct the arm usually accompanies acromial fracture; and crepitation may be obtained by grasping the shoulder while the elbow is forcibly pushed upward. Fibrous is more common than bony union, probably because close contact of fragments is not obtained. The indication for treatment is to immobilize

FIG. 181.

Fracture of body of scapula. (DENNIS.)

FIG. 182.



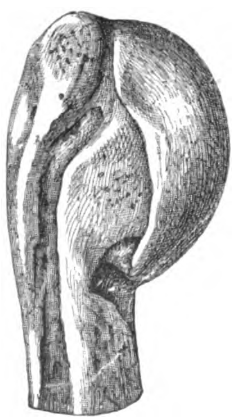
Spence's case of fracture of the neck of the scapula. (GURLT.)

the arm with the head of the humerus forced well up against the scapula. Velpeau's dressing for clavicular fracture answers the purpose very well and should be continued about three weeks. The least deformity is probably obtained by keeping the patient on his back in bed with the arm extended at a right angle to the trunk, in order to relax the deltoid, which is the displacing muscle.

Fracture limited strictly to the constriction immediately behind the glenoid cavity, which has been called the anatomical neck of the bone, is practically unknown. Fracture may take place, however, behind the coracoid process in a line passing downward from the supra-scapular notch or in such a direction as to split off most of the head of the bone while leaving the coracoid process attached to the body of the scapula. These rare lesions are called fractures of the surgical neck of the scapula.

The flattened shoulder, prominent acromion and loss of voluntary motion of the arm make the lesion resemble axillary dislocation of the head of the humerus; but the easy reduction and immediate recurrence of deformity, the crepitation and the absence of the humeral head in the axillary space establish the distinction. The sinking of the outer fragment of the scapula with the attached humerus into the axillary space may mislead the careless surgeon into the belief that a humeral dislocation has occurred. The treatment resembles that for fracture of the clavicle, though an axillary pad to keep the arm out and steady the scapula is perhaps more essential in this instance. The downward displacement is to be antagonized by a short sling or bandage to lift the elbow.

FIG. 183.



Fracture through tuberosities of humerus with head united to the shaft at a lower level than normal. (STIMSON.)

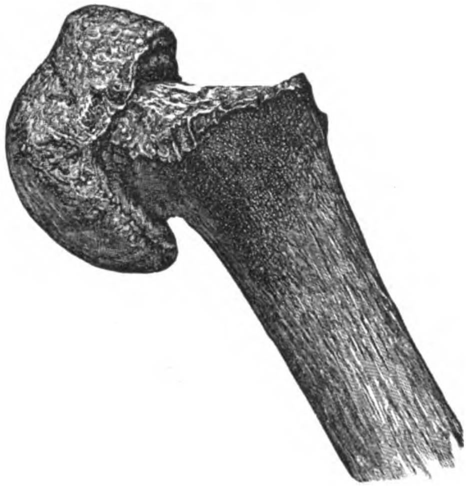
Fractures of the Humerus.

These injuries are conveniently grouped as fractures of the upper end, fractures of the shaft and fractures of the lower end of the bone.

FRACTURES OF THE UPPER END OF THE HUMERUS. **Pathology.**—The usual lines of fracture in this part of the humerus are through the anatomical neck and tuberosities; at the surgical neck, which is the constriction with indefinite boundaries seen below the tuberosities; and at the line of the main epiphyseal cartilage. Fracture of the surgical neck is the most common of these. Fractures of the head alone, of the anatomical neck alone and of the tuberosities alone are possible injuries, but are too rare in occurrence and too difficult of exact clinical recognition to warrant discussion in this treatise. Detachment of a portion of one of the tuberosities by muscular action happens occasionally as an accompaniment of dislocation of the head of the humerus; and is, in fact, a lesion very similar to what has been elsewhere described as sprain fracture.

Fractures through the anatomical neck and tuberosities frequently show little displacement, because the fragments are impacted or are held together by untorn periosteum. There is no evidence that fractures entirely within the capsule of the shoulder joint fail to unite or that the superior fragment acts as a foreign body and causes violent arthritis. Sometimes the lower fragment or shaft is drawn upward by the deltoid muscle in such a manner that the upper fragment or head becomes united to the former at a lower level than normal and gives the joint the appearance of being the seat of an unreduced dislocation.

FIG. 184.



Separation of the upper epiphysis of the humerus; displacement forward of the lower fragment. (MOORE.)

The surgical neck of the humerus is frequently broken and sometimes with but little displacement. Fissured lines may extend upward within the articular capsule, and impaction is not unusual. Displacement of the end of the lower fragment inward seems to be the most common deformity. Separation of the main epiphysis, which consists of the head and tuberosities, resembles in many respects fracture of the surgical neck, but only occurs previous to the twentieth year of life. When displacement occurs there is seen on the front of the shoulder, an inch or so below the acromion, a prominence which on palpation is felt to be a smooth, slightly convex end of bone, moving with rotation of the elbow. It is the upper end of the humeral shaft. Preternatural mobility and soft crepitus may be distinguished. Union of fractures of the surgical neck and of epiphyseal separations occurs in five to six weeks, and is followed by good results if displacement has been corrected. The injury to the epiphyseal cartilage is sometimes, however, followed by arrest of longitudinal growth of the bone. Occasionally, the upper fragment is so rotated by the scapular muscles that its under surface looks forward and outward. In such cases apposition may

FIG. 185.

Fracture of the surgical neck of the humerus. (DENNIS.)

often be obtained by abducting the arm and carrying the elbow up alongside of head until the lower fragment becomes interlocked with the upper one. Coaptation will sometimes be maintained after this manipulation when the arm is gently depressed again.

Diagnosis of Injuries about the Shoulder-joint.—In investigating traumatic lesions in the vicinity of the shoulder, recognition of the fact that fracture exists is more important than a knowledge of the exact variety of fracture. The relation of the bony prominences to each other should be investigated and the correspondence of such relations with that on the normal side carefully established. The surgeon should grasp the head of the humerus with the fingers of one hand while he

FIG. 186.

Skiagraph of fracture of shaft of humerus. (Polyclinic Hospital.)

rotates the arm by the other hand applied to the elbow. If a fracture exists between these two points the motion given to the lower end of the bone will not be transmitted to the head unless impaction has taken place. The same manipulation will in most instances of fracture develop crepitus, especially if some extension be used at the same time to draw the overlapping ends into contact.

In the usual dislocations of the head of the humerus the shoulder will be flattened, the acromion very prominent and with a depression below it into which the surgeon's finger-tips can be pushed, the elbow will be abducted from the chest, the arm rotated inward and the head of the humerus readily felt by palpation in its abnormal location, which is usually the axilla or the fossa just below the clavicle. In addition to these symptoms voluntary motion is lost; passive motion greatly restricted; it is impossible to place the patient's hand on the opposite shoulder while the elbow of the injured side is pressed close to the chest; the long axis of the humerus is not directed toward the glenoid cavity but internally to it; the head of the bone is felt to move when the elbow is rotated; no true fracture crepitus is developed, though a soft rubbing sensation may be detected; and after reduction the deformity does not occur on removing restraint from the limb.

When the head of the humerus is in its normal position the upper portion of a straight rod laid upon the outside of the arm from shoulder to elbow will be half an inch, an inch or perhaps more from the edge of the acromion; but if the head is not in the glenoid cavity the rod will touch the acromion unless very great swelling of the soft parts happens to be present.

Fracture of the neck of the scapula is distinguished from dislocation of the head of the humerus by absence of rigidity during passive movement, which is almost unlimited; by crepitation, and by the immediate recurrence of deformity when pressure which has pushed the arm upward is withdrawn. Fractures of the head and of the anatomical neck of the humerus are too infrequent and too obscure of diagnosis to require further mention than has been previously given. Fracture of the greater tuberosity is unusual also, except as a complication of dislocation. Skiagraphy will aid in recognizing these injuries.

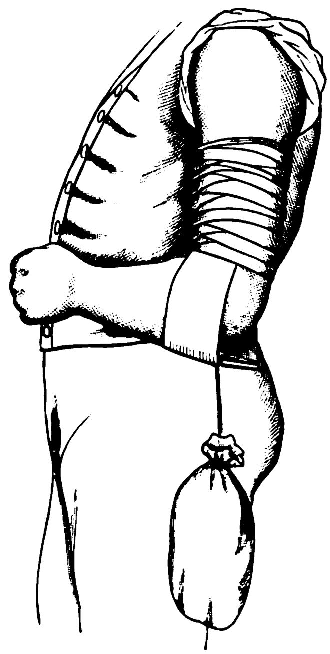
In epiphyseal separation, which occurs not later than the twentieth year, the head of the bone can be felt in its normal position though it does not move with the shaft, the upper end of which lies in front or to the inner side of the head. Soft crepitation is perceptible when the separated surfaces can be placed in apposition; the elbow can readily be pressed close to the ribs, though the arm is directed somewhat outward and backward; voluntary motion is lost; and passive mobility is increased.

Fracture of the surgical neck is common and is therefore the injury in this region which most frequently requires discrimination from dislocation. Displacement similar to that found in epiphyseal separation, the easy demonstration of the head of the bone in its normal position, preternatural mobility and crepitus unless impaction exists, and immediate recurrence of deformity upon removal or support are the usual features. The symptoms of fracture of the surgical neck and of epiphyseal separation are very similar and differ from those of dislocation in almost every particular except that in all three injuries voluntary motion is lost. In dislocation this is due to destruction of the articulation and the entanglement of the humeral head in its abnormal position, which circumstance gives an appearance of rigidity to the limb.

In fracture or epiphyseal separation loss of active motion results from destruction of the lever through which the muscles act, hence occurs an appearance of helpless inactivity. The use of Roentgen rays in the diagnosis of these injuries will furnish important information.

Any of these fractures at the upper end of the humerus may be complicated with dislocation of the scapulo-humeral articulation. The symptoms of the two lesions will then be a flat shoulder, prominent acromion and abnormal location of the globular head, combined with abnormal mobility, crepitus and deformity in the line of the bone. The freedom of passive motion and the ease with which the hand can be placed upon the opposite shoulder while the elbow is pressed to the ribs will differentiate the case from uncomplicated dislocation. When the accompanying fracture is a mere detachment of the greater tuberosity these last two symptoms will not be present. When none of the injuries just detailed has been detected and fracture of the clavicle, acromion or coracoid process also have been eliminated, the surgeon is justified in making a diagnosis of sprain or of contusion. The possibility of dislocation of the long tendon of the biceps may be considered.

FIG. 187.



Method of applying traction in fractures of the humerus. (HAMILTON.)

Treatment of Fractures at the Upper End of the Humerus.—The result of these fractures, if of ordinary severity and if displacement is overcome, is usually good; though in rheumatic patients a certain degree of stiffness often remains for a long time, even when the joint has not been invaded. The treatment of fractures of the head, anatomical neck and tuberosities consists in simple restraint of motion, induced by carrying a broad strip of adhesive plaster or bandage once around the arm and chest and placing the hand and wrist in a sling.

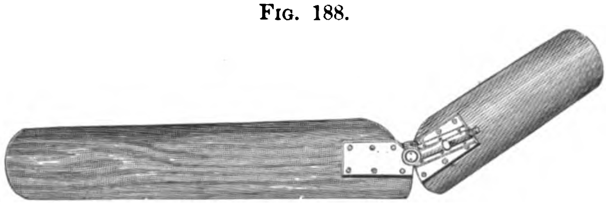
Other fractures at the upper end of the humerus are best dressed by filling up the hollow of the axilla with a folded napkin or thin compress, and then, after replacing the fragments, securing the arm against the chest with the elbow carried a little forward. In this manner the thorax acts as a splint to which the arm is bound by means of adhesive plaster or a bandage. The forearm may be laid across the opposite mammary region as in treating fractured clavicle or may be simply supported in a sling, which should preferably be applied near the wrist in order that the weight of the elbow may furnish some slight extending force. The shoulder cap splint is usually a useless and unnecessary complication. When it is deemed necessary that greater extension should be exerted a weight may be attached to the elbow by an extension apparatus of adhesive plaster such as is used for continuos traction or extension in fracture of the femur. In the event of the upper fragment being so rotated outward that coaptation cannot be maintained unless the lower fragment is carried upward and outward, it becomes necessary to treat the fracture with the arm strongly abducted. This may be done by using a triangular splint, of leather or other firm material, with a rounded apex. The apex should be pushed well up into the axilla and the legs of the triangle fixed to the side of the chest and inner aspect of the arm respectively. Another method is to put the patient in bed and by means of a traction apparatus of adhesive plaster, a pulley and a weight to obtain continuous abduction and extension of the limb. In such instances the arm usually has to be kept at an angle with the long axis of the trunk of from 30 to 45 degrees. Subcutaneous nailing of the fragments together may be preferable to these cumbersome dressings. The arm can then be carried in a sling and the patient allowed to walk about.

The dressing may be discontinued in ordinary cases of fracture of the upper end of the humerus in five or six weeks.

Gunshot and other open fractures involving the shoulder joint may demand excision, but conservative antiseptic measures and secondary excisions have of late years displaced to a great extent primary excisions. In fractures complicated with dislocation an attempt to reduce the dislocation should be made at once. If this is found impossible, the joint should be exposed by a sufficient incision and the head lifted into place by leverage or by inserting, as recommended by McBurney, a hook into a hole drilled into the head. The disability due to old fractures complicated with unreduced dislocation may sometimes be lessened by excision of the head or the upper end of the lower fragment.

FRACTURES OF THE SHAFT OF THE HUMERUS.—Fracture from muscular violence is more common here than in any other part of the skeleton except the patella and olecranon. Displacement in fractures of the shaft depends more on the breaking force than the action of muscles. The usual characteristic symptoms of fracture are present and easily determined. Involvement of the vessels and nerves in the injury is not so very uncommon. Wrist-drop from palsy due to pressure upon the musculo-spiral nerve and gangrene following vascular

FIG. 188.

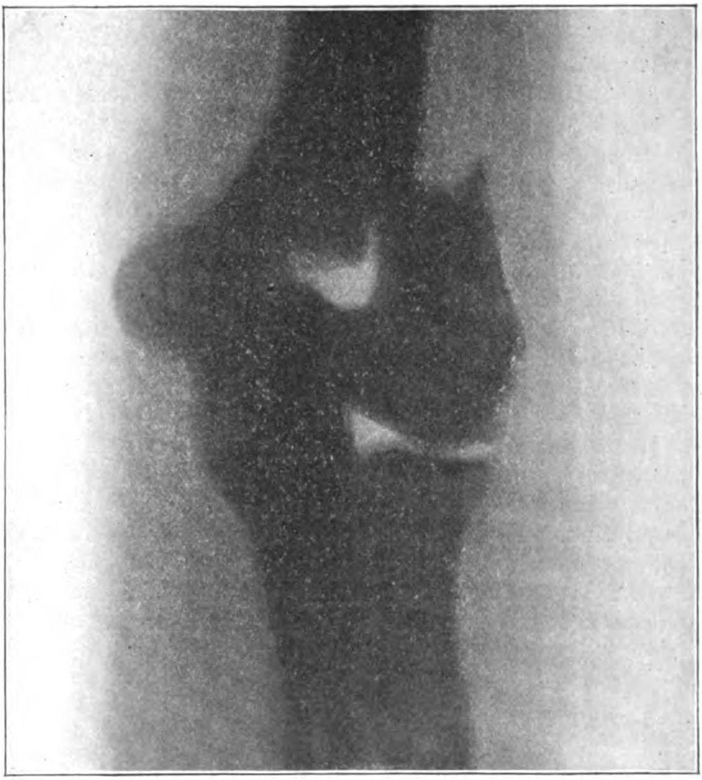


Internal angular splint with changeable angle.

damage must not be hastily referred to improper treatment. Union occurs among children in three or four weeks, among adults one or two weeks later. Delayed union and non-union happen more frequently than in other long bones.

In treating these lesions the surgeon should be especially on the alert to overcome rotary displacement. Such deformity can be detected by observing that a line drawn from the greater tuberosity to the outer condyle is not parallel to the long axis of the bone as it

FIG. 189.



Skiagraph of fracture of external condyle of humerus.

should be. When much swelling is present and when a suspicion of complicating injury of vessels or nerves exists, it is wise to keep the patient in bed a few days and employ simple support by pillows and cushions, lest the more constricting dressing be accused of producing gangrene or paralysis. Few fractures of the shaft require continuous extension by weight from the elbow. Fractures in the upper half of the shaft are well treated, as are fractures of the upper end, by using the lateral thoracic wall as a splint. The thin axillary pad, described in the manner of dressing, may act better if somewhat wedge-shaped and placed with its base downward.

In lesions of the lower, and sometimes in those of the upper half, an internal right angle splint, with or without an external concave splint of pasteboard, leather or guttapercha, makes a good dressing. The internal splint should be well padded at the elbow or have an opening in it to prevent pressure on the internal epicondyle. The elbow should not be drawn upward by the sling used to support the forearm. Sometimes an external angular splint, reaching from acromion to wrist, is preferable. At other times a straight external splint from shoulder to wrist may be found more effective in restraining motion at the seat of fracture, because it better immobilizes the elbow joint. The forearm should be semi-prone when this dressing is employed. The gypsum dressing is often satisfactory after primary displacement and swelling have been removed. When adapted it should be applied, with the elbow flexed, from the hand to above the shoulder with a few turns of the saturated bandage passing around the upper part of the chest. A forearm sling completes the dressing.

FRACTURES OF THE LOWER END OF THE HUMERUS.—The principal fracture lines which may occur at the lower end of the humerus are shown in the diagrams. In addition, the small tubercle on the external condyle, sometimes called the external epicondyle, may be detached and in very rare instances a portion of the articular surface of the bone may be chipped off. Comminuted fractures following no definite lines may occur here as elsewhere in the skeleton. It seems probable that, when falls are received on the elbow, fractures through the condyles may be often due to the olecranon being driven up against the articular surface of the humerus like a wedge.

FIG. 190.

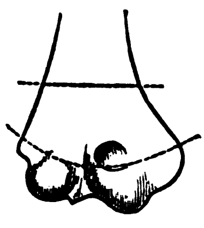
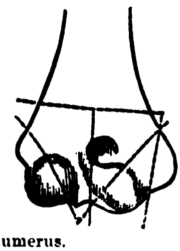


FIG. 191.



Principal fracture lines at lower end of humerus.

In studying injuries about the elbow, it should be remembered that there is normally no lateral motion between the humerus and the bones of the forearm. When the elbow is semi-flexed an apparent lateral motion is observable. It really takes place at the shoulder and not at the elbow, which is a hinge joint alone. Flexion and extension of the joint proper and rotation of the head of the radius are the only possible motions of the healthy articulation. Lateral mobility at the elbow means fracture or some other organic change in the constituents of the joint.

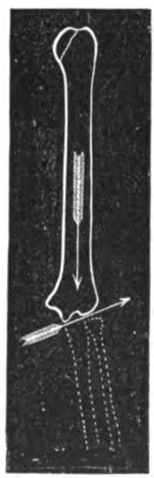
Fracture above the condyles may be mistaken for dislocation of the bones of the forearm, and if complicated with vertical splitting may involve the elbow joint. The most frequent displacement is projection of the upper fragment in front of the lower with angular deviation in the line of the limb. This, if uncorrected, will greatly impair the future utility of the joint. It is the prominence given the olecranon by this displacement that creates a resemblance to dislocation. The normal relation of the olecranon to the condyles, the natural character of the joint motions, the crepitus developed when extension is exerted on the limb and the recurrence of deformity establish the diagnosis.

Separation of the main lower epiphysis, which though small includes both condyles, may occur. In deformity, diagnosis and treatment the injury differs little from supracondyloid fracture. This conjugal cartilage ossifies about the sixteenth year. The prominent tubercle on the internal condyle, called the epitrochlea or internal epicondyle, may be the subject of epiphyseal separation or be broken off with or without a small portion of the bone at its base. The line of fracture is entirely without the

FIG. 192.

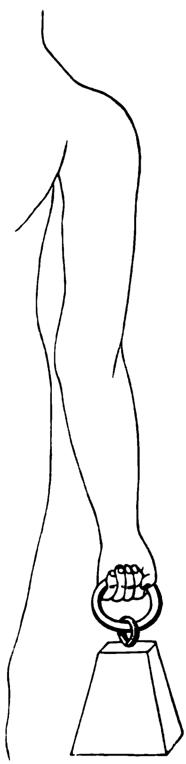
Fracture above condyles of humerus. (STIMSON.)

FIG. 193.



Normal angle of bones of forearm. (ALLIS.)

FIG. 194.



Outward deflection of normal forearm. (STIMSON.)

limits of the joint; hence, the articular motions are unimpaired unless by spasm or fear of pain. Downward and forward displacement of the fragment occurs when its fascial envelope is sufficiently disturbed to permit the influence of muscular traction. Simultaneous injury to the ulnar nerve lying in the groove behind the epicondyle is possible. Abnormal mobility and crepitation are easily detected by grasping the tubercle in the fingers.

Fractures separating either of the condyles from the shaft necessarily involve the joint, and hence are very important injuries. Such fractures are common. The essential components of the elbow hinge are the ulna and the articular surface of the internal condyle. Hence, fractures of the inner condyle are especially dangerous to the future in-

FIG. 195.

Fracture of internal condyle. (HAMILTON.)

FIG. 196.

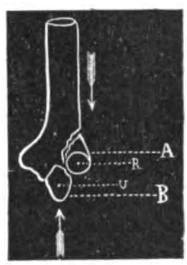
Fracture of external condyle. (HAMILTON.)

tegrity of joint mobility. The ulna joins the humerus in such a way that the axes of the two bones form a divergent angle. This outward deflection of the forearm gives the carrying function to the limb, by which the hand when hanging by the side is enabled to carry burdens without striking the thigh. Loss of this angle by ascent of the

FIG. 197.

Epiphyseal separation or fracture above condyles, showing possibility of deformity by tilting the lower fragment. (ALLIS.)

FIG. 198.



Fracture of external condyle showing similar possibility of deformity. A, external condyle; B, olecranon. (ALLIS.)

internal condyle or descent of the external condyle after fractures causes the gunstock deformity and more or less impairs the usefulness of the limb. Such displacements are very common. The condyloid fragment in fracture of the inner condyle is usually displaced upward and backward and drags the attached ulna with it, thus destroying the divergent angle at the elbow. It is said that a quarter-inch displacement upward will destroy this angular deviation. The anterior or posterior right angle splint often used to dress this fracture is accused of being a frequent cause of this deformity, because such a splint bandaged upon the flexed elbow tends to raise the ulna till it lies on the same plane as the radius, while it normally lies below that bone when the elbow is bent. The displacement in fractures of the outer condyle is often upward, thus increasing the outward angle at the elbow; but the radius with the attached condyloid fragment may be forced down by rectangular splints till it reaches the level of the ulna, so as to cause a loss of the divergent angle at the elbow. Dr. Allis

FIG. 199.

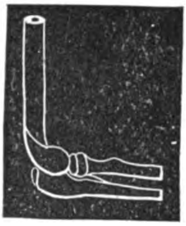


FIG. 200.

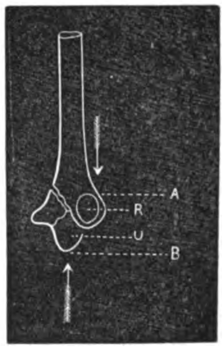


FIG. 199.—Differing planes of radius and ulna. (ALLIS.)

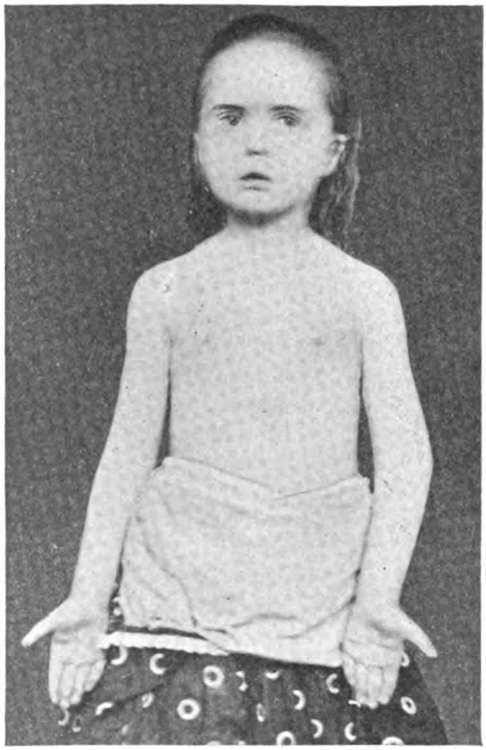
FIG. 200.—Relation of radius and ulna to humerus in fracture of internal condyle, showing ease with which ulna and broken condyle can be forced up by splint and bandage, and thus destroy carrying function of arm. A, external condyle; B, olecranon. (ALLIS.)

thinks that epiphyseal separation and fractures above the condyles may show similar distortion from the use of rectangular splints. Condyloid fractures are occasionally associated with partial or complete dislocation of one or both forearm bones.

The existence of mobility and crepitus is to be determined by grasping the lower end of the humerus and the suspected condyle with the fingers of the two hands and endeavoring to move the condyle alternately backward and forward. In the fully extended normal articulation a line joining the two epicondyles crosses the tip of the olecranon, but as flexion is made the olecranon sinks below this line. The position of the head of the radius, one half inch below the external epicondyle, should also be recollected in order to differentiate dislocation of this bone. If the surgeon places a finger at this point and then rotates the patient's hand, the head of the radius will be felt rolling under the integument. The transverse diameter of the lower end of the humerus is usually increased in condyloid fracture, because of the obliquity of the line of fracture and the common tendency in both fractures to upward displacement; but it is often difficult to be certain of this widening. When backward displacement has occurred after fracture of the internal condyle, the prominent olecranon during flexion and the disappearance of this projection during extension greatly resemble backward dislocation of the bones of the forearm.

The term intercondyloid is applied to those fractures in which the condyles are split apart and at the same time are separated from the shaft. The fracture lines may be exceedingly diverse in direction, but in simple cases assume an irregular **T** or **Y** shape. In intercondyloid fractures, which are, however, not very common, the joint is of course implicated and very often great damage to the soft parts co-exists. Separation of the condyles with the olecranon forced up between them is a not unusual displacement. Great distortion of the joint, increased width of the lower end of the humerus and crepitation when the fractured surfaces are brought into contact render the diagnosis evident.

FIG. 201.



Gunstock deformity after fracture of lower end of humerus treated with angular splint.

Diagnosis of Fractures at the Lower End of the Humerus.—Supra-condyloid fracture with the ordinary backward displacement of the lower fragment shows unusual projection of the olecranon and triceps tendon, increased by straightening the elbow; correction of deformity when traction is made upon the forearm, with recurrence of the same when the traction ceases and the elbow is bent; motion and crepitus above the joint; free mobility at the joint which may, however, be limited by swelling or spasm; and a normal relation of the olecranon and epicondyles. In backward dislocation of the bones of the forearm the usual projection of the olecranon and triceps tendon is diminished by straightening the elbow and the point of the olecranon rises above the level of the epicondyles; when the deformity is reduced there is

FIG. 202.

T-fracture of humerus. (HELFERICH.)

a distinct snap and recurrence of distortion does not readily recur; no motion or crepitus can be developed above the joint, though joint friction may simulate fracture crepitus; the normal articular movements are almost abolished and the joint is fixed, though some abnormal lateral motion may be possible; the relative position of the epicondyles and olecranon is altered; the head of the radius is not in its proper situation; the distance between the epicondyles and the corresponding styloid processes at the wrist is decreased; and the lower end of the humerus feels smoother and wider than the lower end of the shaft in case of fracture.

When the lower fragment is displaced forward the question of diagnosis is easily settled, because forward dislocation of the forearm is exceedingly rare and the symptoms are characteristic.

Fracture of the internal condyle is diagnosticated by crepitus and independent mobility; lateral mobility at the elbow joint when the forearm is extended; and in addition, when displacement is present, change in the divergent angle of the elbow and alteration in the horizontality of the line drawn across the back of the articulation joining the epicondyles and olecranon. If dislocation of the head of the radius coexists, the head of that bone will probably be discovered behind the external condyle and the internal condyloid ridge of the humerus will be felt to terminate abruptly at the line of condyloid fracture. In fracture of the external condyle, crepitation, independent mobility, alteration of the normal lateral deviation of the axis of the limb at the elbow, change of the external condyle's relation with the other condyle and olecranon but a normal relation with the head of the radius will serve to indicate the nature of the lesion.

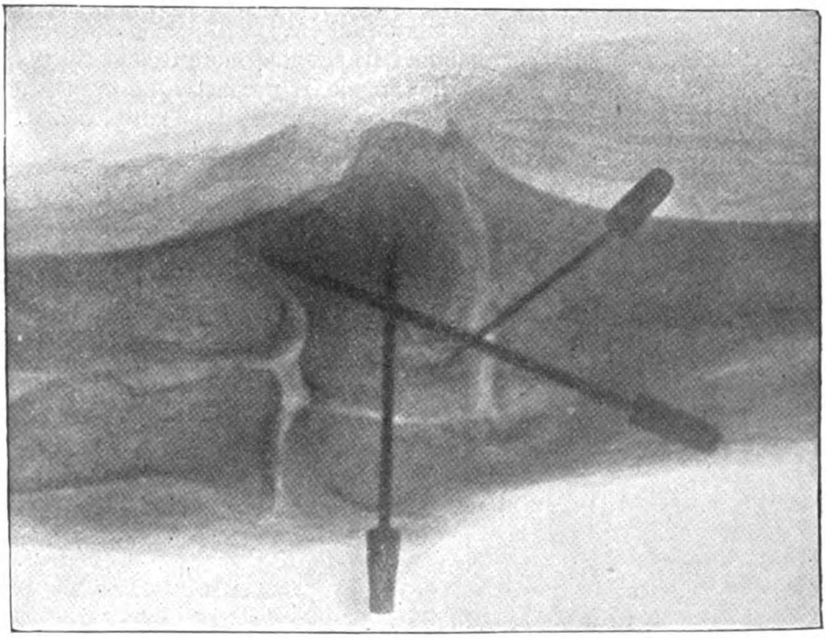
The relation of the external condyle to the head of the radius should be carefully studied when outward dislocation of the radius and ulna is a question to be determined.

In suspected intercondyloid fractures, great deformity with abnormal relation of the bony landmarks, increase in width of the lower end of the humerus, independent mobility of the condyles and between the condyles and shaft, and crepitation, especially noticeable when the olecranon is drawn down and the condyles pressed together, are the symptoms to be sought.

Disability after fractures of the lower end of the humerus has often been ascribed to synovitis due to involvement of the joint by the fracture. It is probable that the stiffness is nearly always due to imperfect reduction of the fragments. This defect in treatment permits mechanical obstruction to free motion; because the fragments or the masses of callus, due to their malposition, alter the shape of the articulating surfaces. Hence, a careful examination under general anæsthesia and with Roentgen rays is often imperative in these fractures. If there be doubt as to the perfection of the replacement, arthrotomy should be performed. An aseptic incision is free from probability of harm and enables the surgeon to do justice to the condition. The front of the condyles is best exposed by an incision over the inner edge of the long supinator muscle. This muscle is then drawn outwards.

Treatment of Fractures at the Lower End of the Humerus.— Many surgeons treat these fractures in the flexed position with anterior or internal angular wooden splints or with posterior angular trough-like splints, made of felt, tin, gypsum or similar material. The best results will generally be obtained by keeping the joint almost completely extended during the time that displacement is likely to occur. Ankylosis in the extended posture is very undesirable, but, unless permanent ankylosis is very certain to occur, disability from the gunstock deformity is best guarded against by keeping the joint extended. Fractures of the epicondyles, some fractures of the external condyle, fracture of the internal condyle with backward luxation of the radius and

FIG. 203.

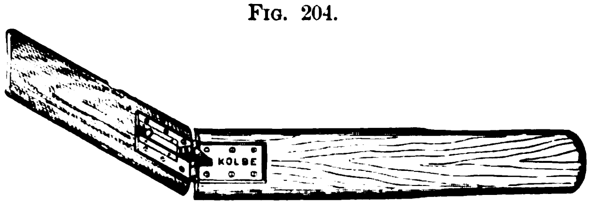


Skiagraph of experimental fracture of lower end of humerus fixed by three nails.

ulna and bad intercondyloid fractures may perhaps give better results when the flexed position is adopted, but for the great majority of cases the extended posture is better. The dressing, then, for fractures at the lower end of the humerus consists of a flat wooden splint, twelve or fourteen inches long, placed upon the anterior surface of the arm and forearm, with a little extra padding at the bend of the elbow as complete extension of the joint is not desired. The application of a moulded gypsum splint to the anterior or posterior surface, or to the entire circumference of the arm, is sometimes preferable. About three weeks is usually long enough to retain the splint upon the limb. In all cases the surgeon should see that the outward deflection of the forearm, due to the obtuse angle between the axes of the arm and forearm, is maintained. It is usually best to have the flat splint cut so as to make a slight outward deflection between the axes of the upper and lower portions. Such splints are quickly cut from a strip of board with a pocket knife. It is well to compare the patient's arms, as the normal outward deflection varies in individuals. If the position of extension is uncomfortable, or if there is reason to believe that permanent ankylosis is about to occur, the flat splint may be removed at the end of two weeks and the elbow carefully flexed to nearly a right angle. Should the fragments remain in good position and no tendency to recurrence of deformity be present, the subsequent treatment may be conducted with an angular splint.

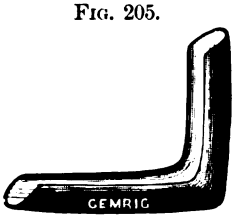
In very bad intercondyloid fractures and fractures involving the radius and ulna as well as the humerus, ankylosis will sometimes occur; hence the flexed position here should be adopted more frequently than in other cases. Proper coaptation, made, if necessary, after incision into and inspection of the joint, will often avert this ankylosis. If

FIG. 204.



Anterior angular splint, with changeable angle.

FIG. 205.



Posterior angular trough.

FIG. 206.

Deviating flat splint for fractures through the condyles of the humerus.

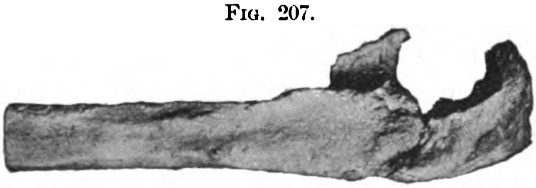
retention of the fragments in proper position is difficult, subcutaneous nailing together of the pieces may be wise. Continuous traction by weights may become necessary to keep the fragments in position. Excision of the joint may be demanded in such fractures, if open. It is better in such excisions to avoid, if practicable, removal of the upper ends of radius and ulna, because otherwise the insertions of the great muscles are disturbed. Passive motion should not be made if it causes pain. The moderate stiffness, usually left even in favorable cases, will disappear in the course of a few weeks after removal of the splints, especially if active and passive motions accompanied by friction be employed. If inflammatory involvement of the joint has taken place, early passive motion will do no good but probably much harm. Union occurs in fractures of the lower end of the humerus in four or five weeks.

Fractures of the Bones of the Forearm.

Fracture of both bones of the forearm near the middle is quite common, but fracture of the shaft of either bone alone is unusual. When the radius alone is broken the lesion is nearly always situated near its lower end, while the ulna when broken alone nearly always suffers such lesion at the upper end.

Fracture of the Olecranon.—Direct violence may cause the olecranon to be broken from the shaft of the ulna, but it is probable that a great majority of these fractures are due to a leverage action consequent upon the triceps holding the process firmly against the lower end of the humerus at the time the impinging force is applied to the forearm. The bone snaps in such cases as a stick is broken by the

FIG. 207.



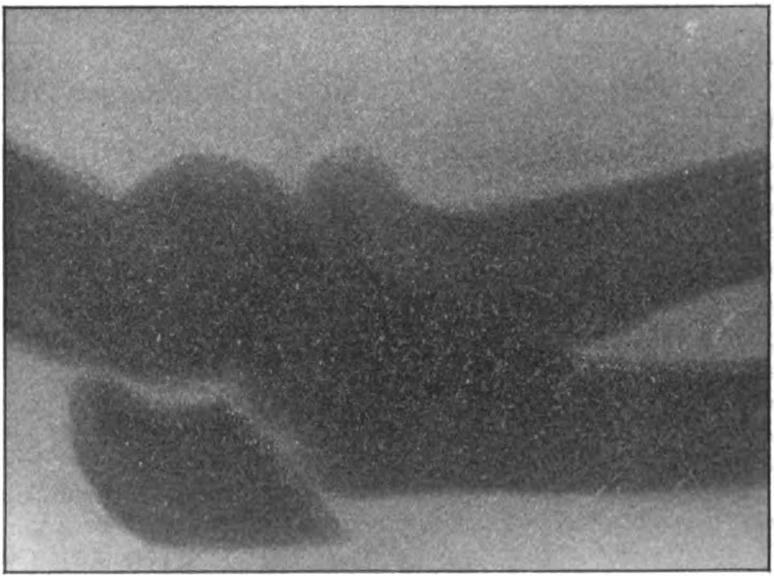
Fracture of olecranon with fibrous union. (PARK.)

hands across one's knee. Muscular contraction alone seldom causes this fracture. The location of fracture varies, but most commonly is near the middle of the process, where there is a narrowing. The epiphyseal cartilage, which ossifies about the sixteenth year of life, is placed near the middle of the olecranon; therefore, supposed fractures in young persons may really be instances of diastasis or epiphyseal separation. The triceps muscle tends to displace the upper fragment upward, but the process is so attached to the humerus by ligaments and the tendinous expansion of the muscle so ensheathes it and the adjacent part of the ulna that not much separation occurs, unless the forearm is flexed. In fact in many instances no marked displacement takes place even in flexion, because the fragments are bound together by the untorn aponeurosis. Under the opposite conditions a separation of as much as two and a half inches is said to be possible, but this probably refers to the joint in a flexed or semiflexed position. The intra-articular effusion that frequently arises and the tendency of the biceps and anterior brachial muscles to draw up the forearm, and thus crowd the humerus into the gap between the ulnar shaft and olecranon, probably have an influence in causing separation of the fragments.

The symptoms are localized pain and swelling, lateral mobility, and crepitus, combined with more or less loss of power to extend the forearm and with, in some cases, a noticeable depression at the seat of fracture. The last two symptoms vary greatly with the degree of laceration of the fibrous envelope of the bone. The development of crepitus may require the fully extended position of the joint in order to obtain contact of the bony surfaces.

Union may be bony, but is generally fibrous. A comparatively long fibrous bond gives but moderate disability, if there coexist no adhesions of the olecranon to the humerus and no intra-articular fibrous obstruction. This is due to the fact that powerful and extensive flexion is a more important function of the elbow than complete extension. Ununited fracture is not very infrequent. In ordinary cases cure takes

FIG. 208.

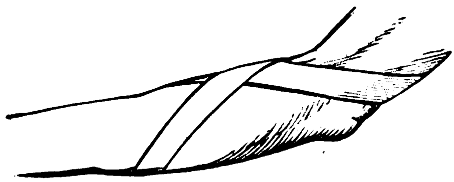


Fracture of the olecranon.

place in about four weeks, and though the joint is necessarily involved, there is no tendency to ankylosis of the elbow.

When separation of the fragments is present, the injury should be treated with a splint to keep the elbow extended to that degree which is seen when the arm hangs passively at the side. As ankylosis is not to be anticipated, the most accurate coaptation possible is to be sought. This is obtainable only by the extended posture; but the extension must not be so excessive as to bend the joint backward, which is possible when the normal check to such motion given by the olecranon is destroyed by fracture. The upper fragment may be steadied, or pulled down if necessary, by a strip of adhesive plaster so applied above it that the ends cross each other upon the forearm. An anterior straight splint of wood or metal or a circular gypsum dressing, leaving the elbow uncovered, is then applied from the upper third of the arm to the lower third of the forearm. If it is impossible to bring the fragments together by extension alone, the upper fragment may be fastened to the shaft by a steel nail driven through the skin, through the upper fragment and into the lower fragment. The nail may be withdrawn in about two weeks. Tenotomy of the triceps tendon would be justifiable to overcome upward displacement. If there is much primary synovial effusion into the joint increasing the displacement, aspiration is proper. When violent reaction occurs and ankylosis seems probable, passive motion may be cautiously made after three weeks, but is to be omitted if it causes inflammatory reaction. When there is little tendency to separation and flexion does not increase the displacement, the limb may be treated in a semi-flexed position, if extension causes discomfort. When great disability has resulted from long fibrous union, great improvement has been obtained by exposing the bone, freshening the ends and fastening the fragments together by wire sutures introduced so as not to penetrate the joint.

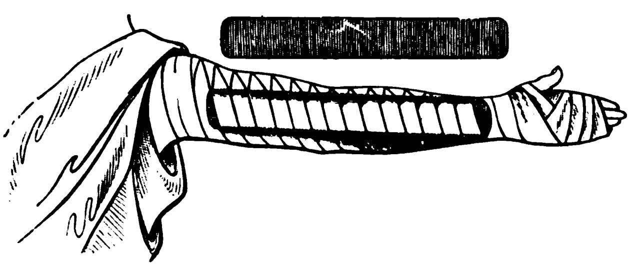
FIG. 209.



Adhesive strip applied to steady olecranon. (AGNEW

Fracture of the coronoid process is very rare except as a complication of backward luxation of the ulna or of radius and ulna together; then the process is liable to be broken off by being driven against the articular surface of the humerus. The symptoms are the presence of a small movable body in the line of the tendon of the anterior brachial muscle, crepitation and usually the symptoms of dislocation of the forearm. Displacement from muscular contraction is impossible, un-

FIG. 210.

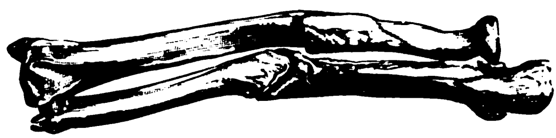


Fracture of olecranon treated in extended position. (AGNEW.)

less the line of fracture be below the base of the process, for the tendon is not inserted upon the apex of the coronoid process. A similar reason proves the supposed detachment of this apophysis by muscular contraction an error. Treatment consists in immobilization with a splint or the gypsum bandage for a couple of weeks with the elbow flexed at a right angle or less. A sling should then be worn for ten days or two weeks longer.

Fractures of the Head and Neck of the Radius.—Of these rare injuries little is known. A splitting off of a part of the articular surface of the head, with the line of fracture running down the neck, is perhaps the most common form and is observed in connection with coronoid fracture of the ulna. The fracture may be entirely within the joint; hence synovitis and defect in bony union might be expected. Loss of power of rotation, crepitation, the presence of a movable fragment and an apparent widening of the head of the radius are the symptoms likely to aid in the diagnosis. The radius may also be broken at the neck just above the bicipital tubercle. Immobilization for three or four weeks in the flexed and supine position, which relaxes the biceps, should be the treatment.

FIG. 211.



Union, with slight lateral displacement, of fracture of radius and ulna.

Fractures Near the Middle of the Forearm. *Fracture of the Shaft of Both Bones.*—When the radius and ulna sustain simultaneous fracture of the shaft, it is usually found that direct violence has caused the injury; and as a rule the radial fracture is nearer the elbow than is the ulnar fracture. Fractures from muscular contraction are occasionally seen. Green-stick fracture is not uncommon. Angular displacement toward the interosseous space, overriding and rotary displacement of the radius are sources of deformity. The overriding may shorten the limb two or three inches. When the radial fracture is above the insertion of the round pronator muscle, the short supinator and the biceps, which is also a supinator have unopposed action; hence the upper part of the bone is supinated and the lower portion, if it is kept pronated by the splints, will unite with rotary deviation. To avoid this the hand should be kept supine by the splints.

The loss of rigidity of the limb, crepitus and abnormal mobility render the diagnosis easy. Union occurs in about four weeks, but a high grade of inflammation is not an infrequent complication. Gangrene from constricting dressings must be remembered as a possible danger, to which attention may not be called by any discomfort felt by the patient. The comparative frequency of these complications probably arises from the usual causation of the fracture by direct violence. The primary bandage under the splints, which is undesirable in all fractures, is to be especially avoided in these injuries. When the two fractures are directly opposite each other, when great laceration or irritation of the interosseous membrane and fibrous tissue has occurred and particularly when inward angular deformity is permitted to remain uncorrected, normal pronation and supination are liable to be diminished or destroyed by an osseous bridge, soldering the radius and ulna together, or by a protuberance of one or both bones. The prognosis in uncomplicated cases is good, though delay or failure in union is not very infrequent. After replacement of the fragments has been obtained by extension and counter-extension and by pressure of the fingers in the space between the two bones, the limb should be placed in the supine position, that is, with the palm of the hand upward, and so maintained by splints until consolidation has occurred. The semi-supine position is often adopted, but as full supination is required to prevent rotary deformity of the radius when it is broken above the insertion of the round pronator, it is safer to teach the adoption of complete supination for all cases of fracture of the shaft. The object of the posture is to prevent the formation bridges of callus between the bones at the seat of fracture.

A straight palmar and a straight dorsal splint extending from the elbow to the fingers make a comfortable and convenient dressing, if the forearm is to be kept in the semi-supine position. If it is desired to maintain the supine position, the elbow and upper arm must be included in the splint. Then a right angle trough applied to the dorsal surface of arm and forearm, or, better perhaps, a right angle splint applied to the anterior surface is required. After partial consolidation has occurred, say at the end of two weeks, two straight splints may be substituted for the angular one, since at that time the risk of rotary distortion is no longer great. In fractures below the insertion of the round pronator such splints may be used from the beginning of the treatment, but must be slightly wider than the arm, so that the bandage shall not press the bones together at the site of fracture. The palmar splint is made more comfortable by having the distal end cut off obliquely and well padded for the fingers to close over it.

FIG. 212.

Angular displacement and union between bones in fracture of radius and ulna. (STIMSON.)

In all these fractures the sling should be broad enough to support both hand and forearm. A narrow sling supporting one part only is liable to permit sagging and angular deformity. This is especially so when the palmar and dorsal splints are employed. The use of a narrow compress under the splint to prevent encroachment of the fragments upon the interosseous space is either unnecessary or inefficient. The circular gypsum dressing is not well adapted to these fractures, though the moulded gypsum splints are not objectionable.

Daily examination is a wise precaution for the first week, since excessive inflammatory swelling and a tendency to displacement are frequent accompaniments of these injuries. The splints may be removed in three or four weeks. Extreme overriding may require the adjustment of continued traction. In cases kept in bed this may be effected by a weight and pulley; in walking cases by elastic bands attached to a splint prolonged beyond the hand.

Fracture of Shaft of Ulna.—If the radius is neither broken nor dislocated, shortening is not possible in fracture of the ulnar shaft. Lateral or angular displacement is readily discovered because of the subcutaneous position of the ulna. Alternating pressure above and below the supposed fracture or grasping the two portions of bone firmly with the fingers and endeavoring to move them in opposite directions will usually prove or disprove the existence of crepitus and mobility. If the tip of the olecranon be quickly tapped with the fingers of one hand, while the lower end of the normal ulna is grasped with the fingers of the other hand, the transmission of the vibration along the entire length of the bone will be readily felt. In a broken bone this transmission will be much less perfect. Attempts to twist the arm may develop crepitus otherwise not easily elicited. Forward dislocation of the head of the radius is said to be a not unusual complication of ulnar fractures and may be overlooked.

FIG. 213.

Fracture of shaft of radius. (HAMILTON.)

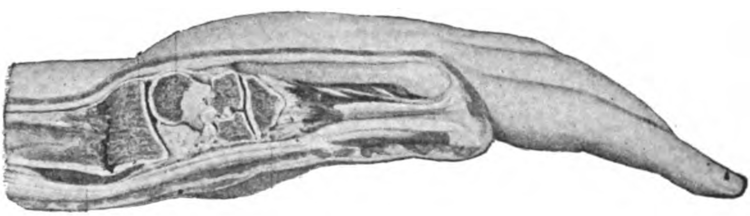
Moulding by digital pressure is the only efficient agent for correcting displacement and must be so exerted as to avert infringement of the interosseous space by angular deviation of the fragments. The same dressing as that described for fracture of the shafts of both bones is applicable, though complete supination is not demanded as in the former case. The prone position is not allowable, but the semi-supine will often do as well as the supine. In most cases the elbow joint had better be controlled. The circular gypsum dressing is often very convenient and efficient. If the posterior gutter of felt or metal is used, it is important that it should support the ulna along its entire shaft as well as at its ends, lest sagging occur at the seat of fracture. The splints should be kept on about three weeks.

Fracture of the Shaft of the Radius.—The function of the radius as the movable segment of the forearm, to which the hand is attached, gives great importance to this fracture and warrants a guarded prognosis. Displacement is liable to be angular, forward and toward the ulna, and the supinating muscles have a tendency to supinate fully the upper fragment if the solution of continuity occurs above the round pronator's insertion; while the hand and lower fragment tend to take the prone position. Marked displacement of the lower fragment at its upper end toward the ulna alters the plane of the lower articular face of the bone and gives the hand an abnormal deviation toward the radial side. Power of voluntary supination and pronation is gone, and the hand and forearm when grasped seem to be loose and flaccid. Overlapping is impossible unless the splint-like ulna be broken or dislocated.

The diagnosis is established by mobility, crepitus, and occurrence of the deformities just mentioned. Absence of rotation of the radial head when the hand is grasped and twisted backward and forward is a certain indication of fracture. In making this examination the surgeon should grasp the elbow and place his thumb on the head of the radius as it lies just below the outer condyle of the humerus. A rubbing sensation similar to fracture-crepitus is here quite often developed when no fracture exists. This is due to friction of the joint surfaces or to inflammatory exudation among the muscles and tendons. The treatment should be the same as in fracture of both bones, with the limb kept in the supine posture. This is especially demanded in fractures of the upper part of the shaft. If the hand is much displaced extention towards the ulnar side may be valuable in obtaining and maintaining correct apposition. In accompanying dislocation of the lower end of the ulna extension by some device may be necessary. Motion of the hand and elbow had better be controlled in most cases. At the end of three weeks the splints may be discontinued and a simple bandage used.

Fractures near the Wrist Joint. FRACTURE OF THE LOWER END OF THE RADIUS.—This exceedingly common fracture was long misunderstood and is still very often improperly treated. It is fre-

FIG. 214.

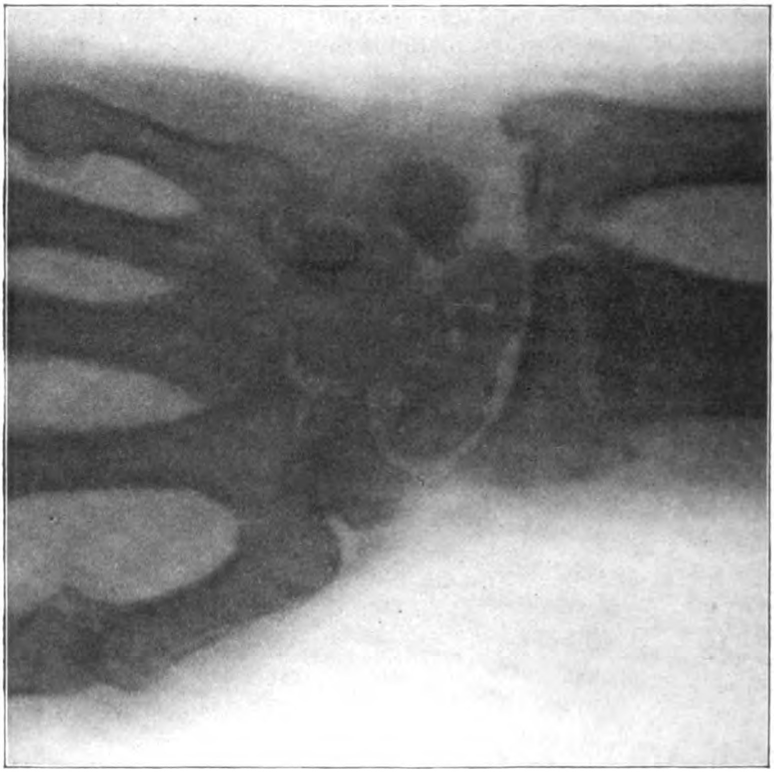


The ordinary or classic fracture of the lower end of the radius. (ANGER.)

quently designated by the name of one or other of those writers who have discussed it, but such nomenclature serves to confuse the student and to perpetuate erroneous teaching. The usual fracture line is situated from one third to three quarters of an inch above the articular surface of the bone; and is generally more or less transverse in direction, though some tendency to lateral or antero-posterior obliquity is not infrequent.

Displacement of the lower fragment backward upon the lower end of the upper fragment is the ordinary deformity and is due to the fracturing force, not to muscular contraction. Some impaction is quite frequent from driving of the dorsal wall of the upper into the cancellated structure of the lower fragment; and actual loss of substance from crushing the bony tissue is not unusual. At times there is little displacement; at others it occurs at the radial but not at the ulnar side of the lower fragment, which is tilted obliquely backward. The styloid

FIG. 215.

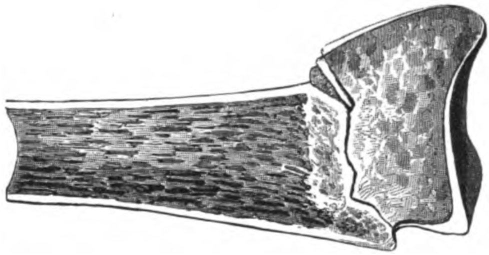


Skiagraph of fracture of radius with the ordinary backward displacement. (Polyclinic Hospital.)

process of the radius is carried upward and backward by this displacement; and, therefore, in fracture of the lower end of the radius the radial styloid process is often on the same level as, or even higher (nearer the elbow) than, the ulnar styloid process.

This angular displacement tends to throw the articular surface with the attached carpus upward, backward and to the radial side. Hence occur the peculiar deviation of the hand and the undue prominence of the lower end of the ulna, which give such a characteristic appearance to the limb after this injury. The hand is, as it were, carried away from the ulna by the force which breaks the radius and displaces the lower fragment. Sometimes the ulna is actually forced through the integument by the violence with which the hand is forced away from it, on account of the forcible shortening of the radius. Such a wound, however, does not necessarily create an open or compound fracture, for the wound does not always communicate with the fracture. Prepared specimens of united fractures give perhaps a false notion of the amount of impaction originally existing, because the formation of callus beneath the stripped-up periosteum on the dorsal surface is misleading.

FIG. 216.



Vertical section of fracture of lower end of radius, showing usual backward displacement. (R. W. SMITH.)

The wrist joint is not involved unless, as often happens, longitudinal lines of comminution divide the lower fragment or base of the bone into more than one piece. Fracture of the lower end of the ulna, or of its styloid process alone, and rupture of the radio-ulnar ligaments and cartilaginous at-

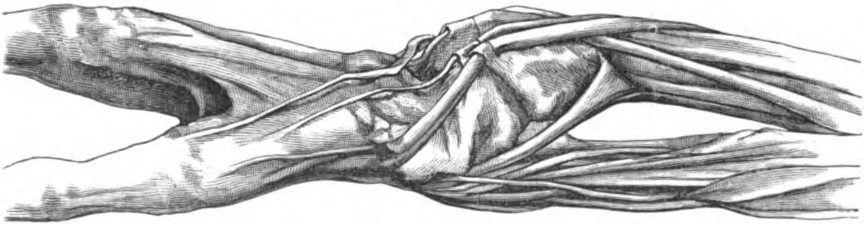
FIG. 217.

Deformity in fracture of lower end of radius. Diagrammatic. (LEVIS.)

tachments are occasional associated lesions; but, as a rule, fracture of the base of the radius is uncomplicated except by comminution.

In young persons epiphyseal separation, with a causation and de-

FIG. 218.



Fracture of lower end of radius with anterior displacement. (Museum of New York Hospital.)

formity similar to that which pertains to fracture, may occur. The treatment of the two injuries is identical.

The fracture just described is the usual one that occurs at the lower extremity of the radius; though in rare cases irregular fracture lines chipping off the posterior lip of the articular surface or splitting off the radial or ulnar side of the base by lines more or less vertical running into the joint have been seen. Displacement forward of the lower fragment, that is, displacement toward the palmar surface occurs, though comparatively rarely.[1]

Fig. 219.

Fracture of the lower end of radius with anterior displacement of lower fragment. Patient of, and skiagraph taken by, Dr. M. J. Stern.

The uniformity of the lesion produced when the radius is broken at the wrist shows that the mechanical conditions causing the fracture are usually the same. When a man falls either forward or backward, his arms are extented to protect himself and the violence is consequently received on the palms of the outstretched and pronated hand. The force is thence transmitted to the radius which is concave on its palmar surface. Fracture occurs across this concave portion of the bone and backward displacement of the lower fragment occurs.

The symptoms of the usual fracture are so marked that, in a typical

[1] See Author's paper in Transactions of American Surgical Association, 1890.

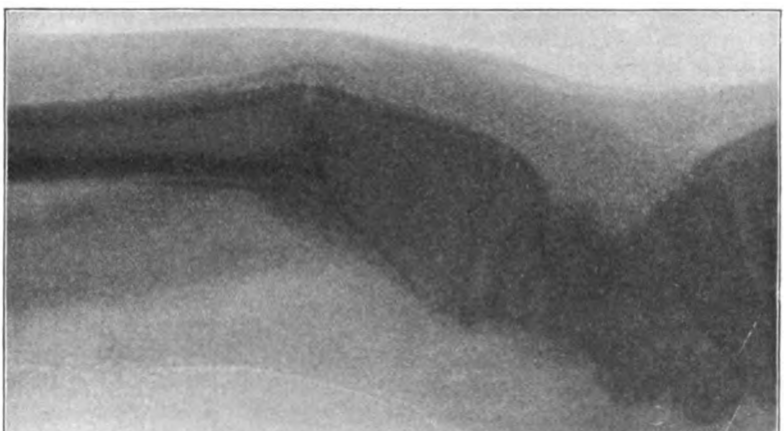
case, error in diagnosis is impossible, if it is recollected that dislocation of the radio-carpal joint is exceedingly rare. The deformity of the fracture so resembles that of backward dislocation of the carpus that the fracture has at times been called a dislocation. This error has received apparent confirmation from the fact that after the displaced lower fragment is pushed into position there is little tendency, except in comminuted fractures, to reproduction of the deformity. The transverse character of the break and the absence of muscular displacing causes render secondary displacement almost impossible unless the wrist is subjected to considerable violence.

FIG. 220.

Fracture of the lower end of the radius with anterior displacement. (Specimen of Mr. C. W. Cathcart in Museum of Royal College of Surgeons, Edinburgh.)

Symptoms.—The characteristic distortion of the usual fracture has given the name silver fork fracture to the injury. The hand is apt to be held semi-prone. Voluntary movements of the wrist are painful, and

FIG. 221.



Skiagraph of Author's case of fracture of base of radius with anterior displacement.

hence are lost, though finger motions are but slightly impaired. On the radial side of the back of the wrist there is a prominence, the upper margin of which can sometimes be felt as a bony ledge. The radial extensor tendons may sometimes be felt stretched across the space between the shaft and the upper portion of this prominence, which is, of course, the displaced lower fragment. Forced flexion of the hand will render these tendons more tense and therefore more easily perceived. On the palmar surface of the wrist there are a transverse furrow behind the ball of the thumb and behind that a prominence, due to the lower end of the upper fragment and the inflammatory effusion which takes place into the sheaths and tendons of the flexor mass of muscles. The hand usually deviates somewhat to the radial side, the ulna is unduly prominent on the posterior and ulnar aspect of the wrist and the styloid process of the radius is on a level or even higher than that of the ulna. Mobility and crepitus are often absent because of impaction; though both may be developed by strong pressure upon the dorsal prominence. The pressure at the same time forces the displaced portion of the radius into position with a sensation of snapping or grating. In comminuted or unimpacted cases motion and crepitus are often easily detected. Motion at the wrist joint or in the carpal articulations may be mistaken for fracture mobility. When no displacement occurs there may be no distinctive symptoms except a tender spot upon the bone, which cannot be attributed to arthritis as it is a little above the known location of the joint.

Diagnosis.—The diagnosis must be made between sprain of the wrist, fracture of the lower end of the radius and dislocation of the carpus. If no deformity such as described above exists, it nevertheless may be a fracture with little laceration of the periosteum and no appreciable displacement. The diagnosis then hangs upon the character of the vulnerating force and the position of the tenderness on pressure. If the patient is beyond middle age, has fallen heavily on his palm and complains of localized tenderness about half an inch above the joint, fracture is the probable lesion. If the point of tenderness is over the wrist joint or if the fall was a slight one, a sprain with subsequent arthritis is the most likely injury. When the usual displacement backward of the lower fragment has taken place, error after a careful examination is unlikely, though it is true that the swelling of severe sprain does sometimes simulate the deformity of fracture.

Backward dislocation of the carpus is the only luxation resembling fracture and any dislocation about the wrist is exceedingly rare. Backward dislocation would show no change in the relative position of the styloid processes to each other, would give a smooth, laterally convex upper border to the dorsal prominence and would be reduced with a smooth snap rather than with a rough grating. Deformity would perhaps be more easily reproduced than in the usual non-comminuted fracture. Dislocation of the radio-ulnar joint would give a very different distortion from that of fracture of the base of the radius.

In a person of less than twenty years, epiphyseal separation is to be expected rather than fracture. The exact diagnosis is, however, unimportant, for the treatment is identical with that of fracture. Interference with the future growth of the bone may perhaps follow epiphyseal separation.

The fracture with anterior displacement gives a different deformity from the common form with posterior displacements. It is recognizable by the prominence under the flexor tendons due to the displaced lower fragment.

Treatment.—The essential point in the treatment of this fracture is early and complete replacement of the lower fragment. The protracted convalescence and frequent stiffness of the wrist and fingers seen after this injury are due to imperfect reduction of the fracture and the confinement of the fingers during the use of the fracture dressing. When there is neither comminution nor loss of tissue by crushing, the fracture can usually be cured in three to five weeks with little or no deformity and without stiffness of the fingers. When comminution and crushing exist, cure without impairment of motion, though perhaps with more or less persistent deformity, is nearly always possible and in the same time. Old and rheumatic patients may perhaps exhibit a greater tendency than others to rigidity of the joints; but stiff fingers are usually an indication of imperfect reduction of the fragments, which by their projection interfere with the extensor and flexor tendons and cause adhesive inflammation. No apparatus should be applied that restricts, at any period of the treatment, full and free motion of the fingers. In uncomplicated cases the splint need not be worn more than about ten days; provided that the patient is sufficiently intelligent to avoid submitting the arm to unexpected strains and blows. This is because of the slight tendency to reproduction of deformity in the properly reduced fracture. In careless patients and in comminuted or otherwise complicated fractures, support with the splint should be continued for three weeks. Uncomplicated cases in intelligent persons may be treated without any splint whatever. A band of adhesive plaster or a roller bandage applied around the wrist at the seat of injury is all that is necessary after perfect reduction has been accomplished. Passive motion is probably never necessary, if the fracture is properly replaced and the play of the fingers not restricted during the use of the splint.

Reduction is always painful, but is usually so quickly accomplished that an anæsthetic is seldom needed. Ether or nitrous oxide should be employed, however, if there is likelihood of the pain preventing perfect coaptation of the parts. Most persons undertaking to treat this fracture do not apply sufficient force to completely replace the lower fragment. The surgeon must apply force directly to the fragments. The force must be great. Let him put the patient's hand in the prone position, grasp the middle of the forearm with one hand and take hold of the patient's palm with the other hand in such a manner that his thumb can make strong pressure upon the apex of the dorsal prominence. By making traction on the hand of the patient and then suddenly flexing the patient's wrist, while at the same time he presses with his thumb, with all his strength, upon the projection at the back of the wrist, he can nearly always force the lower fragment into its proper position. A repetition of this manœuvre is sometimes requisite before accurate replacement is obtained. The grating produced as the fragment, which may have been impacted, is driven into its normal position can at times be distinctly heard by bystanders. The limb at once assumes its normal contour. The disappearance of the bony ledge or shoulder, previously perceptible to the touch where the upper margin of the lower fragment was elevated above the level of the shaft of the radius, is an indication that reduction of the backward displacement has been accomplished. Still further manipulation may occasionally be necessary to reconstruct the normal outline of the radius, which has at the wrist, it will be remembered, a concave palmar surface. If great comminution or crushing has been incidental to the fracture, perfect restoration of shape may be impossible, although the deformity can be greatly diminished. In such cases, also, retention of the fragments in good position may be somewhat difficult.

Firm impaction or entanglement of the fragments in the tendons or dorsal periosteal bands may require that the hand and attached lower fragment be first bent strongly backward, in order to release the interlocking before making traction, flexion and pressure. This preliminary measure is not often necessary.

After reduction has been accomplished any form of dressing is allowable provided it immobilizes the limb, does not tend to obliterate the normal curve of the palmar face of the radius and permits the patient to move his fingers. It was formerly thought that splints deflecting the hand to the ulnar side exerted traction on the radial side of the wrist and were therefore indicated. This is incorrect teaching.

Fig. 222.

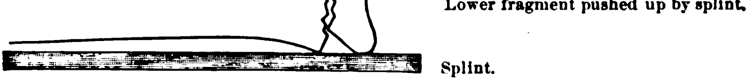
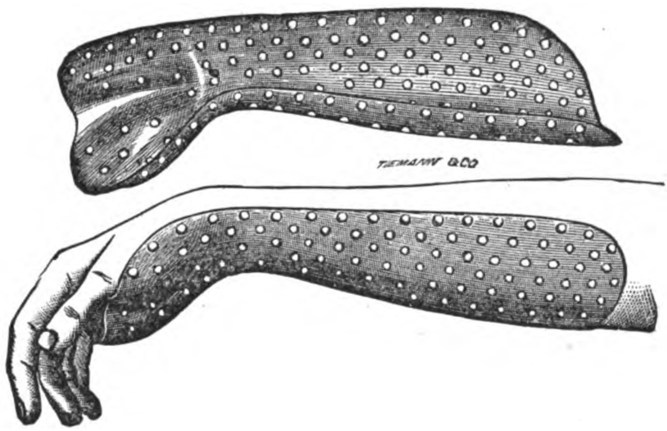


Diagram showing injurious effect of straight palmar splint in fracture of lower end of radius.

Such splints are unnecessary, as the deflection only causes the carpus to roll in the articular surface of the radius. The hand should be placed in the prone or semi-prone position and a single splint, extending from below the elbow joint to the middle of the metacarpus, applied either to the dorsal or palmar aspect of the forearm. It is essential that the palmar splint, if it be chosen, should be convex on its upper surface at its carpal extremity, so as to preserve the integrity of the radial concavity and not make the palmar surface of the radius flat, by forcing upward the lower fragment which has just been pushed down into proper position by the surgeon's manipulations. This convexity may be obtained by using the moulded metal splint of Levis or a splint of wood with a hard convex pad to fit into the palmar concavity of the radius. It should be seen that the pad properly fits. The surgeon can readily make a pad out of soft wood and fasten it with screws to a straight splint. No dorsal splint is needed with either of these splints. If it is inconvenient to obtain a proper form of curved palmar splint, a flat splint may be applied to the dorsal surface of the radius, which presents no marked curve but is nearly straight. Bond's splint, so frequently employed, is dangerous to the future contour and utility of the limb and should never be used. After the splint has been employed for from a week to ten days, varying, as above stated, with the kind of fracture and disposition of the patient, it is well to substitute it by a strip of adhesive plaster, two inches wide, applied circularly around the wrist so as to give moderate support to the partially consolidated fracture. In some cases this adhesive plaster dressing is the only appliance needed subsequent to the reduction of the fracture.

FIG. 223.

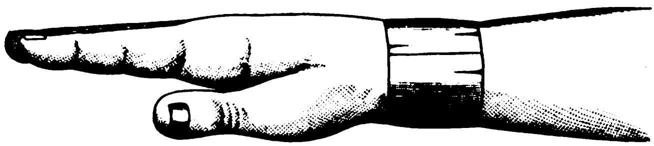


Levis's metal radius splint.

If union has already occurred in a fracture treated without proper reduction, the surgeon should attempt refracture and adjustment even after the lapse of several months, provided that the fingers are very rigid or the deformity great. It is not likely that as much can be accomplished in such cases as was possible immediately after the receipt of injury, but proper reduction should be undertaken even at late periods. Good use of the hand is often obtained finally even where there exists a considerable degree of deformity. Rigidity of the fingers if permitted to occur remains, however, for many months. Refracture for correction of deformity is readily accomplished, if the surgeon will bend the bone across his knee. Osteotomy need not be undertaken except in late cases.

Fracture of the lower end of the radius, with displacement forward —that is, toward the palmar surface has been mentioned as a rare form of injury, due usually to receipt of violence on the back of the hand. It should be treated with the same form of splints as is the common fracture at the lower end of the bone; but of course the primary reduction is to be made by pressure in an opposite direction.

FIG. 224.



Fracture of radius dressed with adhesive plaster.

Other Fractures near the Wrist Joint.—Fracture of the styloid process of either the ulna or radius occurs, though rarely. The diagnosis is not difficult. All that is needed for treatment is such a dorsal or palmar splint as will prevent motion at the wrist and fix the hand in a deflected position; toward the ulnar side in fracture of the ulnar styloid process, toward the radial side in fracture of the styloid process of the radius. A circular gypsum dressing will probably best meet the indications.

Fracture of both the radius and ulna just above the joint occasionally happens. It, in appearance, much resembles backward luxation of the carpus, but is distinguished therefrom by crepitus, mobility and the preservation of the normal relation of the styloid processes to the bony landmarks of the hand. The treatment is similar to that of fracture of the lower end of the radius, but this injury must not be treated without a splint, as some forms of the latter injury may be. In instances, however, where the line of fracture is some distance above the joint, the lesion partakes of the characteristics of fracture of the shafts of the two bones and should be treated as such, in order to preclude the possibility of callus interfering with future supination and pronation.

Fractures of the Carpus, Metacarpus and Phalanges.

Fractures of the Carpus.—Uncomplicated fractures of the carpal bones are rare, though it is probable that they occur at times in connection with radial fractures and other injuries, but are unrecognized. The diagnosis must be made by the presence of crepitus or deformity. Preternatural mobility, unless very marked, could be determined only with difficulty in a region containing so many movable bony components. Ankylosis of some of the articulations of the carpal bones seems a probable consequence of carpal fractures, but it would cause little disability. Crushing injuries, due to direct violence and causing extensive lesions of the soft parts, quite often produce open and comminuted carpal fractures. Such cases, however, do not derive their importance from the broken carpal bones.

Fractures of the Metacarpus.—The so-called metacarpal bone of the thumb is not included in this discussion because it is anatomically a phalanx. Its fractures are included, therefore, under fractures of the phalanges. Metacarpal fractures are generally caused by direct violence received on the dorsal or palmar aspect of the hand, or by force so applied to the anterior extremity of one of the bones as to exaggerate its normal curve. To the latter mechanism is due the occasional breaking of a metacarpal bone when a man strikes a violent blow with his fist, receiving, of course, the impact on his knuckles. The common displacement is angular with the projection of the angle toward the back of the hand and with the anterior end, or head, of the bone prominent in the palm. Lateral overriding is not an unusual feature. The single epiphysis of the bone, which is at the anterior extremity, may be torn off in patients not over twenty years of age and give the symptoms of true fracture.

When firm pressure is made in the palm, pain, yielding and the occurrence of a prominence on the back of the hand will, as a rule, be developed in those cases of metacarpal fracture that are not at once clearly demonstrated by the ordinary symptoms. A sharp pain at the seat of fracture can often be produced by taking hold of the finger, attached to the metacarpal bone supposed to be injured, and suddenly pushing it toward the wrist. Actual shortening of the broken bone is often quite as characteristic as motion and crepitus. Union takes place in two or three weeks.

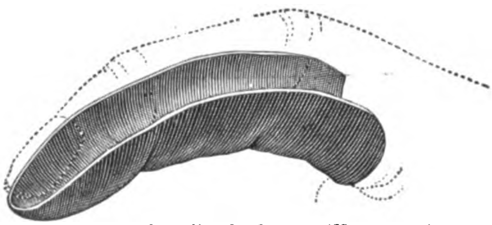
Traction of the finger and pressure upon the dorsal prominence are sufficient to overcome the displacement in the majority of cases. If no tendency to recurrence of deformity exists, a layer of cotton in the palm and another on the back of the hand, held in position by a circular bandage, constitute an efficient retentive apparatus, though care must be observed lest lateral displacement be caused by the bandage. In other cases support to the fragments and the adjoining bones and prevention of deformity is best obtained by placing a cylinder of wood a roller bandage or a spherical object, such as a billiard ball, in the palm and keeping the flexed fingers closed upon it by strips of adhesive plaster carried over the knuckles, from the back of the wrist to the palmar surface of the forearm.

Longitudinal splints applied to the palm or dorsum, or both, and controlling the wrist and fingers, may be preferable in some cases. In other instances short transverse splints placed across the back and front of the hand may be found more efficient in meeting the indications. When the tendency to overlapping is marked, no method is as good as that by continuous traction. This may be obtained by the use of an adhesive plaster strip applied to the back and front of the finger, and a rubber cord extending from the loop of plaster to a nail or screw in the end of a long palmar splint firmly adjusted to the fore-arm and hand and extending beyond the finger-tips. This method is identical in principle with that used in fractures of the thigh-bone. A slender nail or a strong surgical needle may be driven into the fragments so as to hold them in position, if the tendency to displacement is difficult to overcome.

Fractures of the Phalanges.—As these injuries are generally caused by direct violence, they are frequently complicated by comminution, dislocation and great laceration of the soft parts. The phalanges and the so-called metacarpal bone of the thumb, which, properly considered, is a phalanx, are developed from two ossific centers ; one for the shaft and one for the posterior extremity, or base. Epiphyseal fracture is, therefore, a possible lesion in persons not over twenty years of age. The swelling after phalangeal fracture often conceals the deformity to such an extent that mobility and crepitus are the chief diagnostic features. The prognosis is good except when great comminution or the occurrence of suppuration renders necrosis probable. Quite firm union may be expected in about two weeks if the fracture is uncomplicated.

Lateral and rotary deviation is to be corrected with especial care in phalangeal fractures, for a crooked finger is not only unsightly but may interfere with the manual dexterity of an artisan. Bowing of the middle of the phalanx toward the palm tends to prevent the patient grasping objects firmly and must be avoided. If ankylosis is apprehended, the finger should be slightly flexed during treatment, for stiffness in the partially bent position is the least inconvenient and least noticeable. A splint of gutta percha, pasteboard, felt, copper or zinc moulded to the palmar surface of the member and to the finger-tip is a neat and effective fracture apparatus. If the proximal phalanx is the seat of lesion, such a splint should include the palm and wrist. A cylindrical pad in the palm, with the fingers closed over it and kept so fixed by adhesive plaster, as described under fractures of the metacarpus, is often a good dressing. A good straight palmar splint, the circular gypsum dressing or continued extension by a rubber band may, in certain circumstances, be more advantageous. If necessary, the finger or fingers adjoining the broken one may be used for giving lateral support, or two or three fingers may have to be kept motionless by a wide splint in order to immobilize the injured member.

FIG. 225.



Gutta percha splint for finger. (HAMILTON.)

Amputation is frequently demanded in fractures of a complicated character. Conservatism, however, should be the rule, for a portion of a finger or a stiff one is often better than none. Especially is preservation of the smallest apology for a thumb desirable, in order that the patient may have something to oppose to the other fingers when grasping objects. After cure is complete the mechanic can test the utility of the hand for a few months, and then, if the deformed finger is a detriment to bread winning, it may be removed by amputation with little risk.

Fractures of the Femur.

Fractures at the Upper End of the Femur.

Of these there are fractures of the neck which may involve the greater trochanter or head, fractures detaching the greater trochanter and fractures through the base of the trochanter and upper end of the shaft. The first variety is common. The others are exceedingly rare and may be dismissed with a few words at this time.

Pathology.—Fracture of the trochanter is the result of direct-violence, and is to be diagnosticated by displacement of the fragment, character of the injury, local pain and absence of the symptoms found with fracture of the neck of the femur. Epiphyseal detachment may be suspected in such cases if the patient is not over eighteen years of age. A bandage or strips of adhesive plaster around the hips, with an appropriate compress, would seem to be the proper method of treatment. Subcutaneous nailing would not be improper if the displacement was very marked.

Fracture more or less transverse through the base of the trochanter and upper part of the shaft is said to occur. Its diagnosis is uncertain, but its treatment is the same as for fractures of the neck.

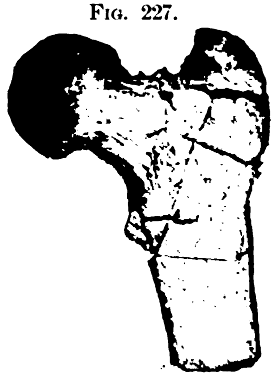
Fractures of the femoral neck are very common and very important surgical lesions. They are divided into fractures of the small part of the neck and fractures at the base of the neck. The former is identical with the class often called intracapsular fractures and includes the rare condition, separation of the epiphysis of the head; the latter includes both the so-called extracapsular fractures and those which are partially intracapsular. The reasons for rejecting the old classification are: that the neck is entirely covered by the capsular ligament in front and below, while behind and above only about three fourths of its length is so covered; that the extent of capsular envelopment varies in different persons; that the synovial membrane does not extend as far out upon the neck as does the capsule, hence a part of the neck is *extra*-articular though really *intra*-capsular; that the line of fracture is frequently not confined to either the intra- or extra-capsular portion of bone; and that the clinical diagnosis between intra- and extra-capsular lines is often impossible, as can readily be understood by what has preceded. Even at the autopsy the fact of a given fracture being intra-capsular, or rather intra-articular for it is the relation to the joint that is important, can only be known by accurate examination of the synovial membrane. This is further complicated by the fact that, after fracture the outer portion of the cavity of the joint may, it is said, be obliterated by adhesion of the capsule to the periosteum.

Impaction and fixation of fragments at the time of receipt of injury is very frequent in fractures at the base of the neck and not infrequent in those of the small part of the neck. Attempts at walking, improper surgical manipulation and other secondary violence often cause undesirable separation of the interlocked fragments. Cervical fractures of the femur are often due to slight injuries, as a twist from catching the foot in a fold of carpet, missteps and insignificant falls on the knee, buttocks and side of thigh. It is possible that in certain positions muscular effects to avoid falling may be a factor in causing the fracture. An important element in their production is weakening of the osseous tissue by senile degeneration, which begins at about the fiftieth year of life and is said to be more marked in women than in men. This degenerative change is the predisposing cause which permits slight injuries to have such a disastrous effect. It is not a relative increase of earthy constituents that renders the bone more friable; but an actual thinning of the wall of the femur and also an increase in size of the spaces within the osseous tissue for vessels and fat. The radiating and arched lines of compact bone, which cross the cancellous portion of the bone and which are so readily demonstrated by section of the upper end of the femur, are thus absorbed. This rarefaction of osseous tissue, and consequent loss of resisting power to strains, is a much more potent factor in the frequent occurrence of fractures of the femoral neck than the change of angle between the shaft and neck, which has been said to occur with advancing age. Fractures from very slight kinds of violence are very apt to be at the small part of the neck, but seldom occur before the age of fifty years. The line, which is apt to be nearly transverse, may be oblique or irregular and even run upward into the head of the bone. Impaction with fixation of fragments and comminution are not unusual features. A portion of the periosteum may remain untorn and assist in keeping the fragments in juxtaposition. In other cases not only is the periosteum completely torn and the fragments separated, but the capsule itself rent by the violence and by displacement of the fragments. The displacement is usually of the shaft upward. In impacted fractures some degree of twisting deformity may exist. The shortening of the limb from displacement is apt to increase gradually during the first week, but rarely exceeds one inch except when, after weeks have elapsed, absorption of the neck has taken place.

FIG. 226.

Fracture of epiphysis of great trochanter and fracture of condyles. (AGNEW.)

FIG. 227.



Fracture at the base of the neck of the femur. (PARK.)

When these fractures are repaired it is usually accomplished by fibrous tissue. Bony union does occur, though rarely. The question is of little clinical importance, since a short fibrous bond gives as useful a limb as an osseous one; and union should always be sought by treatment, if the patient's condition will permit the necessary confinement.

FIG. 228.

Fracture of narrow part of neck. (HAMILTON.)

Examination of specimens, with or without a history of fracture, does not throw as much light on the question as would be supposed, because the arthritic changes of old age and intersitial absorption of the neck of the femur, which occur subsequent to cervical fractures, obliterate or simulate lines of fracture. Simple contusion of the hip is supposed by some writers to be a cause sufficient to induce in the aged interstitial absorption of the neck of the femur.

The cause of the frequent defective union appears to be want of contact between the fragments, imperfect immobilization and some constitutional peculiarity. The difficulty of obtaining perfect contact and immobilization, when the small upper fragment is so inaccessible and floats in such a cup-like cavity as the acetabulum, will be easily understood. The error of rude manipulation, by which impacted fragments may be separated, is shown by this statement. It would seem that the constitutional tendency, already mentioned as a cause of the extreme fragility of this part of the skeleton in aged persons, would tend to interfere with the occurrence of osseous repair. These reasons for defective union seem to be sufficient without recourse to those often given: namely, deficient blood supply to the upper fragment and contact of the fractured surfaces with the synovial fluid. These agencies, however, possibly exert some influence.

FIG. 229.

Fracture at base of femoral neck with upper fragment driven into the trochanteric fragment. (GROSS.)

The symptoms and diagnosis of fractures of the small part of the neck will be discussed with similar topics relative to fractures at the base of the neck. The usual result after fractures of the small part of the femoral neck is disability with eversion and some shortening of the limb. The patient in some cases can walk without crutch or cane, but such a slight degree of lameness is uncommon. Occasionally, feebleness from pain, confinement and age renders the unfortunate patient bedridden.

In fractures at the base of the neck the line of fracture shows a tendency to separate the neck from the shaft in the vicinity of the intertrochanteric line, but may be varied or complicated by lines running downward into the shaft, splitting off the lesser trochanter, extending along the neck toward the head or involving the upper portion of the great trochanter. Bending the neck backward, with crushing or penetration near the posterior part of the greater trochanter, is said to be a very common form of the injury. Various degrees and forms of penetration and impaction of the cervical into the trochanteric fragment have been described. The trochanteric fragment or shaft is seldom forced into the cancellated structure of the neck. These fractures usually unite by bone and in six or seven weeks; showing, therefore, much better reparative effort than fractures of the narrow part of the neck. Bending of the neck of the bone, called coxa vara, due to rickets may occur in children and adolescents. It is possible that some of the cases have been green-stick fractures.

Symptoms.—The distinctive symptoms of fracture of the neck of the femur are motor disability, eversion, shortening and crepitation. To these may be added certain incidental symptoms that occasionally assist in the diagnosis.

The limb is usually so helpless that no voluntary effort can lift it from the bed, nor can the weight of the body be borne upon it in the erect position. Sometimes slight elevation of the thigh is possible, especially if the patient can get a purchase on the bed for his heel. In very exceptional cases walking on the injured limb has been possible. Here firm impaction has almost certainly existed. In making a differential diagnosis, the helplessness from pain following severe sprain or contusion must not be forgotten.

The posture assumed by the limb is almost pathognomonic. It lies, as the patient rests on his back, upon its outer side with the little toe almost or quite touching the mattress and the heel on a level with the space between the inner malleolus and point of the calcaneum of the other foot. A slight degree of flexion and abduction at the hip is quite usual. This eversion is probably, in the main, the result of gravity being unresisted by the normal supporting agencies of the limb rather than due to the action of the external rotators or other muscles. In some cases the eversion is slight, at other times the toes point directly upward, while in rare instances actual inversion exists. Angular deformity at the seat of fracture, crushing, impaction, and interlocking of fragments and entanglement in capsular rents have probably an agency in the production of the varying degrees of eversion and inversion. Eversion is the usual position and is very suggestive of fracture, though it has been observed in simple injuries of the hip. The normal position of the limb, indeed, when the recumbent posture on the back is assumed, is eversion and especially so when the knee is flexed even slightly. It is well to compare the injured limb with the uninjured one, to determine whether eversion is apparent or real, whether the extent of possible eversion at the surgeon's hands is greater or less on the injured side, and whether the supposed fracture interferes with or increases inward rotation, such as is possible in the sound limb. Inversion has been described as occurring in some cases only after the lapse of a day or two from the time of injury. Violent manipulation to determine these points is not justifiable, since other symptoms are available for diagnostic purposes.

Shortening occurs in cervical fractures of the femur from overriding and from alteration of the angle between the shaft and the neck. It varies from a mere fraction of an inch to two, three or even four inches. It may exist to its greatest degree immediately after the injury or may gradually increase with the lapse of a few days. It has been noticed to occur suddenly, when little or no alteration in length was apparent at the first examination.

Great shortening ($1\frac{1}{2}$ to 3 inches) occurring immediately is rather indicative of fracture at the base of the neck, while slight immediate shortening followed by increased shortening is more characteristic of fracture at the small part of the neck.

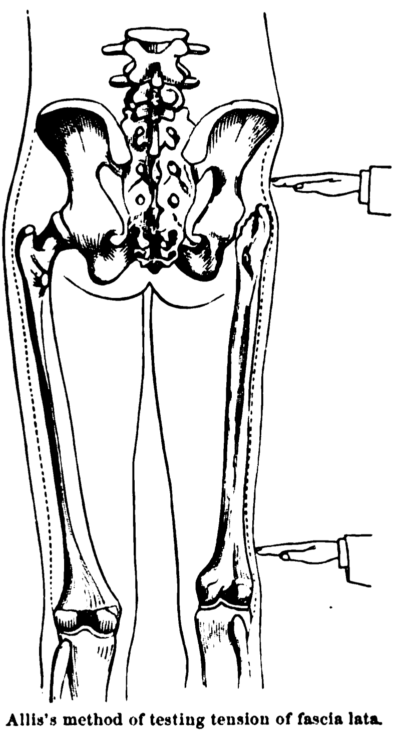
The now well established fact that femurs and tibias are often of unequal length in persons, who have never sustained injuries to the bones of either limb, greatly lessens the diagnostic importance of shortening. Fortunately the normal difference of length rarely exceeds a quarter or half inch.

The most practical method of measuring the length of the limbs is to carry a tape measure from the lower edge of each anterior superior spine of the ilium to the tip of the corresponding internal malleolus. It is well, perhaps, to verify the differential measurement by placing the upper end of the tape at the lower margin of the umbilicus, and holding it there while the lower end is successively carried to the two internal malleoli. During the measuring the pelvis must be horizontal—that is, at a right angle with the median line of the body—and the two limbs in the same condition of abduction and extension. The difficulty of obtaining exactly the same point of measurement on the two sides, because of the mobility of the skin and the want of definite outline in the prominences, together with the fallacy above mentioned, have made surgeons place little confidence in the accurate estimation of fracture shortening.

The determination of the relative position of the two greater trochanters by means of Nélaton's line or Bryant's rectangle is of great value in proving elevation or absence of elevation of the trochanter on the injured side. The method is useful in supposed dislocations as well as fractures, but will be discussed here. Nélaton's test line is applied by carrying a string from the apex of the anterior superior spine of the ilium to the tip of the tuberosity of the ischium. The line so indicated touches the upper border of the greater trochanter, and this relation is not disturbed by flexion and extension of the limb. Displacement of the trochanter upward, from shortening due to cervical fracture, and displacement downward or upward, as a result of dislocation, are indicated by comparing the two hips. The two limbs must be examined when neither abducted nor adducted, since in normal limbs the former position brings the trochanter above the line and the latter below it. Bryant's rectangle consists of two lines drawn while the patient lies upon his back. A vertical line is dropped from the anterior superior spine of the ilium to the bed; toward this line, at a right angle to it, a second line is drawn from the upper border of the trochanter. The last drawn line determines the fact and degree of elevation of the trochanter as compared with the sound side. The fallacy due to abduction or adduction must be remembered here, as in using Nélaton's line. Stimson uses Bryant's method by placing a small stick or pencil vertically against the pelvis in a line with the process and tuberosity, and measuring from it to the trochanter.

Allis has called attention to relaxation of the fascia lata between the iliac crest and trochanter and above the outer condyle of the femur in fractures accompanied by shortening. Cleemann has directed the profession to observe a wrinkle in the skin over the ligament of the patella, which will be obliterated when the shortening is corrected by extension. If shortening has been detected, its correction may be attempted for diagnostic and therapeutic purposes by gentle traction and slight internal rotation. Marked rotary movements, however, and absence of support to the limb are liable to cause separation of fragments which may be impacted, and should therefore be avoided. The shortening corrected by traction will usually recur when the traction is intermitted, and thus confirm the diagnosis of fracture.

FIG. 230.



Allis's method of testing tension of fascia lata.

Crepitation is a symptom of cervical fractures of great diagnostic value when elicited, but is often unobtainable. It should seldom be sought for with avidity because of the risk of separating impacted fragments. Pressure behind the trochanter or traction, with or without rotation, will often make it evident; but impaction, great splintering, wide separation of the fractured surfaces or the impossibility of keeping the small upper fragment steady in the acetabulum often prevents its production. Cases showing from other symptoms evidence of fracture should not be submitted to persistent manipulation for the production of crepitus. Rubbing of the outer fragment or a dislocated head upon the ilium sometimes simulates crepitus between two broken surfaces. The character of grating then is softer than in fracture crepitus. Crepitus is more frequently detected with ease in fractures of the base of the neck than in those of the constriction of the neck, especially if the fracture line runs into the trochanter.

The other symptoms liable to be found in cervical fractures are pain referred to the trochanter, groin or thigh, tenderness on pressure in the groin outside the femoral vessels, swelling or diminished depressibility at the upper part of thigh, ecchymosis appearing only after two or three days have elapsed, spasm of muscles, flattening in the trochanteric region and enlargement of the trochanter due to splitting or comminution. The outer surface of the trochanter may be further than normal from the middle line of the body, nearer to it, or may present no change in this respect, according as angular deformity, crushing and separation exist alone or are combined.

It is evident that, if the normal limb is rotated, the trochanter must move in the arc of a circle whose radius is the distance between the articular surface of the head and the outer surface of the trochanter; but, when the neck is broken and unimpacted, such rotation will be in the arc of a circle whose radius is the distance from the line of fracture to the trochanteric surface. The second radius will be shorter and hence the arc of rotation traversed by the trochanter more curved. Such change may be estimated by placing the hand on the outside of the trochanter while an assistant rotates the limb. This test has often been recommended as worthy of diagnostic credence, but it has at my hands been of little service. If thickening of the soft parts and a large amount of callus is detected in the groin or about the trochanter, at the end of one or two weeks, fracture of the base of the neck is of course the probable lesion.

Diagnosis.—The diagnosis that fracture of the neck of the femur exists can usually be made with comparative ease, but whether the lesion is at the constriction or at the base of the neck is a problem much more difficult to solve. It is not a question worth attempting to answer, except in those cases where it is almost self-evident. The treatment of both injuries is the same, the elaborate tables of supposed diagnostic differences between fractures of the constriction and of the base have been proved unreliable, and the endeavor to make an accurate diagnosis is fraught with great danger to the future usefulness of the limb by reason of breaking up impaction and severing untorn periosteal attachments. Roentgen ray skiagraphs are often valuable aids in diagnosis of these injuries. When there is doubt as to the kind of fracture or as to whether fracture, contusion or sprain exists, always treat the lesion as fracture of the base of the neck, and the result will clear up the doubts in the course of a few weeks.

The differential diagnosis of fractures of the neck and dislocations of the head of the bone is important. Inversion is so rare in fracture that its existence should at once suggest posterior dislocation. Fracture with inversion would not show a flexed, adducted and such a fixed hip as the posterior luxations; nor would the presence of the head of the bone over the iliac dorsum or sciatic notch and its absence from the acetabular region be demonstrable. In fracture with inversion, traction may convert the inversion into eversion and correct the shortening, but not so in dislocation. The anterior dislocations are rare injuries, and present flattening of the trochanteric region, abduction and flexion of the hip and the unusual fulness or prominence at the abnormal site of the head of the bone. The pubic dislocation is accompanied by shortening, the thyroid not by shortening but by apparent lengthening. In dislocation there is a marked limitation of passive motion, and the limit of possible mobility is reached by a sort of sudden stopping or check felt by the surgeon's hands. In a normal femur the internal surface of the inner condyle and the head of the bone always point in the same direction: therefore, the position of the head can be determined in dislocations by observing the situation of the inner condyle. This is not true of fractures of the femur. If there is anterior spinal curvature the hip may be somewhat flexed and still appear extended. This possible source of error is eliminated by placing the man on his back and flexing the opposite thigh completely on the abdomen, when the second thigh will be raised from the bed, if it be in a state of flexion concealed by the spinal curve.

Prognosis.—Patients with fractures of the femoral neck have died not infrequently from rapid debility, severe arthritis or other inflammation about the injury, or hypostatic pneumonia. Especially has this been the case in the aged. The unfortunate tendency was possibly dependent in some measure upon fat embolism, but more probably upon the rigid confinement to bed with cumbersome and uncomfortable fracture dressings, which formerly were enforced for long periods. Our present methods of treatment with continuous traction and less absolute immobility in bed seem to permit a much better prognosis. The unfavorable outlook so often spoken of in hip fractures is possibly scarcely warranted by our present experience. A certain amount of shortening, eversion, stiffness and pain often persists even in fractures that have recovered with fibrous or osseous union; but fair, or even very good, use of the limb is not unusual, even in old persons who have apparently or certainly sustained fracture of the constriction of the neck. Even when the fracture remains ununited fair walking is possible, because hypertrophied muscular and tendinous bands may support the pelvis as by a sling attached to the greater trochanter.

Treatment.—In treating fractures of the lower extremity, a firm level mattress is much more important than in similar lesions of the upper limb. A plain mattress made of hair and a bed pan for receiving the dejections are often preferable to any one of the various forms of fracture bed sold by manufacturers. Careful nursing will prevent injurious movement during the use of the bed pan. Union is to be sought in all cases of cervical fracture, and its acceptance even in faulty position is more judicious than the production of non-union or violent arthritis in the aged, by reason of vigorous and repeated manipulation, for the purpose of establishing the exact line of fracture or obtaining accurate coaptation. If the existence of dislocation is eliminated, all doubtful cases should be treated as fractures of the base of the neck. Continuous extension or traction, applied by means of a weight or a rubber band attached to the leg with adhesive plaster, and lateral support to the limb by means of sand-bags, as employed in fractures of the shaft of the femur, is the proper treatment for all fractures of the neck of the bone. The trochanter may in some cases need support by a small pad or sand-bag placed under it. This method of immobilization is to be kept up until consolidation of the fracture takes place. Proof that union will not occur or satisfactory evidence that the injury was a mere sprain or contusion indicate its discontinuance. It must also be discontinued if it becomes evident that the patient's life is endangered by the confinement to bed and to one posture. Then, attempts at gaining union may have to be discontinued in order to prevent death from failure of the vital forces. Even when no union occurs, comfort is usually gained by the rest given to the joint and limb for two or three weeks by traction. Union, when it occurs, takes place in from five to six weeks.

The extending force should equal about six to eight pounds, while the counter-traction is to be gained by elevating the foot of the bed about six inches, so as to use the weight of the patient's trunk as a counter-force. The foot should be maintained in a position with the toes pointing upward and a little outward, which is the normal posture of the limb when a man lies on his back. Catheterization will be necessary in some patients, and the occurrence of sacral bedsores must be averted by watchfulness and cleanliness.

In order to get more complete immobility at the seat of fracture, the pelvis and both thighs may be encased in gypsum bandages. In addition, a pad adjusted by a screw, passing through a frame attached to the gypsum dressing, may be arranged to make pressure upon the outside of the trochanter and thereby hold the fragments in apposition.

Gunshot fractures of the femoral neck will require provision for free drainage, and perhaps excision of the head of the bone. Attempts to fasten the capital fragment to the trochanteric one by screws and pegs have been made in the endeavor to avoid non-union, but such attempts seem scarcely warrantable in the aged patients usually the subject of this injury.

Fractures of the Shaft of the Femur.

Pathology.—Fractures of the shaft of the femur include those occurring in the shaft of the bone anywhere except just above the condyles. The latter, being near the knee joint and liable to special complications, are discussed under Fractures at the Lower End of the Femur. Transverse fracture of the shaft is not rare in children, but in adults such an occurrence is very unusual. In fractures of the femoral shaft, deformity due to overriding and to angular or rotary displacement is apt to be great. When the fracture is in the upper third, the lower end of the upper fragment is generally tilted outward and forward by the great psoas, iliac and external rotator muscles of the hip and the upper end of the lower fragment drawn upward and inward by the flexors of the leg and adductors of the thigh. This special angular distortion is mentioned because it at times compels the adoption of unusual methods of treatment.

Symptoms.—The symptoms indicative of fracture of the femoral shaft are: total loss of voluntary power in the limb, eversion of the foot and leg and the usual concomitants of fractures: deformity, abnormal mobility and crepitus. Rotation of the limb is not accompanied by movement of the greater trochanter. The deformity and flexibility of the thigh at the seat of fracture are often entirely sufficient for diagnosis without requiring successive attempts at getting crepitus, which cause pain and may do harm. The shortening, which is chiefly due to the powerful muscles surrounding the broken bone and to the obliquity of the fracture, may be very great, but is overcome partially, if not entirely, during the continuance of strong traction. The estimation of the degree of shortening by measuring is, as has been mentioned under Fractures Near the Hip, subject to fallacies. The symptoms may be a good deal modified by impaction or interlocking of fragments. This condition, however, is unusual.

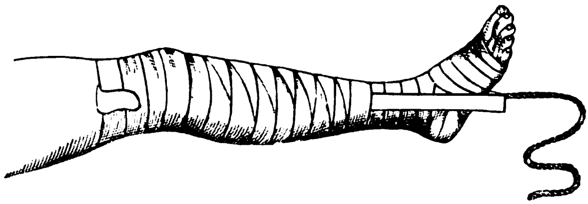
Union occurs in ordinary cases in about six weeks, after which time the patient may be trusted to use crutches, provided that all possible strains upon the repaired fracture are avoided by suitable supporting dressings and that no weight is borne on the injured limb in walking. Effusion into the knee joint often occurs after the fracture, sometimes within a few days, and occasionally it persists for many months. It has been attributed to involvement of the synovial membrane; to invasion of the joint by the blood extravasated at the time of fracture; to coincident sprain of the knee; to interference with venous return, and to the posture and prolonged immobility of treatment. Fractures at the lower third should be expected to present this complication most frequently. It needs, as a rule, no special treatment.

Some permanent shortening is to be expected after every fracture of the femur; but, if union is obtained with the fragments in good line, without rotary displacement, a shortening of even three quarters of an inch will cause little limp in the gait. Rigidity of the knee may remain for a long time in rheumatic or aged patients.

Treatment.—In all fractures of the femur, with rare exceptions, permanent horizontal traction, or extension as it is often called, by means of adhesive plaster and attached weights is the best method of treatment. Counter-extension is to be obtained by elevating the foot of the bed six inches. This procedure makes the weight of the trunk act as a counter-extending force. Any tendency to lateral mobility or deformity of the fragments may be avoided or corrected by short coaptation splints of wood, metal or paste-board or by long narrow bags well, but not too tensely, filled with sand and laid closely along the inner and outer sides of the limb. The outer bag should extend from below the sole to within a few inches of the axilla, the inner bag from below the sole to the perineum. Long narrow boxes containing bricks may be used instead of sand bags.

Before the application of the plaster strips the thigh and leg should be shaved. A piece of thin board, three inches wide and five inches

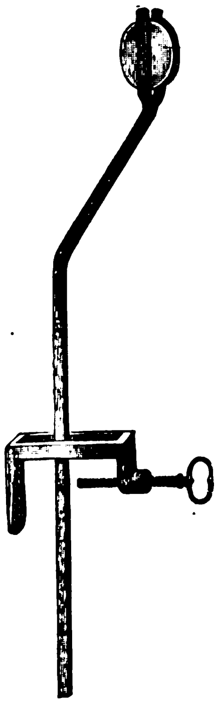
FIG. 231.



Adhesive plaster and foot-board applied for continuous traction.

long, is fastened lengthwise to the middle of the adhesive side of a strip of rubber adhesive plaster three inches wide and six feet long. This stirrup-like apparatus is then smoothly attached to the limb by applying the plaster up the sides of the leg and thigh to a point just below the seat of fracture. Its adherence to the skin is further assured by applying narrow bands of plaster around the limb and the side strips at three points: namely, above the knee, below the knee and about an inch above the ankle. A bandage is next applied over the foot and malleoli under the stirrup, and then carried up the limb over the adhesive plaster attachment until it nearly reaches the height of the fracture. The ends of the plaster which project above the last fold of the bandage are now turned over the bandage, so that their adhesive surface becomes external. Around these turned down ends the bandage is applied by a few more folds, until no vestige of the plaster is seen. The attachment of the plaster to the skin should extend above the knee. The turning over of the ends gives additional security against the traction weights causing the adhesive strips to slip on the skin. To the foot piece a cord about three feet long should be attached so that in the course of an hour, when the plaster has become firmly adherent to the skin, the traction weights may be tied to the apparatus. When it is thought that the plaster will bear the weight without slipping, the surgeon props up the foot of the bed, and, taking hold of the foot and ankle, makes powerful but steady traction to overcome the muscular spasm causing the over-riding and shortening. If there is great shortening or if the patient is very muscular, it may be well to obtain relaxation of the muscles by producing a slight degree of general anæsthesia with ether or nitrous oxide. When the deformity has been overcome as much as possible, two or three bricks or an equivalent weight, are tied to the cord and suspended over a pulley at the foot of the bed. The pulley should be placed high enough to lift the heel a little from the mattress, and in such a position laterally as to keep the axis of the limb correct. The cord should not let the bricks rest on the floor when the patient slides toward the foot of the bed, though it should be long enough to let the patient slide up and down for the distance of a foot or so. There should be no shelf or obstacle above the floor upon which the bricks may catch and suddenly fall off with a jerk. The pulley must have side pieces or an arch projecting above the groove, that the cord may not be pushed off by persons passing the foot of the bed. Instead of using the adhesive plaster apparatus a series of straps may be adopted.

Fig. 232.

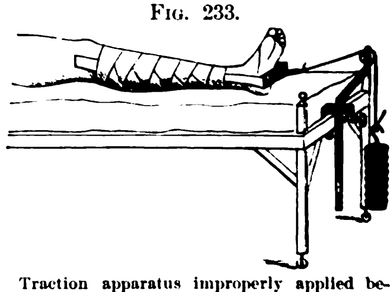


Levis's pulley for continuous traction apparatus.

The amount of weight for the first three weeks should be from fifteen to twenty five pounds for an adult, according to the muscular development and tendency to spasm. At the end of that time the amount may be decreased one half, and be discontinued at about the sixth week. Then a circular gypsum or silicate of sodium dressing is applied from the ankle to the hip, including the pelvis if the fracture is in the upper third, and walking with crutches is permitted. The patient should not bear any of his weight on the foot till the tenth or eleventh week. If the gypsum or silicate dressing is not adopted, sufficient lateral support may be obtained by using coaptation splints of moulded pasteboard, provided that the knee and hip are fixed by them. It is, of course, understood that the patient shall not be permitted to walk even with these dressings, unless the fracture has lost its mobility. Caution must be exerted against subjecting the limb to strains or falls, for rupture of the callus readily occurs, even as late as three or four months after the original injury.

Usually a slight amount of padding is required on the bed beneath the popliteal space, because the absolutely straight position of the knee becomes painful unless a little support is given at the point mentioned. If lateral deviation at the site of fracture is not prevented by the sandbags or if there is antero-posterior bending, three or four coaptation splints of wood eight to ten inches long may be applied over the bandage and kept in place by a few turns of another bandage. Pasteboard or other plastic material may be moulded to the front or side of the thigh, if the surgeon prefers. Care must be taken that pressure of the heel on the bed does not cause

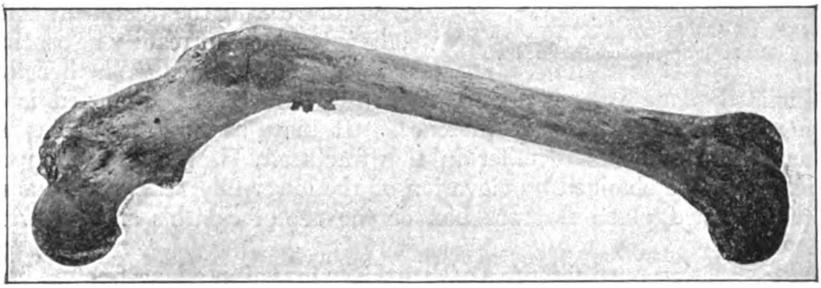
Fig. 233.



Traction apparatus improperly applied because the adhesive plaster does not extend high enough and the malleoli are not protected by the bandage.

a bedsore. A mass of oakum, wool or cotton, hollowed out like a bird's nest, to receive the heel or a pad placed beneath the tendon of Achilles so as to lift the heel from the mattress are the simplest devices for relieving this injurious pressure. The bed clothes must not rest on the toes, since their weight will press the foot outward and evert the leg. Any sort of an arched frame, such as can be made from pieces of barrel hoop, placed over the foot will hold the coverings up.

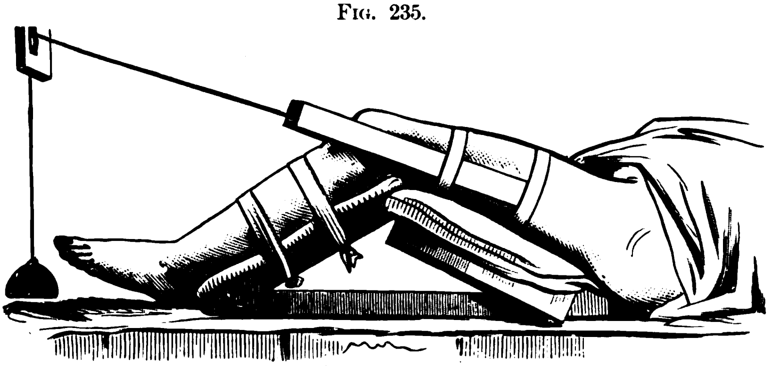
FIG. 234.



Displacement on account of action of psoas and iliacus muscles and external rotators. (DENNIS.)

It is also necessary to see that the patient lies flat on his back, for if he turns a little on his side or if the pelvis sinks into the mattress on one side, while the foot and leg are held motionless by the dressing, rotary deformity will remain when the fracture is united. The foot should be kept very slightly everted, as has been stated under the treatment of Fractures Near the Hip. The patient should not be allowed to sit up in bed nor have a high pillow or bolster, until at least three weeks have elapsed. Then he may be propped up in the

FIG. 235.

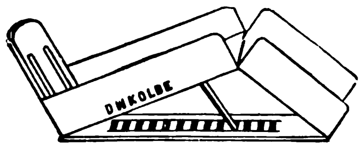


Inclined plane and traction apparatus. (AGNEW.)

half-sitting posture, if it shows no tendency to displace the partially united fracture. The sliding movements up and down in the bed, which are permissible from the beginning, relieve the monotony of confinement very much, and enable the nurse to adjust the bed pan and keep the patient clean.

When, in fractures of the upper third, there is marked tilting forward of the upper fragment, the straight position just described is not always satisfactory. It may become necessary to elevate the lower fragment in order to meet the displaced upper fragment and preserve the proper axis of the limb. In order to get proper apposition of the fragments the limb with the traction apparatus attached should be elevated upon an inclined plane of wood and maintained in that position during the treatment. The weight extension can readily be continued at the same time. Whether the inclined plane is such as will keep the knee straight or flexed is a matter of comparative indifference. It may be good treatment to nail the fragments together in this fracture. Usually correct apposition can be obtained by elevation of the lower fragment by means of the inclined plane fracture box or the use of Smith's anterior wire splint.

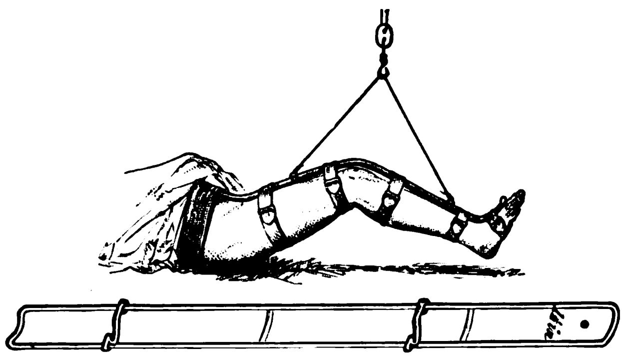
FIG. 236.



Double inclined plane fracture box.

In treating open fractures with much suppuration a long fracture box or the anterior wire splint of Nathan R. Smith are often convenient. The method of using the anterior splint is well shown in the illustration, except that the pulley should be placed over the middle of the leg so as to obtain extension or traction by the weight of the buttock.

FIG. 237.



Smith's anterior splint, before it is bent to fit the limb.

The ambulant method of treating fractures of the thigh is employed by some surgeons. In it the fragments are reduced by traction and counter-traction, perhaps during general anæsthesia, and then a gypsum splint or a steel splint like that used in coxitis is applied. The weight of the patient is borne on the splint, which must have a purchase on the tuberosity of the ischium and on the perineum and extend below the sole of the foot. The danger of permitting overriding of the fragments is greater in this method of treatment than in that by continuous horizontal traction with the patient recumbent.

In infants below five years it is often difficult to prevent soiling of the traction apparatus by the alvine discharges; hence, vertical extension has been employed with good results. This is effected by flexing both hips at a right angle, placing straight splints along the posterior surfaces of the limbs to prevent flexion of the knee and attaching the feet to a support over the bed. The buttocks thus act as a traction weight and the little patient can be kept clean. If preferred a pulley and a weight of four or five pounds attached to the leg and foot may be used to increase the traction power. When the child is over four or five years of age the ordinary horizontal traction is easily employed. The weight should be about one pound for every year. Union becomes firm in children in about four weeks.

Fractures of the Lower End of the Femur.

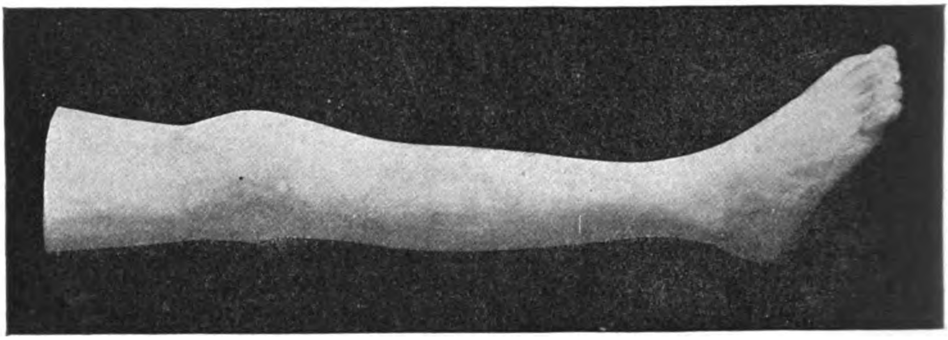
Pathology.—These injuries, occurring so near the knee joint and having a short lower fragment, which may be difficult to control, deserve some special consideration. The line of fracture may be in the shaft just above the condyles, may at the same time run downward between the condyles, splitting them apart, or may not involve the shaft at all but merely separate one of the condyles or a part of a condyle from the rest of the bone. Sometimes small pieces of the bone are torn up by strains on the crucial ligaments. The last two varieties are very rare. The epiphysis, which includes the entire condyloid portion of the bone, may be detached in persons not over twenty years of age.

The line of fractures just above the condyle is usually oblique, but a transverse direction is said to be more common than when the bone is broken at a higher point. The lower fragment in fractures above or through the condyles is frequently displaced backward and may, by pressure upon, or laceration of, the popliteal vessels and nerves, cause gangrene or paralysis of the leg. The same result may follow similar displacement of the upper fragment.

Symptoms.—The usual symptoms of fracture are present. The lateral mobility possible above the knee, the backward displacement of the lower fragment and the leg, and the prominence and normal mobility of the patella in supra-condyloid fracture or its sinking between the separated condyles in inter-condyloid fractures are additional aids to diagnosis. A pointed upper fragment is sometimes driven into the fibers or tendon of the four-headed extensor muscle or thrust through the integument. Effusion or hemorrhage into the knee joint is particularly common in fractures involving the condyles.

Treatment.—The proper treatment is permanent horizontal traction, as in fracture of the shaft, with even greater care to keep the knee joint immovable. This immobility may be attained by a pasteboard splint adjusted to the back of the joint. The adhesive strips for traction should extend along the limb only as far as the knee. If the straight posture does not maintain the lower fragment in proper position, the knee may be partially flexed, by placing a pillow or a double inclined plane under it or by using a Smith's anterior splint. Severe arthritis is an argument for the extended position, since, if ankylosis occurs, a nearly straight knee is more useful than a flexed one. If the distention of the joint with fluid is too great to allow the joint to be sufficiently extended, the fluid may be partially withdrawn with an aseptic aspirator needle.

FIG. 238.



Foot-drop from epiphyseal fracture of lower end of femur and contusion of external peroneal nerve. The projection of the lower fragment backward can be seen at the outer part of the popliteal space. (Author's case.)

If spasm of the gastrocnemius muscle prevents adjustment of the lower fragment, tenotomy of the tendon of Achilles is justifiable, to weaken the displacing cause. If the upper fragment is buttonholed and so tightly held in the substance of the extensor tendon that reduction of the fracture is impossible, its liberation by open section of the muscle is proper. Arthritis, if severe, requires appropriate treatment. The formation of pus in the joint is a demand for immediate incision under antiseptic measures.

Fracture of a single condyle is a very rare injury and, owing to the slight deformity attending it, may be mistaken for a sprain or arthritis of the knee. The integrity of the other condyle and the attachment of the broken piece of bone to the tibia prevent shortening and marked displacement. Suppuration of the joint has followed condyloid fracture. The diagnosis is to be made by localized pain and ecchymosis, motion and crepitus. Horizontal traction with care to correct any lateral deviation at the knee is the treatment; though a gypsum splint may be better at times. The joint should be kept immovable for three or four weeks. These fractures and those in which small splinters of bone are torn off within the joint resemble in their symptoms severe sprain, and should receive much the same treatment.

Fractures of the Patella.

Pathology.—The patella is broken generally by sudden and forcible contraction of the four-headed extensor of the leg, and occasionally by direct violence. The patient usually attributes the fracture to a fall upon the knee; but the fall in most cases is due to the previous giving way of the patella from muscular strain exerted upon it, for it is a sesamoid bone in the tendon. A slip of the foot occurs and, as the man tries to save himself from falling, the violent muscular contraction bends the patella across the condyles and fractures it by the cross-breaking strain or else tears it asunder simply by the powerful traction upward. A similar result may occur in efforts at kicking or lifting. This usual causation of the fracture is proved by the fact that in falls upon the bent knee the impact is usually received on the head of the tibia rather than on the patella, and by the further circumstances that the line of fracture is usually transverse, that in fractures known to be caused by direct violence the bone shows vertical, oblique or comminuted fractures, and that no bruise is seen over the patella in the ordinary cases.

The fracture from muscular contraction is usually more or less transverse, is situated near the middle of the bone and is generally repaired by fibrous union. Comminuted and oblique fractures usually unite by bony instead of fibrous tissue.

FIG. 239.

Transverse fracture of patella.

FIG. 240.

Oblique fracture of patella.

FIG. 241.

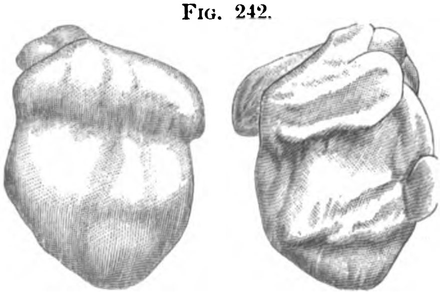
Bony union of comminuted fracture of patella. (GURLT.)

The transverse fracture, from muscular action, is so much more common than any other that the subsequent description refers to it, unless otherwise stated. The lower fragment retains its normal position; but the upper one is drawn upward by the muscle and pushed upward by the rapidly occurring intra-articular effusion, until the separation amounts to half an inch or an inch. If the muscular aponeurosis surrounding the bone is greatly torn, the displacement may be much greater; and, on the other hand, if the fibrous envelope is not ruptured the fragments may remain in contact. Lateral displacement may at times occur, but in any marked degree is not common. Some tilting of the fragments due to the surgeon's dressing or to the intra-articular effusion is not unusual. The fragments may thus be tilted so that they are in contact at one side, but separated at the other, or may be so everted that the fracture surfaces are directed in an anterior direction.

Symptoms.—The symptoms are a sudden loss of extending power at the knee, often accompanied by a sharp snap at the moment the bone gives way; pain and difficult progression, though walking is often possible if care is taken to keep the tibia and femur in a straight line and the heel to the ground; a well marked furrow felt with the finger between the fragments; independent mobility of the upper and lower parts of the bone, with crepitus when they are pressed together and moved laterally; and swelling of the knee from blood and inflammatory products within the synovial cavity of the joint and the surrounding structures. The arthritis accompanying the fracture does not give rise to the intense pain so common in other cases of synovitis of the knee, probably because the tearing open of the joint prevents intra-articular tension. The patient is unable to extend the knee after it has been flexed or to raise the foot from the surface of the bed upon which he lies. The disability, however, varies, as would be expected, with the amount of laceration of the tendinous aponeurosis surrounding the patella. The bone has the vastus muscles inserted into its lateral margins and the general aponeurosis spread over its front. Hence, extension of the knee may be accomplished to a limited degree by such untorn attachments, even after fracture of the patella.

The diagnosis is readily made by palpation and the symptoms above described. Fractures with little or no separation and traumatic bursitis, in which the bursa in front of the patella is filled with blood and inflammatory products, may need careful consideration before a correct understanding of the lesion is obtained. It is said that crepitus and the feeling of separated bony fragments may be simulated by blood-clots in the bursa. After about ten days have elapsed the swelling of the joint decreases, and, if the pieces of bone are in close contact, a short fibrous, in rare cases an osseous, bond of union is established. In untreated or improperly treated cases the permanent separation between the fragments may be three or four inches. Use of a quite well repaired fracture of the patella has often caused the fibrous union to stretch, and the stretching may be greater on one side than on the other. Osseous union occasionally takes place, but many close fibrous unions have been mistaken during life for bony repair. Nodules of bone are at times found in the fibro-ligamentous tissue between the fragments. Rupture of the bond holding the pieces together or fracture near the point of union is not infrequent. Such secondary accidents show at times little attempt at union. When the tissues have become rigid and adherent about the seat of fracture and there still remains some stiffness of the joint, the integument may be torn and the joint laid open at the time the secondary fracture occurs. The open fractures so caused and those originally open are, of course, very serious injuries, unless managed antiseptically.

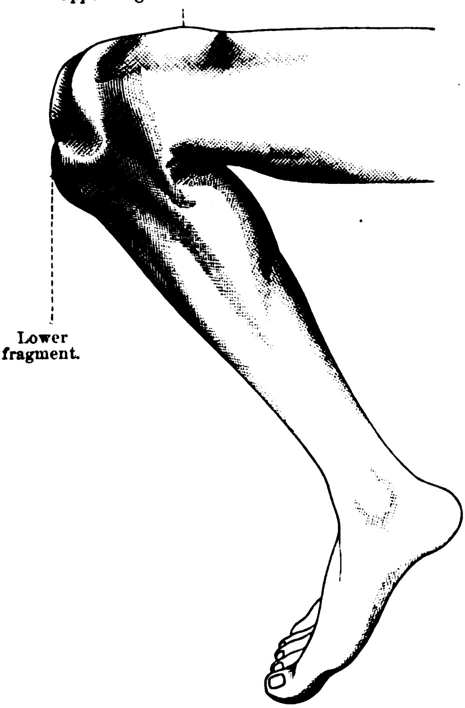
FIG. 242.



Close ligamentous union resembling bony union. (LEVIS's specimen in Mütter Museum.)

A severe arthritis may leave a stiff knee; and, even in ordinary cases, free motion of the limb may not be attained for six months. This is partly due to the fear of tearing or stretching the ligamentous union by early attempts at motion, which induces the surgeon and the patient to insist upon protracted wearing of splints and abstinence from strong passive movements. The fear is a well grounded one. After freedom of flexion and extension of the joint has finally been gained, the disability from fibrous union, even an inch in length, is not very great. The patient may scarcely limp; though a rapid gait or the ascending and descending of stairs will show his imperfect power of control over the knee. Going down stairs is especially troublesome. Active extension of the joint will probably be possible only when the limb is put in an almost straight position.

FIG. 243.



Ununited fracture of patella showing displacement during flexion.

Treatment.—In treating fracture of the patella, inflammation of the joint should be moderated and a short bond of union secured. Usually rest is all that is required to effect the first result. Dry cold, by means of a bag of cracked ice, may be employed if the arthritis promises to be severe. When there is very great intra-articular effusion, aspiration of the joint with an aseptic aspiration needle should be performed. The small size and irregular margins of the fragments, their being imbedded in a tendinous aponeurosis which is attached to the bone at the anterior edge of its margins and the convex surface of the condyles on which the fragments rest all make accurate adjustment by encircling dressings difficult and unsatisfactory. The best treatment for the majority of cases is obtained by drawing the fragments together by means of steel hooks thrust through the skin and imbedded in the tendon above and below the upper and lower fragments respectively. The hooks devised by Malgaigne are effective, but on account of the irregular shape of the bone do not permit as accurate coaptation as do those devised by Levis. These latter are separated pairs and can, therefore, be introduced parallel to each other or at an angle, varying with the line of fracture and tendency to irregularity in the displacement. Each pair of hooks has its points held together, after coaptation of the fragments, by a screw or by a lateral clamp.

To lessen the muscular cause of displacement the leg should be kept fully extended on the thigh and the thigh perhaps slightly flexed on the pelvis. This is readily done by elevating the limb on an inclined plane, or by supporting it with pillows after placing any form of rigid

FIG. 244.

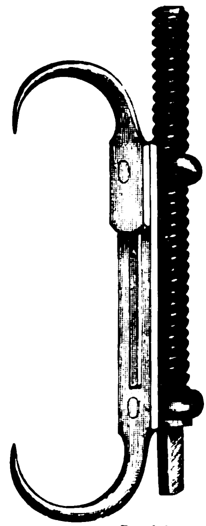
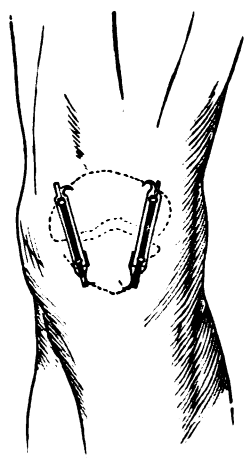


FIG. 245.



Levis's modification of Malgaigne's patella hooks.

splint behind the knee. This position relaxes the three muscular masses arising from the femur and also the rectus, which has its origin from the pelvis. Absolute rest in this position for about a week, with perhaps the local application of cold, will cause absorption of the articular effusion which aids in separating the fragments. If it does not, aspiration is justifiable. At the end of this time the fragments can usually be pressed together by the surgeon's fingers and held, while the hooks are inserted so as to keep them closely approximated. It is best to put the lower hook of the pair in position first; and then the upper fragment, which is the displaced one, can be controlled by the insertion of the second hook.

The points of the hooks must be sharp and should be thrust as deeply as possible into the tendon close to the margin of the bone. There is no danger of entering the joint, for the tendon is very thick and tough. After one pair has been inserted the other is to be placed where it will best hold the fragments firmly together. The skin should be drawn tightly over the patella before the hooks are inserted, and the surface of both the skin and hooks cleaned and made aseptic. Ether may be required in some patients, since the operation is rather painful, though not a tedious one. The points of puncture and the surrounding skin should be dusted with boric acid or acetanilid, and the parts surrounded with dry antiseptic cotton or gauze. The hooks should be kept in place for six weeks; and when they are removed, the patient, though using crutches, should wear a posterior splint for five or six weeks longer, in order not to tear the broken bone asunder by suddenly flexing the joint. Sometimes the hooks may need tightening once or twice as the swelling subsides, but usually no such change is required. Their removal from the first punctures is not to be expected until they are finally taken out. The irritation produced by the hooks is inconsiderable.

When there is little tendency to separation an adhesive plaster dressing may be employed instead of the hooks. It is applied as follows: After the knee has been extended and the entire limb elevated, the middle of a strip of adhesive plaster about two feet long is placed on the skin beneath the lower patellar fragment and its ends carried upward and crossed upon the back of the thigh. By this and two or more strips applied in a similar manner, but not exactly corresponding with the first, the lower fragment is steadied. Then similar overlying strips are placed above the upper fragment and used to draw it down toward the lower one. The ends are crossed on the back of the calf of the leg. Over the whole a roller bandage is applied from foot to hip, and the limb kept extended and elevated by an inclined plane. Renewal of the adhesive plaster will be required about once a week during the six weeks that the dressing is used, before permitting the patient to be up on crutches. In applying this and similar constricting dressings there is a great tendency to tilt the fragments so that the anterior edges of the broken surfaces are further apart than the posterior. Perhaps this may be avoided by one or two additional strips applied directly over the front of the knee joint.

Before inserting the hooks or applying the adhesive plaster dressing, the surgeon should rub the surfaces of broken bone vigorously together in order to push aside bands of torn periosteum and fascia which are liable to become interposed between the fragments. After this manipulation the fragments should be kept pressed together until the dressing is adjusted.

For a long time after discarding all apparatus and crutches the patient should support the patella by wearing a knee joint bandage of elastic webbing.

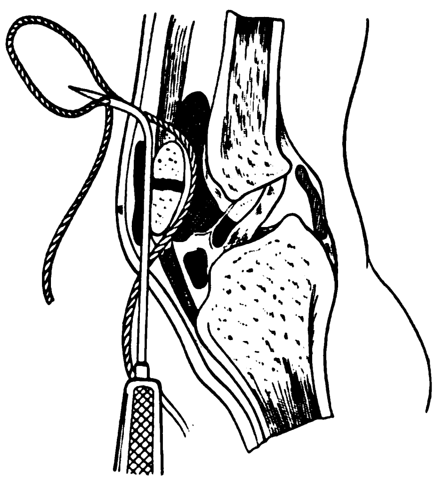
Open fractures of the patella should be treated by free incision into the joint, washing out the synovial sac with a one per cent. solution of carbolic acid or a sublimate solution (1:5000) and free drainage by tubes. If the opening is very small and the injury just received probably aseptic, the attempt to convert the fracture into a closed one without free incision may be proper; but the first sign of joint inflammation is a signal for free incision, antiseptic washing and drainage. The use of the hooks or the adoption of suture or nailing of the bone will necessarily be the treatment in such cases, since the adhesive plaster dressing and similar devices can scarcely be applied. The drainage tubes need not, as a rule, be retained over a couple of weeks.

Rupture of the bond of union or refracture of the patella should be treated as the original fracture though it may be better here to lay open the skin and suture the fragments with catgut or wire. Sometimes the tendon of the great extensor mass of muscles is torn from the upper edge of the patella by the same mechanism that usually breaks the bone. Suturing is here the proper method of treatment. The same treatment is to be employed if the patella and the ligament of the patella are torn apart.

The treatment of fractured patella by wiring the fragments and the management of cases with long fibrous union by resection and suture are sometimes justifiable, when other methods of treatment seem inefficient. Most careful asepsis is requisite. In recent fractures the hooks will be found as efficient as wiring or suturing with chromicized or formaldehyde catgut, and are much safer because the joint is not opened. In cases of old fracture with long fibrous union, resection of the ligamentous bond and suture of the fresh surfaces of bone is proper, if the lameness is annoying.

Fractures of the patella have been treated satisfactorily by other methods, which deal with the fragments more directly than the hooks or adhesive plaster. The method of passing a silk suture horizontally around the two fragments, by means of a long needle thrust through the skin and muscles, and tying the fragments together seems likely to give good results and does not invade the joint. Another method passes a similar suture vertically around the two fragments and ties them together. This suture traverses the joint immediately below the patella. These operations, especially the latter, make separation of the pieces of the patella almost impossible and restraint in the extended position of the joint need not be maintained for more than two or three weeks.

FIG. 246.



Barker's operation for transverse fracture of the patella by means of a ligature passed around the bone. (KEEN and WHITE.)

Fractures of the Tibia and Fibula.

The tibia and fibula are each developed by three ossific centers, one for the shaft and one for each extremity. The upper epiphyses unite at about twenty five years of age, the lower at about twenty years. Occasionally the tubercle and malleolus of the tibia develop from separate centers. The possibility of epiphyseal separations occurring when the bones of the legs are subjected to violence should be recollected. Such diastases are, however, very rare.

Fractures Near the Knee.—Fractures at the upper end of the tibia, which usually are accompanied by fibular fracture, are frequently transverse and may, by more or less vertical lines, invade the knee joint. If the fibula is neither broken nor dislocated, it aids in preventing displacement. Epiphyseal separation of the tibia here, as elsewhere, is liable to interfere with growth of the bone in length. Then the uninjured fibula as it grows must either become bowed or dislocated at one of its ends.

The usual symptoms of fracture may be associated with those of synovitis of the knee or of injury to popliteal vessels and nerves. The fibula is seldom broken at its upper end, except when the tibia also is fractured.

Fractures of the Shaft of the Tibia and Fibula. Pathology.—The tibia alone is seldom broken except when the fracture is due to direct violence, such as a kick on the shin. The line of fracture is then apt to be somewhat transverse. The fibula, being the smaller bone, may readily be broken while the tibia remains intact. If both bones are involved, the fibula is likely to give way at a higher point than the tibia. The most common point of fracture of the bones of the leg is near the junction of the middle and lower thirds, and a frequent displacement is projection of the upper fragment forward and inward while the lower fragment is drawn upward, behind the upper fragment, by the great muscles of the calf. The subcutaneous situation of the tibia makes perforation of the integument and the conversion of the fracture into an open one quite frequent.

Symptoms.—The symptoms of fracture are easily discernible, especially when both bones are broken, since mobility and deformity are then present to a greater extent than under the opposite condition. The tibial crest and inner surface are so easily felt through the thin overlaying tissues that deviation in outline here can scarcely be missed, unless sufficient time has elapsed for the development of the great swelling which so often happens. Patients have occasionally the ability to walk upon a broken tibia, and even when both bones are fractured such a feat is not impossible. Walking after fracture of the fragile fibula is neither surprising nor uncommon. If it has been ascertained that the tibia is broken, fracture of the fibula may usually be assumed, unless the history is that of an injury of a localized character received in the tibial region. If the fact is not evident from the general deformity and preternatural mobility of the limb, pressure along the fibula may perhaps elicit pain, crepitus or yielding sufficient to establish the fact of its fracture. The formation of blebs on the surface of the leg, great swelling, violent cellulitis and fat embolism are not unusual accompaniments of the severe injuries that give rise to fractures of the leg bones.

Union in uncomplicated cases of tibial fracture is firm in five or six weeks; in fibular fracture in from three to four. The bridge of callus occasionally uniting the bones after the cure is of no evil consequence, since rotation is not a function of the leg and foot, as it is in the upper extremity. Non-union is not so very infrequent. Comminuted and very oblique fractures require more time for consolidation. Neuralgic and rheumatic pains, persistent œdema, rigidity of the ankle and chronic ulcers from defective restoration of circulation are not unusual sequences of fractures in the leg.

Fractures of the Tibia and Fibula near the Ankle. Pathology.—These injuries are frequent and often very serious injuries. Both bones may be broken without complication, they may be greatly shattered with the ankle joint involved, the fibula alone may be fractured

FIG. 247.

Fracture of tibia and fibula near ankle often called Pott's fracture. (HOFFA.)

FIG. 248.

Exaggerated deformity in Pott's fracture. (PARK.)

or one or both malleoli may be separated from the corresponding shaft. The lower end of the tibial shaft is scarcely ever broken without the fibula being similarly injured, though the fracture of the latter bone may be two or three inches above its tip.

On account of the mortice-like manner in which the astragalus fits between the malleoli, lateral mobility of the normal ankle joint is impossible, though it is stimulated during the extended position of the foot by the slight rotation about a vertical axis which is possible. Lateral motion between the tarsal bones is sometimes mistaken for lateral movement in the ankle joint. The impossibility of other motions than flexion and extension renders the occurrence of bad fractures common when falls, twists or direct violence tend to forcibly evert or invert the foot at the ankle joint. By such mechanism one bone may be fractured, or one malleolus may be torn off by avulsion through the lateral ligament, while the other is broken from the shaft by the astragalus within the joint being driven against its inner surface. Instead of involving the malleoli only, the force may fracture the tibia and fibula above the malleoli, rupture the ligaments holding the lower ends of these two bones together and even so displace the foot laterally as to drive one of the bones through the skin.

The dissolution of integrity of the inferior tibio-fibular ligamentous bond allows, by widening the mortise in which the astragalus lies, lateral mobility in the joint, and suggests severe damage to the articulation, unless examination shows that the line of fracture has been limited to one of the malleoli or to the fibula above its malleolar extremity. Occasionally the astragalus has been actually driven up between the tibia and fibula.

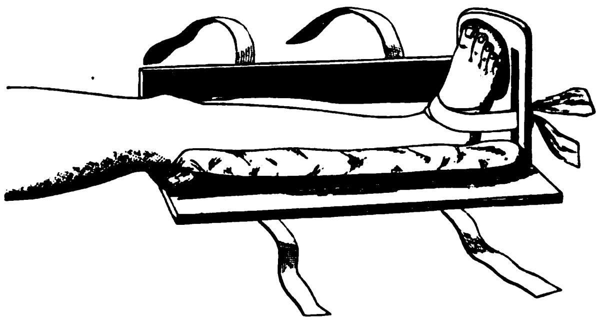
Symptoms.—The symptoms in the majority of cases are characteristic of fracture, though occasionally it is necessary to examine the malleoli and fibula carefully in order to avoid calling the injury a sprain. Localized tenderness and ecchymosis will often be determining symptoms in obscure fracture of these parts. Sprain-fracture, or sprain with detachment of a small piece of bone from the end of the malleolus, is not uncommon at the inner malleolus. The fracture of the fibula may be two and a half inches above its tip.

In the form of injury depicted in Fig. 247 which is quite common, the foot is displaced to the outer side, the inner malleolus prominent, the sole of the foot everted and the heel sometimes apparently elongated. There is occasionally a groove on the outside of the ankle at the point where the fibula has given way. Pain and ecchymosis will probably be found in both malleolar regions; and lateral mobility at the ankle joint will be detected, if the calcaneum and astragalus are seized with one hand while the lower end of the leg is grasped with the other. Motion in the tarsal joints must not be mistaken for ankle motion.

Fracture of the lower part of the fibula can often be detected by placing the fingers behind the upper third of its shaft and endeavoring to lift it forward. If this causes pain about the lower portion of the bone, it is evident that the fibula is fractured and movable at the point of pain.

Uncomplicated fractures about the ankle, without much displacement or with easily corrected displacement, give good results and do not leave a stiff ankle. The period of union is about five weeks, but it requires many weeks to restore the mobility of the ankle. When there is great deformity and when the eversion or inversion of the foot is not overcome, permanent disability results from the weight of the body being carried on a foot out of proper line. The strain on ligaments and bones in the unusual relations creates lameness and a tendency to

FIG. 249.



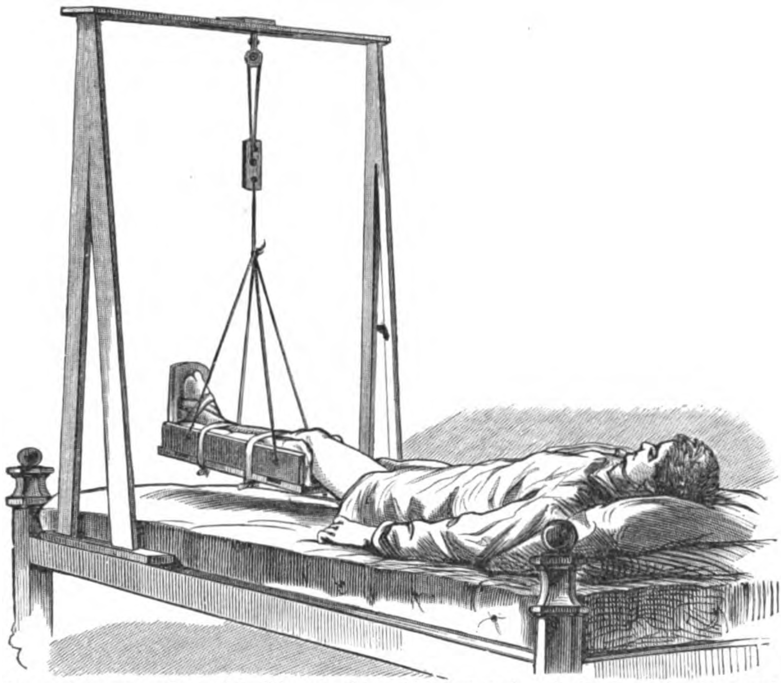
Method of adjusting the leg in a fracture box.

increased deviation from the normal axis. Open fractures in which suppuration occurs are of serious prognosis. Free incisions and the introduction of drainage tubes may not only avert amputation but save life. Ankylosis is common in bad fractures entering the joint. Such fractures, especially, should be treated with the foot at a right angle to the leg.

Treatment.—There are few fractures of the bones of the leg that cannot be properly treated in a fracture box, with hinged sides and foot piece and appropriate compresses. Continuous horizontal traction can be added to the box, if the case is such as to demand it. Unless traction is simultaneously used, and it is seldom required, the box should be suspended, because thus the patient can have greater freedom of motion in bed without danger of displacing the fragments. Instead of using the fracture box the surgeon may tie the limb up in a pillow or with straight splints for a few days, until swelling subsides, and then apply a gypsum bandage; or he may make moulded splints out of gauze soaked with gypsum and water, when he first sees the patient. The circular gypsum splint may do harm, if applied before swelling has occurred; unless it is cut open immediately after it has been adjusted to the limb and provision is thus made for swelling. Thus employed it is a very satisfactory fracture dressing.

The fracture box is prepared by opening its hinged sides and laying within it a small feather pillow just large enough to fill the space which would exist between the leg and the inner surface of the box when the sides are closed. Upon the pillow, close to the footboard, should be placed a ring of oakum, tow or cotton to receive the point of the patient's heel; and over the ring a strip of bandage two feet long should be laid. The leg is to be placed upon the middle of the pillow with the ankle bent at a right angle and the foot close to the footboard, from which it is separated by only a soft compress. The foot is affixed to the footboard by the ends of the piece of bandage mentioned being carried over the top of the foot, where they are crossed, car-

FIG. 250.



Suspended fracture box, with slide on cord by which box can be raised or lowered. (AGNEW.)

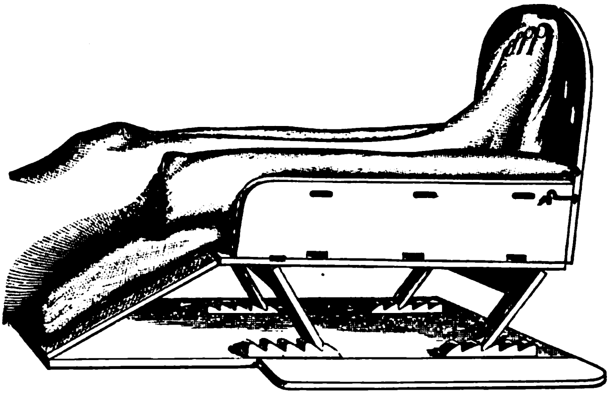
ried through the slots in the footboard and tied on its outside. The next step is to raise the sides of the box, by which means the edges of the pillow are pressed against the broken limb, and to hold them in position by pieces of bandage drawn underneath the box and tied over the top. The amount of pressure exerted by the sides of the box, which act as lateral splints, can be regulated or changed by tightening or loosening the encircling strips of bandage or altering the thickness of the pillow. If any lateral deviation in the line of the leg is observed by running the finger tip along the crest of the tibia, it can be corrected by compresses slipped between the sides of the box and the pillow at the appropriate places. Anterior or posterior displacement can usually be overcome by elevating or depressing the heel, which is done by increasing or diminishing the size of the ring used to prevent a bedsore on its tip.

FIG. 251.

Slide by which fracture box is raised and lowered. (AGNEW.)

No primary bandage should ever be applied to the leg from the toes to the knee, as the danger of gangrene produced thereby is too great. In suspending the fracture box, which should always be done except in some fractures close to the knee joint and in those which require

FIG. 252.



Elevated fracture box. (STIMSON.)

horizontal traction from the foot, cords should pass through openings in the upper part of the sides of the box and be attached to a single cord carried to a pulley fastened above the bed. It is easy to devise methods by which the height of the box from the bed may be changed to suit the patient. The posterior end of the box must not be allowed to drag on the bed nor should any position be assumed which tends to permit motion or displacement at the site of fracture. Rotary displacement is a particularly unfortunate deformity, as permanent inversion or eversion of the toes is unsightly and interferes with walking. The surgeon should see to it that the ball of the great toe, the inner malleolus and the inner condyle of the femur are in the same vertical plane, or that the great toe is on a line with the inner edge of the malleolus. When muscular contraction prevents complete reduction at the first dressing, anæsthesia will cause relaxation of the muscles. Flexing the knee and extending the foot will relax the calf muscles. Stimson says that compression of the femoral artery for a few minutes has induced for him relaxation of the muscular spasm. Subcutaneous section of the tendon of Achilles will be found valuable, and is not employed as much as it should be, in cases where displacement recurs despite the fracture dressing employed to prevent it.

When the fracture is at the upper part of the leg the knee must be kept immovable; hence the fracture box should extend above the knee, which is to be kept straight or slightly flexed, according as one or other posture favors accurate adjustment of the fragments. If flexion is necessary, a double inclined fracture box like that used occasionally for fractured femur may be needed. It is not easy to suspend this form of box, nor is it necessary; but, with the knee in a straight box, suspension is readily accomplished. The synovitis, often compli ting, should be watched, and if purulent must be treated by incisioı anti-septics and drainage.

In very oblique fractures of the shaft continuous longitudinal traction may be needed to correct the over-riding. This can be attained by elevating the foot of the bed as in femoral fractures and attaching a weight to the footboard of the box, after placing under the box a smooth board or kind of railroad upon which it can slide up and down. Another method is to apply a stirrup to the leg, as in fractures of the femur but by means of shorter adhesive strips, and to substitute for the fracture box lateral coaptation splints or sand bags. When the fracture is too low to give sufficient attachment for the plaster, a thin board may be cut in the shape of the sole and attached to the foot by strips of plaster. To this footpiece or sandal, cord and weight may be fixed and the lateral splints then applied to the legs.

When the fibula alone is broken, when one of the malleoli is split off and even when the tibia itself is fractured, if the line is transverse and the fibula intact, little support is needed. A circular gypsum ambulant dressing may usually be applied to such cases at once or after waiting a day or two for the swelling to subside.

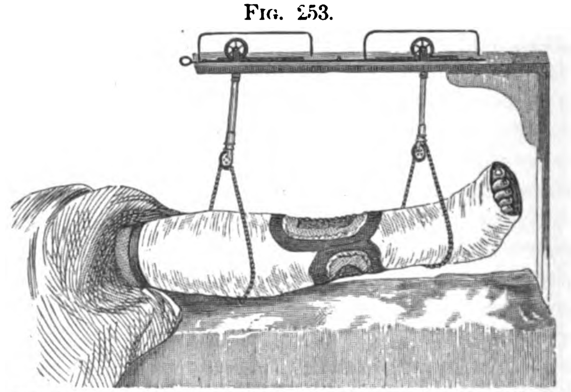
In those cases of severe fracture at the ankle in which the foot is greatly everted or inverted, it is of primary importance that the correct axis of the foot should be regained. Hence it is necessary to over-correct the deformity by inverting the everted foot or everting the inverted foot and keeping it so till some degree of consolidation has occurred. This being neglected will permit union to occur without reëstablishing the close mortise between the malleoli in which the astragalus fits, and thereby will leave a want of solidity at the ankle. The projection backward of the heel must also be corrected by elevating it in the fracture box. Backward displacements can sometimes be well corrected by passing a piece of adhesive plaster under the heel or ankle with its adhesive side against the skin and tacking its ends to the upper and outer part of the sides of the box. The fracture box, with the judicious use of compresses and the other adjuvants mentioned previously, will accomplish these indications as well, if not better, than more complicated dressings. Such cases are often managed much better by tenotomy of the tendon of Achilles, as soon as the difficulty of preventing muscular displacement is evident, followed by the application of a removable gypsum splint.

The blebs frequently seen on the surface, even if containing bloody serum, are of no importance as a rule, and need no treatment. If large, they may be evacuated with a sterile needle and afterward be covered with powdered boric acid. They soon dry up. They are, perhaps, due at times to the unnecessary swathing of the broken limb in lead-water and laudanum, or similar lotions, which are often employed immediately after the fracture.

At the end of a day or two in uncomplicated fractures and after the lapse of from two or three weeks in more serious cases, the box should be discarded and the circular gypsum dressing applied from the base of the toes to the knee or above it. The patient can then go about on crutches. When the fracture is at the ankle the dressing should be made additionally firm there by extra turns of the bandage. The foot should in such case be held in the correct position for from fifteen to thirty minutes, till the gypsum sets firmly. Care must be observed in order that the tarsus itself may be pressed over, and not merely the anterior part of the foot. The gypsum cast should be worn about three weeks in all cases. The gypsum splint may be split down the front with a knife or saw. It is then possible to remove it every day or two to examine the condition of the fracture, to bathe the limb and use massage to the muscles. Such treatment is very advantageous. An easy way to split the splint is to lay a flexible strip of lead along the front of the leg before applying the gypsum bandages, and make the splint over the lead. When the plaster of Paris has set, a penknife is employed to cut through splint down to the soft lead which does not dull the point of the knife. The lead strip, which has previously been greased is then drawn from under the splint. The splint is thus divided throughout its entire length, and may be opened and removed with ease. It is held firmly in place by an ordinary bandage or strips of adhesive plaster.

Open fractures, not demanding immediate amputation, are well treated in a fracture box after being made thoroughly aseptic and being surrounded by a large gauze dressing. Drainage must be well arranged, even if additional incisions are needed for the purpose. Free drainage and frequent irrigations are demanded if the fracture cannot

FIG. 253.



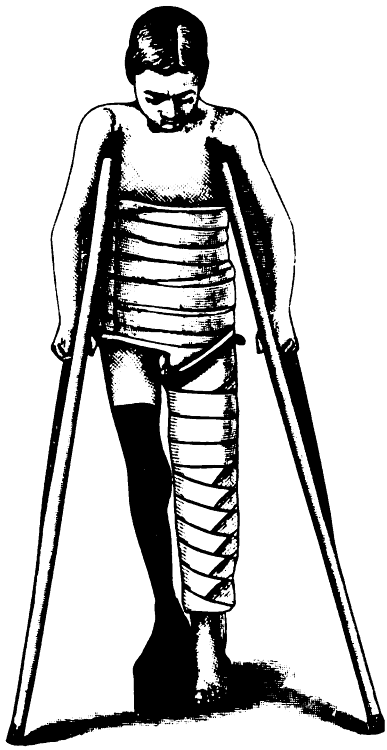
Van Wagenen's suspended fenestrated gypsum dressing for open fracture of the leg. (HAMILTON.)

be converted into an aseptic wound. When union has become pretty firm, or earlier if suppuration has been averted or has diminished greatly a fenestrated gypsum dressing may be substituted for the fracture box. Crutches are allowed when the fracture becomes firm.

Fractures of the Fibula have been discussed with those of the tibia; hence little further need be said. Injury of the peroneal nerve is sometimes an accompaniment of fibular fracture and is shown by paralysis. Localized pain and crepitus and pain felt at seat of tenderness, when the upper part of the shaft is lifted as previously described, are diagnostic symptoms, but are not always present. When the fracture is low down and accompanied by spreading apart of the malleoli, lateral motion of the astragalus becomes possible. The upper end of the fibula has occasionally been broken from the shaft by violent contraction of the biceps muscle. In such cases flexion of the knee to relax the muscle will be a judicious measure during treatment. Union after fibular fracture occurs in three or four weeks. When the fibula alone is broken the ambulant gypsum dressing may be applied at once. In some cases nothing more than a bandage is needed from the first.

The ambulant method of treating fractures of the leg and thigh has been advocated and employed a good deal of late. It is especially applicable to fractures of the tibia and fibula with little swelling and comparatively little tendency to displacement. It has not been used so much for fractures of the femur.

FIG. 254.



Ambulant treatment of fracture of the femur by means of Thomas splint and plaster of Paris bandage. (WARBASSE.)

The principle is to reduce the fracture and then apply a gypsum splint or metal brace in such a way that the limb can be used in locomotion, by having the weight of the body in walking borne by the splint or brace. The patient is not confined to bed at all or only for a few days. He uses crutches or a cane until he becomes accustomed to putting his weight on the walking splint. The surgeon may employ one of the forms of brace or extension splints employed in coxitis, which, by means of ischiatic support, a pelvic girdle, a perineal band and a cross bar under the sole transmits the pressure usually borne on the sole of the foot to the pelvic bones. In addition to this, lateral support is supplied at the seat of fracture.

Gypsum splints may be employed in the ambulant method by making the splint very thick and strong and carrying it about one inch below the sole of the foot, after covering the sole with a mass of cotton one inch thick. The broken leg then hangs in a strong case of plaster of Paris and gauze, which transmits the pressure in walking to the tuberosity of the ischium in femoral fractures, to the condyles of the femur in fractures of the tibia and fibula. The shoe of the sound limb should have the sole increased in thickness so that the two limbs will be of the same length. The broken limb practically hangs within an artificial leg of gypsum and, therefore, bears no weight.

Fracture of the Bones of the Foot.

These lesions are usually the result of severe violence, which is often direct; hence many cases present, in addition to the fracture, great damage to the soft parts. Comminuted and open fractures are, therefore, common; and amputation or excision of bone often required. Very little apparatus is, as a rule, sufficient to immobilize fractures of the foot, because the size and shape of the bones and the manner of mutual articulation does not favor a wide range of displacing motion. Union is to be expected in uncomplicated cases in three or four weeks.

Fractures of the Tarsal Bones.—The astragalus and calcaneum are the only tarsal bones whose fractures require special discussion. Fracture of the astragalus is not infrequently associated with dislocation of the ankle and fracture of the fibula or with calcaneal fracture. Marked displacement is not very common when the bone injury is unaccompanied by a wound leading to the seat of fracture. The diagnosis is difficult, because the crepitus, the inability to bear the weight of the trunk on the foot, the pain and the swelling may be due to fracture of the calcaneum or other tarsal bones. The treatment consists in reducing any apparent displacement and immobilizing the ankle and foot by a moulded or circular gypsum dressing. The foot should be at a right angle to the leg and its sole neither everted nor inverted. In closed fractures with extreme displacement of fragments, which cannot be overcome and which threatens, by tension on the integument, to produce ulceration, excision of the fragments may be performed at once under antiseptic methods.

In open fractures free incisions, counter openings, drainage and antiseptics are essential elements of success. Febrile reaction and pain are often the surest indications that putrescent fluids are imprisoned. The best point for incision is probably between the extensor tendons of the great and second toes. Ankylosis may result and hence the foot must be kept at a right angle to the leg during treatment.

The body of the calcaneum may be broken by falls, the sustentaculum tali snapped off by forced inversion of the foot and the posterior portion of the calcaneum, where the tendon of Achilles is inserted, pulled off by the calf muscles. Flatness of the sole, increased breadth of the foot in the calcaneal region, approximation of the sole to the malleoli and the limitation of crepitus, pain and motion to the known location of the calcaneum are the distinguishing features of these lesions, which are often obscure in diagnosis. Fracture of the ledge of the bone on the inner and upper aspect, called the sustentaculum tali, is said to allow sinking of the inner malleolus and eversion of the foot and to be attended by shortening of the heel, as shown by measuring around the back of the heel from one malleolus to the other. The treatment of calcaneal fractures comprises immobilization by a circular gypsum dressing; with care to obtain correct position of the foot when the sustentaculum tali has been broken, by moderate inversion. In muscular fracture of the point of the heel, flexion of the knee and extension of the ankle will usually be required to keep the fragment down in contact with the rest of the bone. A slipper attached by a cord to a band around the lower third of the thigh will accomplish this. If preferred, an anterior splint may be moulded to the anterior surface of the limb and the dorsum of the extended foot.

Occasionally the force received tears out a little scale of bone at the point of attachment of one of the ligaments to a tarsal bone. The astragalus is subject to this lesion, which has been termed a sprain-fracture, on its posterior aspect, where the external lateral ligament is attached near the groove for the long flexor tendon of the great toe. A similar lesion may occur at the point where the external ligament is attached to the calcaneum.

Fractures of the Metatarsal Bones.—The metatarsal bones most often broken are those of the great toe, really by development a phalanx, and that belonging to the little toe. Metatarsal fractures show little deformity unless several contiguous bones are broken. Displacement, when it occurs, is apt to cause an angular projection on the dorsum of the foot. Pressure of a toe backward toward the tarsus will often, after injury, reveal fracture of the corresponding metatarsal bone by giving rise to pain at the suspicious spot. Immobilization by a circular gypsum dressing is the proper treatment. Open fractures and burrowing of pus must be met by drainage and antiseptics. If the deformity in either closed or open fractures is irreducible and of a character to produce lameness or to interfere with wearing a shoe, excision of the projecting portion of bone is justifiable.

Fractures of the phalanges are often compound, and in such cases immediate amputation may be done more frequently than in corsponding injuries of the fingers, because the deformity and disability is not as important in the foot as in the hand. The toe in other cases may be made immovable by strips of adhesive plaster holding it to the adjoining toe, by a gypsum dressing or by a small pasteboard splint bound to the top of the foot and back of the toe by adhesive plaster.

CHAPTER XVIII.

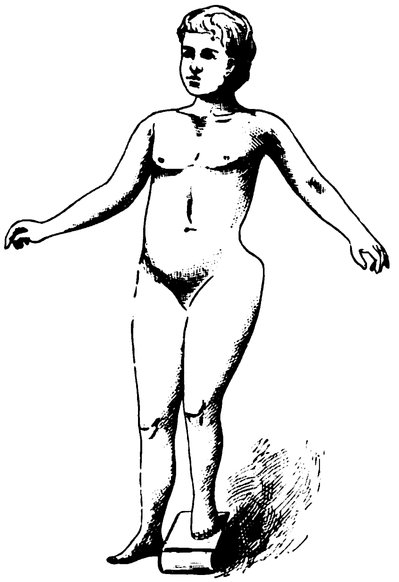
SURGICAL DISEASES OF THE JOINTS, CARTILAGES AND LIGAMENTS.

CONGENITAL DISLOCATIONS.

THESE conditions are due to arrest of development during embryonic life or to injuries of the fœtus received within the uterus. They are not very frequent and occur principally at the hip, though other joints are occasionally the seat of such deformity. Other congenital defects are not uncommonly found in children with congenital dislocation.

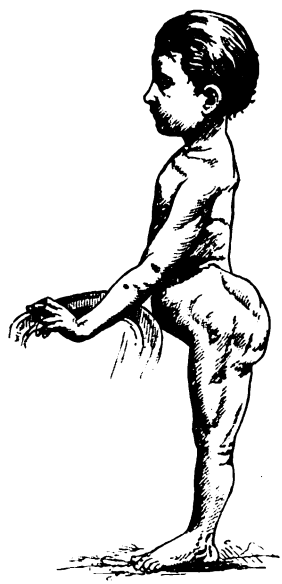
Some cases of supposed congenital dislocation are probably injuries received at the hands of the obstetrician during the birth of the child, but which have been unrecognized at that time.

FIG. 255.



Unilateral congenital dislocation of the hip. (KRÖNLEIN.)

FIG. 256.



Double congenital dislocation of hip. (STIMSON.)

The treatment of congenital dislocations is not very satisfactory because the joint surfaces are abnormal in shape and, indeed, may be absent. Reduction should be attempted and may at times result in restoration of a normal condition of the articulation. Sometimes an apparatus may be adapted which will enable the patient to use the joint in a more normal manner and perhaps prevent increase of the deformity. Division of contracted or constricting tissues, or the formation of a false joint by dividing the bone near the articular end or excision of its extremity may at times be serviceable. Operations have been devised for the treatment of congenital dislocation of the hip joint, whose object is to deepen the deficient acetabulum and thrust the displaced head of the femur into it.

FIG. 257.

Congenital subspinous dislocation of humerus. (Author's case.)

Synovitis and Arthritis.

Definition. — Inflammation limited to the synovial membrane of a joint is termed synovitis. If, in addition, the other joint structures are inflamed the term arthritis is employed.

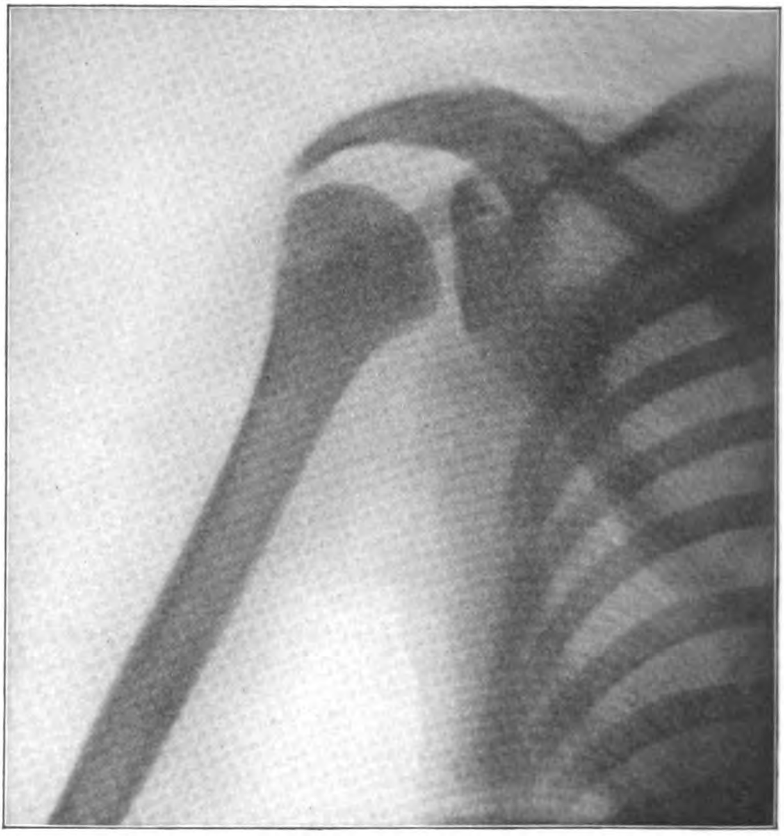
Pathology.—Synovitis may be acute, subacute and chronic; serous, dry or purulent. Chronic synovitis is very apt to be followed by changes in neighboring structures constituting arthritis. The causes of synovitis are mechanical, as injuries; chemical, as in gouty cases due to uric acid in the blood; and infective.

The knee, wrist, ankle and phalanges are probably the joints most commonly affected. The synovial membrane becomes red and swollen, sheds its superficial cells and exudes serum. The exudate may be colorless, tinged with blood, turbid or purulent.

Symptoms.—Pain, swelling, immobility of the joint, creaking on motion, fluctuation and perhaps a slight elevation in local and general temperature are symptoms of synovitis. A chill sometimes occurs at the beginning of the inflammation. The joint is apt to assume a position which relieves the tension due to the fluid in the joint cavity. This is in most joints one of partial flexion. In synovitis of the knee joint the patella is lifted by the effusion from its normal position in contact with the condyles of the femur, when the leg is partially or completely extended. Sudden pressure upon the patella will enable the surgeon to feel it strike against the bone beneath, from which it is afterwards lifted by the fluid getting between it and the condyles. A satisfactory way to make this test is to have the patient lean forward with the knee slightly bent and with his hand pressing downward upon the muscles on the front of the thigh. This position relaxes the capsule of the joint and prevents the muscles from holding the patella against the femur. A slight tap with the tip of the examiner's fingers will demonstrate the fact that the patella floats away from the condyles.

Treatment.—The constitutional cause, such as rheumatism, gout and syphilis, requires the appropriate constitutional remedy. Traumatic synovitis if noninfective quickly subsides under rest. The local treatment of all cases may be summarized as follows: Rest in the most comfortable position of the joint, cold applications, leechings or wet cups, counter-irritation by blisters and moderate pressure by

FIG. 258.

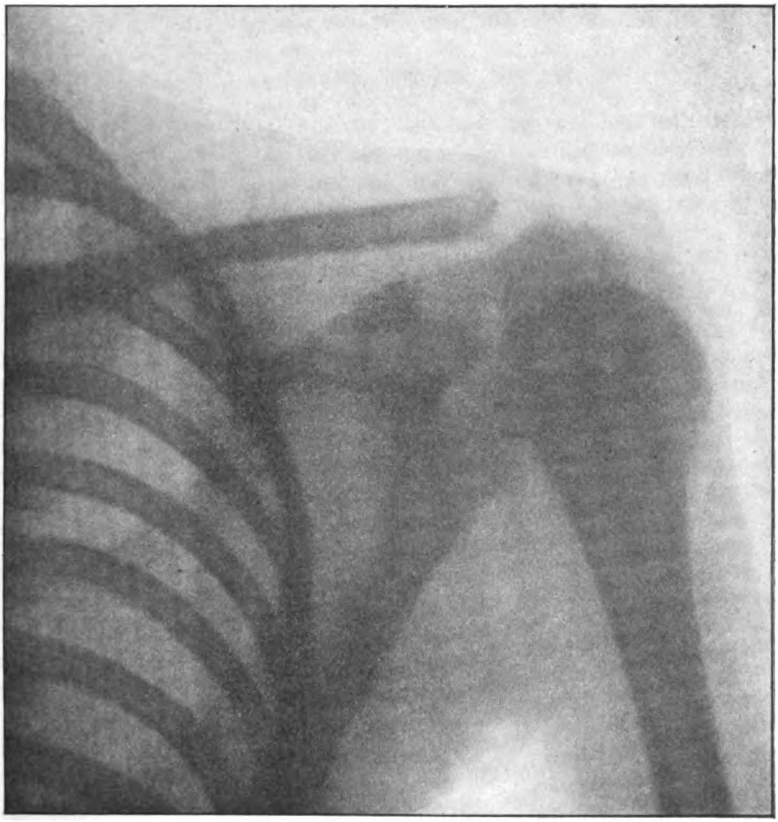


Skiagraph of congenital subspinous dislocation of left shoulder. (Same case as Fig. 257.)

means of bandages. Ichythol or ointments of belladonna and mercury are favorite local applications. Subcutaneous puncture or aspiration under perfect antisepsis, to permit the excess of fluid to escape from the joint will sometimes be advantageous treatment and greatly relieve the pain. Rest of the joint must not be persisted in after the subsidence of the acute stage; then moderate passive motion and massage are indicated to prevent adhesions within the joint and to restore its function. Subacute and chronic cases require more active counter-irritation. The actual cautery is valuable. Stimulating liniments may be employed in both forms of synovitis. The adaptation of a plaster of Paris splint is often valuable in subacute cases.

If the patient's temperature remains high and is accompanied by recurrent chills and other constitutional disturbances, the presence of

FIG. 259.



Skiagraph of normal shoulder of patient shown in Fig. 257.

purulent synovitis should be suspected; the diagnosis may have to be confirmed by aspiration. Such cases must be treated by incision and drainage of the joint. Irrigation of the cavity through the drainage tubes may be necessary to insure thorough cleansing of the sac. A sterile salt solution or a very weak antiseptic solution may be employed for this purpose. In dry synovitis the amount of exudate is small and fibrinous in character. The fibrous exudate sometimes causes the formation of small rice-like bodies within the joint; at other times anchylosis occurs rapidly from organization of the exuded lymph. This form of synovitis should be treated by counter-irritants and internal remedies appropriate to the exciting cause. Syphilitic synovitis is apt to be symmetrical and does not give rise to much pain. The patient must be put on antisyphilitic treatment and the remedies appropriate to the local condition should be adopted. Excision of the thickened synovial membrane may be required in cases where there is a tendency to the formation of fibrinous deposits. The distention of a joint with blood as the result of synovitis or injury may demand aspiration or incision, if absorption does not take place under the line of treatment indicated by the acute or chronic synovitis coexisting.

Arthritis.

Definition.—The distinction between synovitis and arthritis is often clinically impossible; and is a matter of no great importance as regards treatment, for both conditions demand similar constitutional and local management. If arthritis exists, synovitis is almost sure to be present during some stage of the disease. It is possible, however, to have the inflammation limited to the synovial membrane, though, as previously stated, the other structures of the joint are apt to become involved if the synovitis exists long.

Pathology.—The phenomena of arthritis are usually more severe than those of synovitis due to the same cause. At times arthritis may be localized in one portion of a given joint. Rheumatism, gout, syphilis, infection with the micro-organisms of tuberculosis, gonorrhœa, typhoid fever and pus or trophic changes due to disease of the nervous system are the common causes of arthritis.

Acute Suppurative Arthritis.

Acute suppurative arthritis is due to a pyogenic infection of the constituent parts of the joint. The infection occurs through wounds or the blood current, or by involvement from a contiguous suppurative epiphysitis, periostitis or osteomyelitis. The joint becomes filled with a purulent or sero-purulent effusion. It constitutes what is practically an abscess within the cavity of the joint. The pus may burrow into surrounding tissues and finally be discharged externally. The cartilages, ligaments and bones may become softened and destroyed by the activity of the suppurative process; and necrosis, anchylosis of the joint, septicæmia and pyemia may result secondarily.

The symptoms of acute suppurative arthritis are similar to those of acute suppurative synovitis, but are more intense. The joint is swollen and painful, the skin hot, red and œdematous; fluctuation will be present at points where the capsule of the joint is most superficial. The intra-articular tension due to the increase of fluid will cause the joint to assume the characteristic posture spoken of under synovitis. The pain may be worse at night and is increased by motion. Fever will be high and probably accompanied by chills. Constitutional evidences of septic contamination will make the surgeon suspect the presence of pus in the inflamed joint. Aspiration may be necessary to confirm the diagnosis. This form of arthritis is not uncommon in pyæmic conditions. In such instances the joint affection will be preceded by the symptoms of septic inflammation elsewhere. In pyæmia several joints are likely to become involved in the septic process.

Treatment.—Before the diagnosis of pyarthrosis or purulent effusion into the joint is made, the treatment is practically that of synovitis. Free incision into the joint, evacuation of the pus, thorough and prompt irrigation and removal of the pus from surrounding tissues, into which it may have burrowed, are demanded by the gravity of the condition. Drainage and irrigation must not be delayed. The suspicion of pus within a joint must always be followed by early diagnostic aspiration, lest the patient's strength be undermined by septic contamination of the blood from the unrecognized pus in the serous synovial membrane. Prompt evacuation of pus may save not only the integrity of the joint, but the patient's life. Prompt treatment may be followed by little or no anchylosis. Anchylosis, however, is a very common condition after suppuration of a joint if the patient survives. Excision or amputation may be required in cases where great destruction of the bone and soft tissues has resulted from unsuccessful or dilatory treatment.

Gonorrhœal Arthritis or Gonorrhœal Septicæmia.

Pathology.—A synovitis or arthritis may occur during the course of an attack of acute or chronic gonorrhœa and is believed to be due to septicæmia produced by the gonococcus. The disease seems to occur more frequently when the intensity of the gonorrhœal inflammation is abating or has assumed a chronic course. The term, gonorrhœal rheumatism, should not be employed for this condition for the disease is not rheumatic. The disease is found almost exclusively in males and generally involves a single large articulation, such as the knee. It may, however, be symmetrical, or attack small joints.

Symptoms.—The pain is great, is apt to be worse at night and is accompanied by swelling and œdema. Tenderness on pressure and pain on motion are features of the disease. The exudate is fibrinous rather than serous, causes a grating sensation on motion and is apt to produce anchylosis. The temperature as a rule is not high. The gonococcus has been found in the exudate. Suppuration rarely occurs; when it does, there is a possibility of the infection being a mixed one. The access of gonorrhœal arthritis appears to have no special effect upon the urethral discharge, but beneficial treatment of the urethritis appears to lessen the joint symptoms and prevent involvement of other articulations.

Treatment.—Post-gonorrhœal arthritis is an unsatisfactory condition to treat and is apt to be an affection with a prolonged convalescence. Leeches, counter-irritation by numerous blisters, applications of belladonna and mercurial ointment, tonics, good diet and hygienic surroundings constitute the proper line of treatment. Rest of the joint by the application of a plaster of Paris bandage may be serviceable. When the effusion of the joint is large, which is not usual, aspiration and irrigation with a five per cent. solution of carbolic acid has been recommended. Subjecting the joint to a temperature of 300°-500° of dry heat in an oven has apparently been followed by good results in some cases. The salicylates and similar antirheumatic remedies do not seem to be of much benefit in arthritis due to gonorrhœa. Quinine and other tonics seem more efficacious.

Tubercular Arthritis.

Pathology.—This form of arthritis is due to a local infection with the tubercle bacillus, though slight injuries may be the cause of the lowered resistance of tissue which renders the parts a satisfactory soil for the growth of the micro-organism. Typhoid fever, scarlet fever and measles may be the cause of this lowered resistance and be followed by tubercular arthritis. The disease is more common in childhood and adolescence, but may occur at any age. It is stated that in the aged the process is apt to be rapid in its destructive course and to lead speedily to degeneration of the joint and the contiguous bones. It may occur in more than one joint, and follow, be accompanied with or precede tuberculous processes in other parts of the body. It is the form of disease to which the terms white swelling and gelatinous degeneration of joints were formerly applied. The tubercular deposit may first occur in the synovial membrane, the other soft parts of the joint or the articular extremities of the bones. The irritation caused by the micro-organism results in the formation of granulation tissue in abundance. Then occur effusion into the joint cavity and distention and softening of the ligaments which finally rupture or disappear. The cartilaginous and fibrous structures of the joint are replaced by gelatinous yellowish or brownish granulation tissue, and the bones become softened and degenerated.

Pyogenic infection may occur secondarily and be followed by suppuration within the joint, leading to the formation of sinuses from which portions of necrotic or carious bone may be discharged. Reflex muscular contraction which occurs early may finally cause pathological dislocation of the joint, because of degeneration of the ligaments and the change in the shape of the bony surfaces. If the process is arrested before great destruction has occurred, the joint may show little change except more or less anchylosis due to organization of the inflammatory products causing intra-articular adhesions.

Symptoms.—Slight impairment of function with moderate pain are the early symptoms. Subsequently more pain occurs and the swelling becomes marked. The process which is a chronic one causes little elevation of general or local temperature. The soft tissues assume a white, swollen appearance, with the superficial veins rather conspicuous, and upon palpation transmit to the fingers an elastic sensation which often gives the impression of true fluctuation. Pain is usually not marked, except on motion, though it is said to be severe when the disease occurs in the epiphysis. The doughy swelling, due to the distended joint and the structures infiltrated with the granulation tissue, gives the joint a peculiar spindle shape deformity. If suppuration occurs, true fluctuation, abnormal joint movement due to destruction of ligaments, grating on motion and the formation of abscesses and sinuses will be observed. Portions of disintegrated or necrotic bone and cartilage may be discharged through the sinuses leading from the seat of tubercular inflammation. The pyogenic infection which often occurs secondarily may lead to symptoms of hectic fever.

Amyloid degeneration of the internal viscera is not unusual in long standing cases of tubercular disease of bone or joints.

Prognosis.—Early and efficient treatment may at times lead to almost perfect recovery of joint function. In more severe cases, even if well treated, some stiffness of the joint will probably remain. Erasion and excision of the joint, if done before the health is deteriorated too greatly and too large areas of bone are diseased, are successful; though the joint is necessarily anchylosed after such operations. Patients may live many years with the diseased joint subject to exacerbations of inflammation and discharging sinuses. The inconvenience suffered by them is often little more than that which arises from the stiffness of the joint.

Constitutional infection of the lungs, cerebral meninges or other organs may occur from the tubercular joint as a primary focus. The tubercular inflammation is sometimes, after a long period of quiescence, aroused into activity by slight injuries.

Treatment.—Absolute and prolonged rest of the joint through many months is essential. It must be supplemented by building up the health of the patient with good food, tonics and cod liver oil, and the employment of such local measures as have been suggested for synovitis and arthritis. When these measures do not arrest the disease, it is proper to perform the operation of arthrectomy or erasion. This consists in scraping away the diseased synovial membrane, ligaments and cartilages and scooping out the tubercular deposits in the articular extremities of the bones. By this means the tubercular material is removed and a stiff joint obtained without submitting the patient to the more severe operation of formal excision of the joint. Arthrectomy has the additional advantage when successful of leaving the limb longer than is a limb which has been subjected to excision of the joint. If the destruction has been so great that arthrectomy is useless, a formal excision of the joint or an amputation of the extremity is demanded. Operative measures are required particularly in those classes of the community which cannot be treated on the conservative plan for the one, two or three years required to obtain a cure of the disease. A patient with tubercular joint disease who can afford efficient surgical treatment under the best hygienic surroundings may recover without a cutting operation. Passive congestion of the tubercular joint has been employed to prevent the progress of the disease.

This is accomplished by applying a moderately tight rubber bandage around the limb above the diseased articulation in such a way as to keep up a chronic venous congestion of the joint structures. The patient wears this elastic constriction for many months. The injection of iodoform and oil into the tissues infected has been advocated as an efficient local remedy.

Syphilitic Arthritis.

This is a disease whose causation is not infrequently overlooked. It may be found in children with congenital syphilis, but is seldom seen except in the tertiary stage of acquired syphilis. The deep layers of the synovial membrane become infiltrated and this thickening affects the neighboring structures. The deposit usually occurs as numerous gummy tumors, which cause bulging of the synovial membrane into the joint cavity. There is little effusion into the joint. The early stage of the disease is not very different from other forms of sub-acute arthritis. At a later period, however, the development of the gummy masses makes the diagnosis of syphilitic arthritis easy. The spongy sensation imparted to the joint, the slight pain and creaking on motion and the limited effusion suggest the causation of the disease. Sometimes the syphilitic arthritis occurs secondarily to a syphilitic osteomyelitis occurring close to the joint.

Rest obtained by splints, or traction on the joint; counter-irritation and the administration of antisyphilitic medicines constitute the proper treatment. The affection is, however, apt to be slow in responding favorably to treatment. Fibrous anchylosis is liable to occur after the absorption of the gummy masses; and sometimes the gummy deposits soften and by emptying into the joint cavity set up a suppurative arthritis. Excision or amputation may be demanded, when the articulation has been destroyed by the syphilitic process before sufficiently large doses of antisyphilitic remedies have been administered or when for any reason the specific treatment has not been followed by satisfactory results.

Other Forms of Arthritis.

Rheumatic and gouty arthritis are diseases of medical rather than surgical interest, though their occurrence must be remembered in making differential diagnoses of joint affections. Osteo-arthritis, often called rheumatic gout, rheumatoid arthritis and arthritis deformans, is also a medical rather than a surgical disease. A nervous origin has been assigned to it with some probability of truth. The degeneration of the articular cartilages, which wear away at the points of contact, and the cartilaginous outgrowths, which finally become bony, and the wearing down of the articular ends of the bones are peculiarities of this disease. The subsequent pathological dislocations of many joints and the anchyloses in the distorted positions are unlike other forms of joint inflammation. These characteristics and the unsuccessful results of careful treatment make the affection one of great scientific interest.

Atrophic arthritis, sometimes called Charcot's disease, is an arthropathy occurring in connection with spinal sclerosis. It is dependent upon trophic changes due to the pathological condition in the central nervous system. The affection most commonly shows itself in the knee and is chronic in its course. In the beginning the symptoms are like those of rheumatoid arthritis; but the more rapid melting away by retrogressive changes of the articular ends of the bones, the absence of ankylosis and the evidences of locomotor ataxia in the patient make the character of the affection evident. The amount of locomotion which the patient is able to obtain, notwithstanding the atrophy of the ends of the bones and the flail-like character of the distended joints, is often remarkable.

FIG. 260.

Atrophic arthritis or Charcot's disease. (Author's case.)

Treatment practically consists in giving support to the joint, since the condition is an irremediable one. Amputation above the atrophic joint and the adaptation of an artificial limb might be considered in selected cases.

Neuralgic and Neurotic Joint Affections.

These conditions are subjective disorders and are difficult to distinguish from each other. They are more common in women than in men. In painful joints of a neurotic character the pain of which the patient complains is out of proportion to the other symptoms. It may be associated with voluntary or involuntary stiffness of the joint and slight swelling may occur from increased vascular tension in the soft tissues. The anemia of the skin seen in hysterical affections will more often perhaps render the surface of the joint pale. The pain is more liable to change its position than in cases of inflammation and a local or general hyperæsthesia of the skin will not infrequently be present. The stiffened joint may be subjected with ease to passive motion, when the patient's attention is directed to other matters or when general anæsthesia has been obtained. Similar movements of the joint may be produced after long continued traction. Occasionally false anchylosis and muscular wasting may occur from the long continued disuse of the joint.

FIG. 261.

Skiagraph showing backward dislocation of tibia and fibula and atrophy of the condyles of the femur in patient with atrophic arthritis shown in Fig. 260.

The diagnosis of neurotic pain in connection with joints is to be made only after a careful study of the condition of the patient; it may require several examinations to enable the surgeon to avoid error. The varying and anomalous symptoms occurring in connection with the joint pain will usually lead the shrewd observer in the right direction. Neuralgia of joints occurs as does the same condition in other parts of the body. It is diagnosed, as in other regions, largely by exclusion of organic affections, and should be treated as neuralgia elsewhere. Both neurotic and neuralgic joint pain require building up of the general health, the establishment of a normal mental condition and the judicious use of massage, electricity, tonics and anti-neuralgic remedies. Counter-irritation, as with a red hot iron, prolonged traction and passive motion under anæsthesia will often render great service.

TUBERCULAR ARTHRITIS OF SPECIAL JOINTS.

Tuberculosis of the Vertebral Articulations.

Definition.—Pott's disease of the spine is the name given to tuberculosis of the articulations between the vertebræ and of the vertebræ themselves. It is sometimes termed caries of the spinal column and tubercular spondylitis; and is the condition which gives rise to the deformity called hunchback.

Pathology.—No period of life is exempt from spinal tuberculosis, but the affection is more common between the third and sixteenth years. The lower dorsal region is most commonly involved, but any portion of the spinal column from the occiput to the coccyx may be affected. Occasionally the disease affects two or more regions of the spine; and the number of vertebræ involved in the destructive process in one location varies very much. Spinal tuberculosis may be a manifestation of general tuberculosis; may be the only local manifestation of infection; or being the primary seat of infection may by autoinfection cause lesions elsewhere. The disease is generally chronic in its course, but acute cases are occasionally seen.

As in tuberculous arthritis elsewhere, slight injuries may be the cause of the lowered resistance which renders the tissues of the vertebral articulations susceptible to the tubercular infection. Injuries of moderate or insignificant severity seem more likely to exert this influence than violent hurts. The frequency of spinal tuberculosis is perhaps due to the fact that the vertebræ retain their soft and embryonic character longer than many other bones of the skeleton. The tubercular infection often begins in the epiphyseal junctions of the vertebræ, though sometimes the origin of the process will be found in the inter-vertebral fibro-cartilages or the synovial membrane. Wherever the disease begins, the joints with the adjacent cartilage and bone are soon destroyed. The softening process seldom attacks the laminæ and spinous processes. The disease sometimes ceases spontaneously or as the result of treatment, before the destruction has been great. As a rule the vertebræ become carious or necrotic and disintegrate. The weight of the head and shoulders, aided by the action of the abdominal muscles, causes an angular deformity from bending forward of the upper portion of the spinal column. The tubercular material may break down into puriform fluid, which may burrow in the muscular sheaths and travel long distances from the origin of the disease. If the contiguous vertebral bodies destroyed are numerous, great antero-posterior angular curvature occurs and the hunchback appearance is very marked. The spinal arches with the articular and spinous processes are not destroyed, and thus the lateral supports of the spine remain. It is these uninjured processes of the column which cause the prominence posteriorly. The protrusion backward does not show as rapidly in the lumbar region as in the dorsal and cervical regions because of the normal curvature forward in the lumbar region and also because of the broad articular surfaces which the vertebral bodies possess in this region.

If the patient's health is not so deteriorated as to cause death from exhaustion or general tubercular infection, the disease may come to a standstill and ankylosis of the vertebræ, brought together by the angle of deformity, occur. The patient may then live for years in a normal condition of health, but with a persistent deformity called kyphosis. In the comparatively rare cases occurring in patients the subject of old lateral curvature of the spine, the deformity will not be directly antero-posteriorly. The so-called cold abscesses may appear at the surface before deformity or other symptoms are marked. In other cases no external evidence of suppuration is ever seen and, as the tubercular process subsides, the puriform fluids become absorbed or undergo cheesy degeneration. The angle of deformity does not as a rule cause direct pressure on the spinal cord because the disintegration of the anterior wall of the spinal canal makes more space for the cord than normal. Paralysis of motion and sensation in the parts below the seat of disease occurs, however, at times from pressure due to inflammatory products. The approximation of the ribs resulting from the angularity of the spinal column may give rise to localized nervous symptoms from pressure on the nerve trunks emerging laterally from the spinal column. The danger of pressure upon the cord is quite great in tubercular disease of the atlas and axis, because forward displacement of the atlas from involvement of the ligaments may cause direct pressure upon the medulla oblongata and death. Pressure upon the trachea and thoracic viscera may produce dyspnœa; and vertebral displacement in the dorsal and lumbar regions may interfere with digestion. In the paralysis which takes place from pressure of inflammatory products upon the cord, sensation disappears after motion and returns first when improvement oc-

FIG. 262.

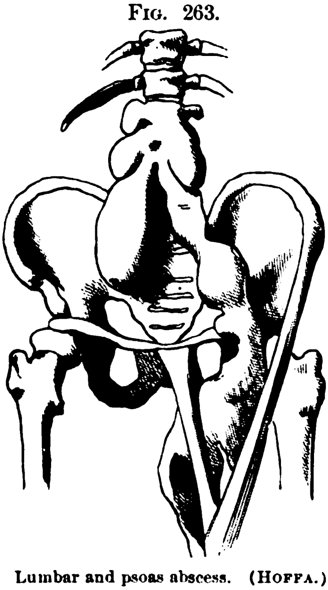
Psoas abscess. (DENNIS.)

curs from absorption of the inflammatory exudate. In such cases of paraplegia control of the bladder and rectum is not completely lost, because of the integrity of the sympathetic nervous supply.

The contents of the tubercular abscesses are shut in by thickened periosteum, anterior common ligament, pleura and peritoneum, which by thickening form a tough abscess wall. The fluid travels downward and by entering the sheath of the psoas muscles often reaches the inner side of the thigh. The muscle is destroyed to a greater or less extent. The abscess sometimes presents in the loin by passing backward through the quadrate muscle of the loins. The sheath of the iliac muscle sometimes influences the direction in which the puriform fluid reaches the external surface of the body. In the cervical region the abscess may dissect up the muscles in front of the vertebræ and cause a retro-pharyngeal abscess.

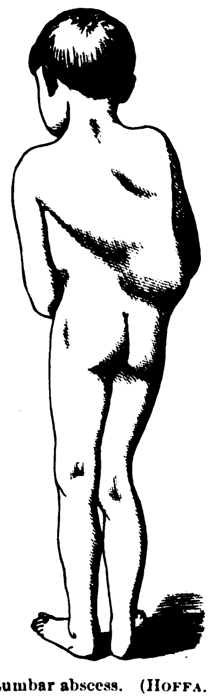
Curvature of the spine simulating the angular curvature of tubercular spondylitis may occur in rachitic children from softening of the vertebral column, and in persons of rather advanced age from rheumatoid arthritis (spondylitis deformans). In these cases the curvature is not as angular as in tubercular spondylitis. The bend is more of a curve than an angle.

FIG. 263.



Lumbar and psoas abscess. (HOFFA.)

FIG. 264.



Lumbar abscess. (HOFFA.)

Symptoms.—The disease is usually so chronic that the first marked symptom is not infrequently the appearance of a prominence in the back due to the projection of the spinous processes after the angular curvature has begun. The previous deterioration of health with rigidity of the spine may have passed unnoticed. Persistent attacks of pain, resembling colic, in children should always lead the physician to suspect the possibility of a beginning tuberculosis of the spine, since pain reflected along tbe intercostal and lumbar nerves is often one of the earliest symptoms. The pain from tuberculous spondylitis is aggravated by motion or concussion of the spine, such as occurs in riding in cars and carriages, is always referred to the same location and is relieved by rest. It may be mistaken for rheumatism, neuralgia, muscular cramps, colic or dyspepsia ; or be attributed to the impossible "growing pains" of childhood. Sometimes other aberrations of sensation, such as tingling, burning, formication and itching, may be observed in carefully watched patients. The girdle pain, or sensation as of a cord tied around the abdomen or chest, and spasmodic abdominal pain with flatulency are not unusual. The pain may be referred to the hip and suggest coxitis. The painful sensations are relieved in most cases by longitudinal traction of the patient or bending the spine slightly backward. The latter manipulation is accomplished by placing the hand under the patient's back as he lies supine and lifting him. A rise in daily temperature is usually absent, though it may in acute cases be marked. When the tubercular abscesses become infected after opening, hectic fever may result. The general health of the patient gradually breaks down during the progress of this insidious affection. The loss of strength, anæmia and other symptoms of debility increase with the progress of the disease and disappear as cure with ankylosis occurs.

The amyloid degeneration of the viscera liable to occur in long standing bone disease is a late sequel. Special symptoms arise from involvement of special organs or muscles in close relation to the seat of disease ; for example, spondylitis affecting the atlo-axoid or occipito-atloid region may cause spasm of the sterno-mastoid muscle or choreic movements of the muscles of the neck. Laryngeal cough or stridor and difficulty in respiration, deglutition or phonation may be due to disease in the cervical region. The peculiar way in which the head sinks between the shoulders because of shortening of the neck is quite characteristic. The patient may hold his head in both hands, in order to support it and take the weight from the diseased vertebræ. Sudden death may occur from involvement of the medulla oblongata and cord.

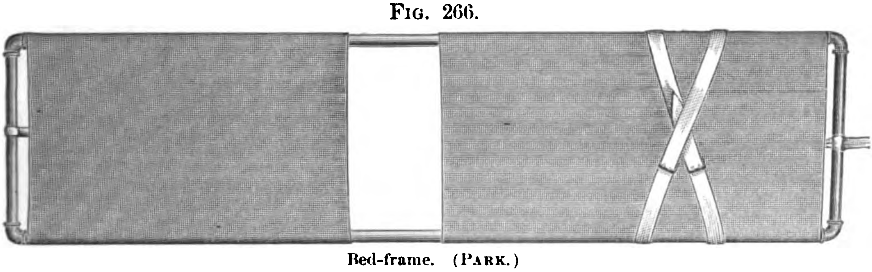
Diagnosis.—A thorough examination can only be made by having the patient entirely divested of clothing. Pain due to spinal disease can best be demonstrated by passive motion of the column and downward pressure exerted by the surgeon upon the head and shoulders. The most significant early symptom is the muscular rigidity assumed, in order to prevent movement of the spinal column or pressure upon the diseased vertebræ. The characteristic postures and restricted movements thus induced will lead to early recognition of the disease by the careful observer. The importance of such recognition cannot be overestimated, since treatment at this early stage is highly successful and prevents the occurrence of deformity. At this period of the disease, the patient who is usually a child, easily becomes fatigued and shows a tendency to desist from play. There is no complaint of acute pain, but the careful walking, with an absence of normal elasticity, and the fear of jarring indicate the discomfort produced by motion transmitted to the backbone. The child's movements are guarded; and if he wishes to pick up an object from the floor, he rests one hand upon the corresponding thigh and bends the knees and hips rather than the spine. If the disease is in the cervical region he may support his head with his hands. This early stiffness due to the muscles guarding the spine from movement is of the utmost value and is characteristic of the disease. Tubercular spondylitis must be differentiated from rheumatism, neuralgia, spinal meningitis and myelitis, sprains of the back and tubercular coxitis. A careful study of the case with recognition of the early muscular rigidity and the recollection of the fact that the pain often resembles the stomach ache of childhood will usually make the diagnosis clear.

FIG. 265.

Early dorsal vertebral tuberculosis; typical posture in stooping; child cannot bend spine when picking up object and supports his weight by hand on knee. (SMITH.)

Treatment.—Treatment should be commenced at the earliest stage of the disease, because its progress may then be checked. The general health of the patient must be improved so as to increase the resistance of the tissues to progressive tubercular invasion. Hygienic surroundings, good diet and such medicines as cod liver oil, iron, strychnia and compound syrup of hypophosphites are valuable. Stimulants may sometimes be beneficial. A sojourn in the country or at the seashore will often do great good. Daily removal of the patient from the house

FIG. 266.

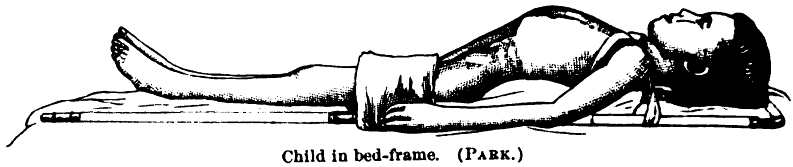


Bed-frame. (PARK.)

to the yard, street or roof may be followed by marked improvement. Massage, electricity and bathing should not be neglected.

From the time the disease begins until consolidation of the vertebræ at the carious focus occurs, immobility of the spinal column is to be secured as much as possible. When the disease is active the patient should be kept in bed lying flat upon the back. At times traction

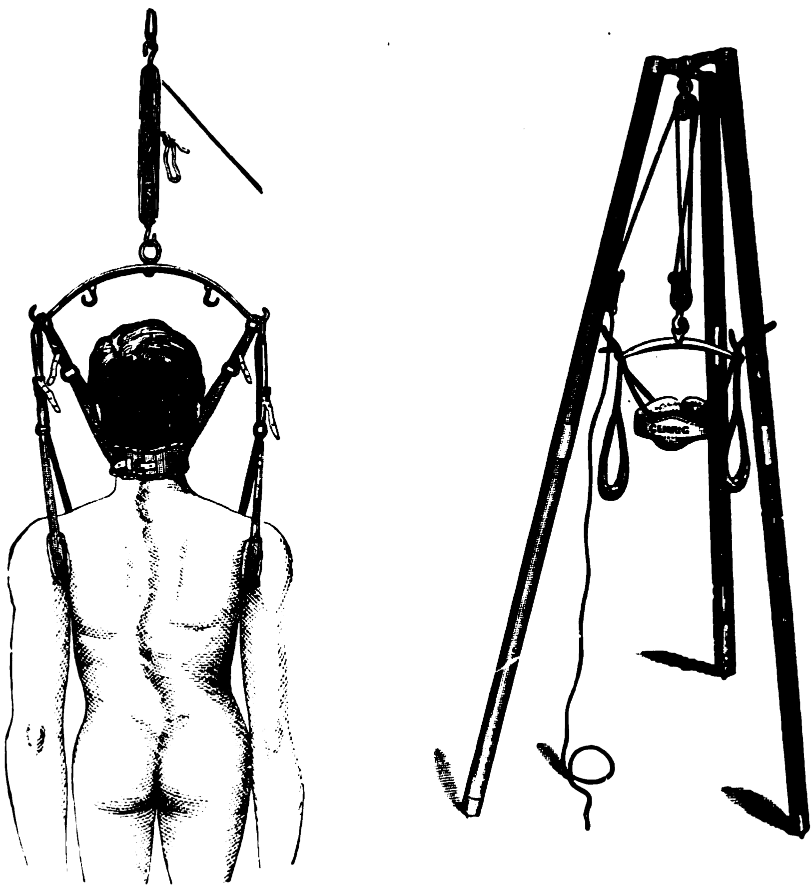
FIG. 267.



Child in bed-frame. (PARK.)

and counter-traction exerted upon the head and legs may be necessary to maintain local rest. Heavy sand bags may be placed alongside of the patient to prevent lateral motion of the trunk. A small, soft pillow may be placed under the spine at the point where angular

FIG. 268.

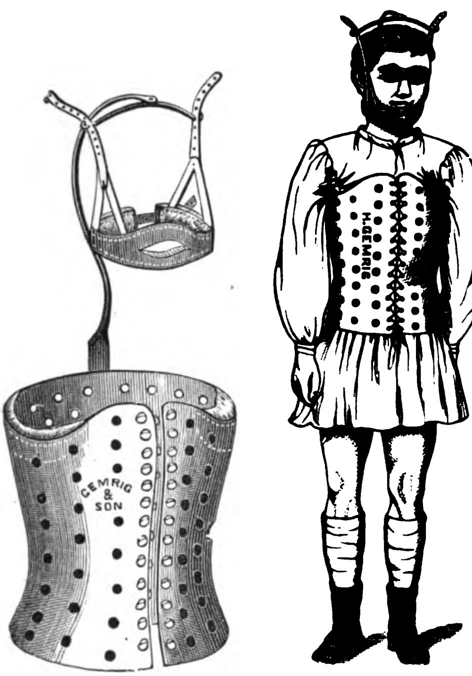


Suspension by means of tripod, for application of jacket in spinal disease.

deformity is beginning. This gives support where the vertebral bodies have been destroyed. When the acute symptoms have subsided and in cases which are chronic in their course from the first, some form

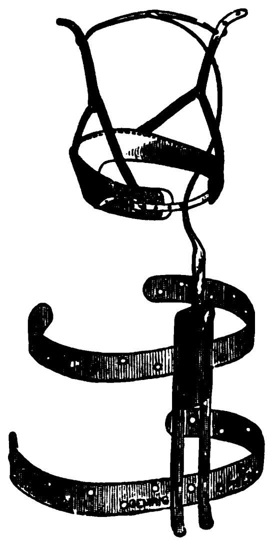
FIG. 269.

a *b*



a. Leather jacket with jury-mast. *b.* Same applied.

FIG. 270.

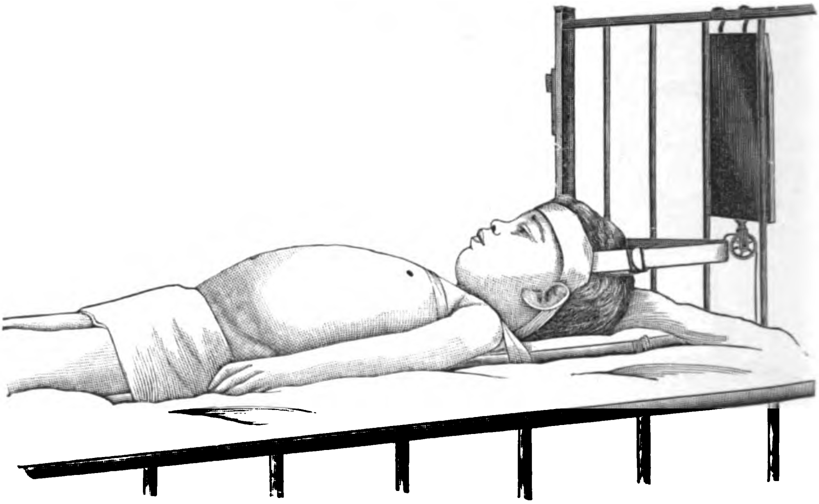


Head support for spinal tuberculosis.

of spinal brace may be adjusted and the patient allowed to go about. Instead of confining the patient upon an ordinary bed the surgeon may have him bound by straps and bandages to a frame. This may then be lifted off the ordinary bed when it is desired to carry the patient into the open air.

The best support for walking cases is the plaster of Paris jacket adapted to the trunk while the patient is suspended vertically or laid horizontally. This prevents bending of the spine at the seat of disease. If the disease is high up in the dorsal region or in the cervical region, it is necessary to support the head by means of a jury-mast attached to the plaster of Paris jacket or splint. Instead of making the spinal jacket or support of plaster of Paris bandages, a mould of the child's trunk may be made and from it a neater, though more expensive, spinal support may be constructed of leather or some similar plastic material. In applying the plaster of Paris jacket the patient is divested of clothing and covered with a closely fitting merino shirt extending below the trochanters. He is then suspended by the shoulders and head and successive layers of gypsum bandage are applied over the undershirt. A folded towel is placed over the lower portion of the abdomen before the application of the bandages and removed subsequently, to permit distention of the abdomen after

FIG. 271.



Child in bed-frame, with head traction. (PARK.)

eating. The plaster jacket may be allowed to remain for a number of weeks without being removed from the body, or it may be removed and reapplied after being split down the front and furnished with eyelets for lacing. The protuberance due to the vertebral curvature must be protected by a ring of cotton, to prevent pressure upon it causing a bedsore. The spinal support made of plaster of Paris bandages, if removable, need not be worn when the patient is lying in bed. When the spinal disease has become quiescent and the ankylosis is complete the jacket is dispensed with. Freedom from pain when pressure is made upon the shoulders or head is an indication that the tubercular process has subsided. The patient's general condition will usually have greatly improved by this time, for his general health and the subsidence of the pathological process are pretty sure to be contemporaneous. A metal support is sometimes preferred to the jacket. It is possible to put the plaster of Paris jacket upon a patient while lying in the horizontal position with the shoulders and hips supported. A suspension chair in which the patient can stand and walk about is a desirable adjunct to treatment in cases in which the disease is partially cured or not very active.

Operations to reach the diseased vertebræ and remove the softened bone by curetting as in arthrectomy have been advocated, but not extensively employed.

Tubercular abscesses which show as swellings upon the surface of the body should be opened and the abscess cavities washed out with a ten per cent. solution of iodoform and oil, rendered sterile by boiling. The opening should be protected from infection by pyogenic germs. It is probably best to operate as early as possible in order to avoid extension of the abscess. Counter-openings and insertion of drainage tubes are sometimes essential to afford free and thorough drainage. The abscess cavity may be wiped out with sponges attached to long forceps and a great deal of débris thus removed, when it would be impossible to thoroughly curette the irregular and deeply seated pockets in which the puriform fluid has been contained.

FIG. 272.

Suspension chair of Dr. Meigs-Case.

It has recently been proposed to forcibly break up the ankylosis of cured tuberculosis of the spine in order to overcome the hunchback deformity. This is done by strong pressure on the prominence in the back while the patient lies on his abdomen. The operation has been successful, but has not yet been widely accepted as generally useful.

Tuberculosis of the Sacro-Iliac Articulation.

Pathology.—Tubercular disease of this joint is not so very uncommon and is liable in the incipient stage to be mistaken for sciatica and tubercular coxitis. It is more common between the ages of fifteen and thirty five years than in children. It may occur as a primary condition or secondarily to tubercular inflammation of the spinal column or the pelvic bones.

Symptoms.—The symptoms are pain, which may radiate into other regions and which is aggravated by motion, and tenderness upon pressure. Sometimes there is interference with defecation and urination; or these acts are accompanied by pain. Œdema of the limb due to inflammatory pressure upon the iliac vein is rare, but may occur. The patient inclines his body toward the sound side in order to relieve pressure on the diseased joint, which occurs when the leg of that side is used for standing. When he throws his weight on the sound limb, the extremity of the diseased side makes some extension by its weight and lessens the suffering. The swelling over the sacro-iliac joint shows at an early period. When abscess occurs the swelling may change the contour of the buttock, but does not produce the characteristic deformity of the buttock seen in coxitis. Wasting of the gluteal muscles and restriction of motion and power in the limb of the diseased side occur. The limb is apparently lengthened, because the pelvis is dropped to lessen pain, and the foot is everted. Tubercular abscess may occur, and may discharge externally or open into the pelvis, into the ischio-rectal fossa, alongside of the rectum, or upon the inside of the thigh. The diagnostic differences between this condition and caries of the vertebræ or innominate bone, hip-joint disease and sciatica will be apparent to the careful observer.

Treatment.—The treatment consists in rest, traction, tonics, good diet and hygienic surroundings. In the early stages traction and counter-traction may be valuable. Elevation of the opposite foot by means of a high shoe and the use of crutches will enable the patient to get out into the open air and take exercise, without increasing the disease by motion of the joint. At a later period, incision through the soft parts and scraping away the tubercular material at the ischio-iliac joint will perhaps hasten cure.

Tuberculosis of the Hip Joint.

Pathology.—Coxitis, often called hip joint disease and coxalgia, is a disease of frequent occurrence. Most of the cases occur before the age of sixteen. Sometimes both hips are attacked in the same person. The disease may begin as a tubercular epiphysitis of the femur, a tubercular synovitis or a tuberculous osteomyelitis in the floor of the acetabulum. The affection is usually chronic in its course, but under some circumstances it may assume an acute type. The disease may be so extensive as to destroy the head of the femur or perforate the bottom of the acetabular cavity. Ankylosis is a common result in cured cases. The destruction of the head of the bone, aided by continuous muscular contraction, may result in dislocation of the deformed upper end of the femur upon the dorsum of the ilium ; thus causing great deformity as well as ankylosis.

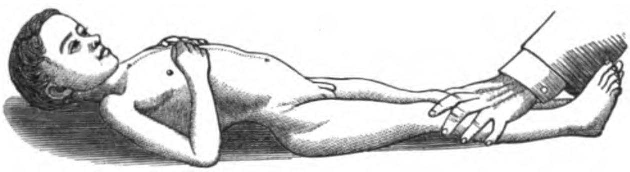
Symptoms.—The early symptoms are frequently obscure, and may be mistaken for the so-called growing pains of children or escape notice. The exhibition of lassitude or fatigue after moderate exertion, with loss of strength and a general appearance of failing health, should excite anxiety and cause a search to be made for tubercular disease of hip or spine. After a time, the child will perhaps be seen to save one leg while standing or playing. Then a slight stiffness of the joint with lameness may be observed. In order to prevent pain in the joint a characteristic posture is assumed in standing. The patient is apt to lean a little forward, throwing all his weight upon the sound leg while the other is thrown forward and abducted and at the same time rotated outward and slightly flexed. This position of flexion with abduction and outward rotation is seen in the early stage, because it is the position which permits fluid in the joint with least pain. At a later period the abductors draw the limb inward. Some stiffness of the joint occurs as an early symptom, because the muscles are endeavoring to protect the joint from painful motion. This muscular ankylosis can be well demonstrated by placing the child flat upon his back on a level bed or table and attempting to straighten the affected hip. The tension of the psoas and iliac muscles causes the lumbar vertebræ to be arched forward when the popliteal space of the affected leg is brought down upon the table. This arching of the lumbar spine does not take place when the sound limb is similarly treated. The adductor muscles soon become rigid and prevent passive abduction of the leg.

FIG. 273.

Test for fixation of hip joint. Position of leg when spine is straight. (SMITH.)

The interference with full extension of the hip joint found even in beginning coxitis may be simulated by tuberculosis of the vertebræ. A further test to prove that the stiffness is in the hip joint itself is made by flexing the thigh upon the pelvis to an angle of 120 degrees and then attempting rotation of the joint. The interference with rotation due to the spasmodically contracted rotators of the hip will show that

FIG. 274.



Curvature of spine when leg is extended. (SMITH.)

the condition is not a spinal one. These manipulations must be made without anæsthesia, because the muscular stiffness disappears when fear of pain is abolished.

Pain is usually present in the hip to a certain extent, but is most conspicuous in the neighborhood of the knee, either over the patella or at the inner side of the thigh. It seems to be referred to these regions when the tubercular disease is situated in the femoral head. It is believed to be due to the manner of distribution of the branches of the obturator nerve. When the disease starts in the synovial membrane the local pain is severe and constant, but pain at the knee is absent. If the capsule of the joint becomes tensely distended, there is much tenderness in the groin and above the great trochanter. When the capsule becomes perforated by the disease and the fluid escapes, the severe pain suddenly ceases. Sudden crying out when asleep may occur, because during sleep the rigid muscles do not protect the joint from movement so perfectly as when the child is awake. Pressure applied to the great trochanter so as to press the joint surfaces together increases the pain. This method of developing the pain for diagnostic purposes is of more value than tapping upon the heel or flexed knee. The patient sometimes crosses the legs to relieve himself of pain or hugs the leg of the diseased side up against the abdomen.

FIG. 275.

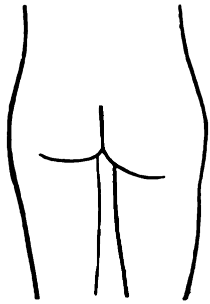
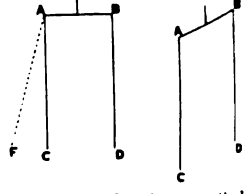


Diagram showing flattening of buttock and lowered position of gluteal crease on diseased side.

Swelling is particularly developed in tuberculosis of the synovial membrane. It is most prominent in the groin, though it shows also in the buttock. There may be some local rise of temperature, but redness of the overlying skin is not common.

Atrophy of the muscles begins in the incipient stage of the disease and is seen not only in the muscles near the joint, but in those lower down the limb. An extremity which has been the seat of hip joint disease seldom overtakes the other limb in bony and muscular development, even when an early cure of the disease occurs. The wasting of the gluteal muscles and the swelling which occurs in that region make the buttock flatter and broader, obliterates or makes more shallow and lowers the gluteo-femoral crease and causes the vertical line between the two buttocks to deviate toward the sound side. Coxitis gives rise in the course of time to a lateral curvature of the lumbar spine with a compensatory curve in the dorsal region.

FIG. 276.



Diagrams showing practical shortening and lengthening of a limb by abduction and adduction and tilting of the pelvis at the hip. AB, line of pelvis; AC and BD lower extremities. (BRADFORD and LOVETT.)

The spinal deviation, the tilting of the pelvis and the abduction or adduction of the thigh make the leg appear longer or shorter than that on the other side. Little or no real change takes place in the real length of the limb until bony destruction occurs or a pathological dislocation takes place; then shortening occurs. Deformity is purely muscular until the late stages of the disease. The destruction of bone then permits dislocation of the altered femur upon the dorsum of the ilium.

Before this time adduction and inversion of the leg is usually present; and becomes more marked when the dislocation occurs. Occasionally the head of the femur may actually pass through the destroyed acetabulum and enter the pelvis.

Tubercular abscess is very common. It is almost invariable in inefficiently treated or untreated cases of coxitis. When the puriform fluid is confined within the capsule, pain is great. This symptom disappears when ulceration of the capsule permits the tension to be lessened by the escape of fluid. After evacuation of the abscess pyogenic infection occurs unless an aseptic condition is carefully maintained. Then constitutional disturbance and hectic fever are very likely to complicate the symptoms of the disease. It is possible that tubercular abscess may occur without starting within the capsule. The abscesses may open above or below Poupart's ligament. The latter is the common situation.

Diagnosis.—Careful investigation must be made to discriminate hip joint disease in the early stage from rheumatism, injuries of the hip, tuberculosis of the spine or sarco-iliac joint and periostitis of the upper portion of the femur. In the late stages of the disease the diagnosis is not difficult.

FIG. 277.

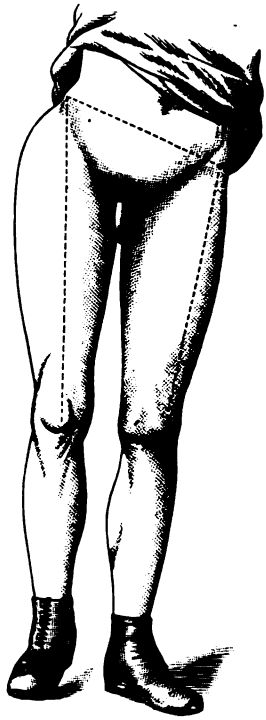
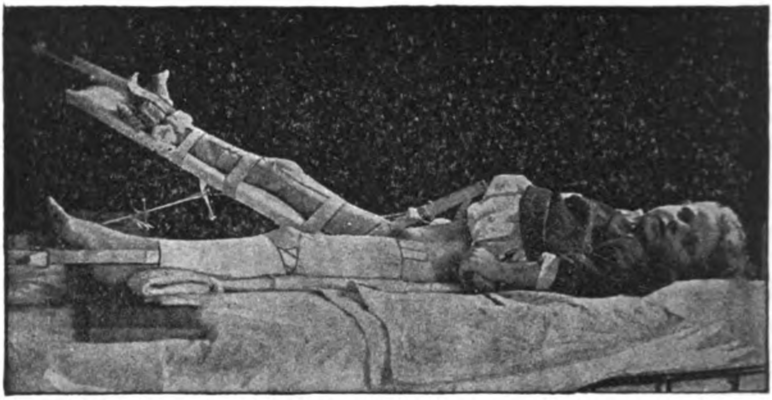


Diagram showing practical shortening of right leg from adduction. (BRADFORD and LOVETT.)

Treatment.—Treatment should be instituted as soon as the disease is suspected. A rheumatic or traumatic inflammation of the joint will not be made worse by such early treatment, while delay in the treatment of tubercular coxitis will be very dangerous to the patient. Here, as in tubercular disease of other joints, absolute rest of the articulation with attention to the general health of the patient is the essential treatment. The patient should be put to bed; and continuous traction be made upon the joint by means of adhesive plaster, a foot piece, a cord and a weight. The patient should not be allowed to sit up in bed, and counter-traction should be made by elevating the foot of the bed or fastening the patient's shoulders to the head of the bed by sheets or straps. If horizontal extension gives pain or causes aching of the spine, the direction of the traction should be in the line of the axis of the diseased limb. This may require the pulley to be moved a little to one side of the axis of the limb as well as elevated; and may necessitate the use of a wedge shape pillow or support between the mattress and the limb.

After traction in the line of deformity has been maintained for some time, the limb can usually be brought gradually into a more nearly normal position. This, of course, cannot be done in the late stages when ankylosis has taken place. It is desirable to use massage to the muscles to prevent atrophy during the many weeks' continuance of treatment. The joint itself should not be moved. Counter-irritation by blisters to the hip is valuable in some acute cases. When pain is great from distention of the joint, aspiration of the joint through the gluteal muscles will relieve it. A change in position or in the direction of the traction will sometimes lessen pain. After traction, combined with general tonic treatment has been kept up for months, the acute symptoms subside, unless the affection has been unmanageable and continues to progress. The patient may, in the former case, be allowed to get up with some form of mechanical appliance adapted

FIG. 278.

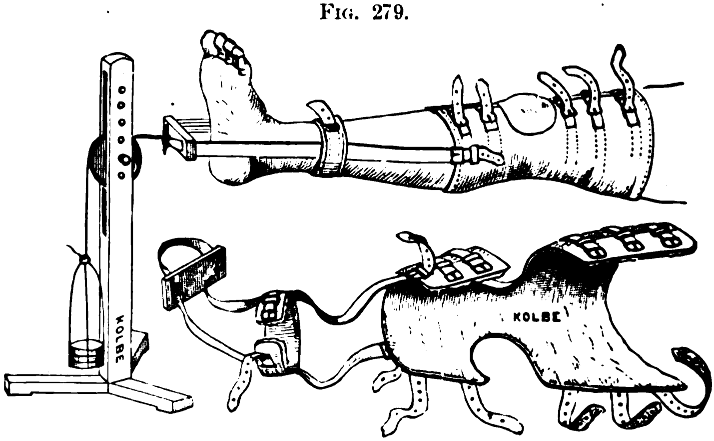


Bed-traction in a case of flexion and abduction (LOVETT; by permission of the Trustees of the Fiske Prize Fund).

to prevent motion and pressure from the weight of the body upon the diseased hip. The apparatus worn during the day, when the patient is walking about, may be discarded at night and the traction apparatus employed.

Abscesses should be incised, curetted and irrigated; and either sutured or drained. They must be protected from putrefactive and pyogenic infection. Sometimes the wound made for evacuation of the tubercular pus may be closed antiseptically and union by first intention obtained.

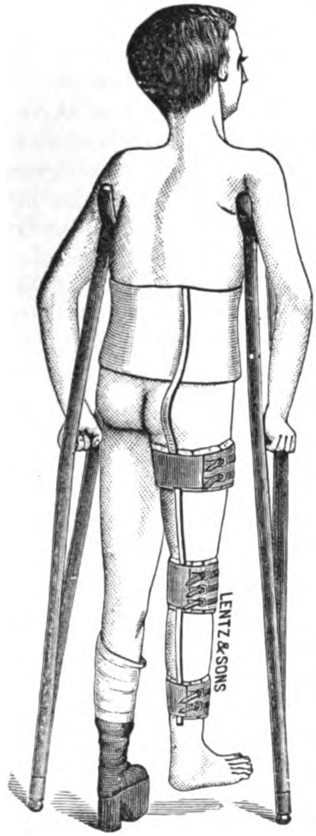
FIG. 279.



Morton's extension apparatus for traction in tubercular coxitis.

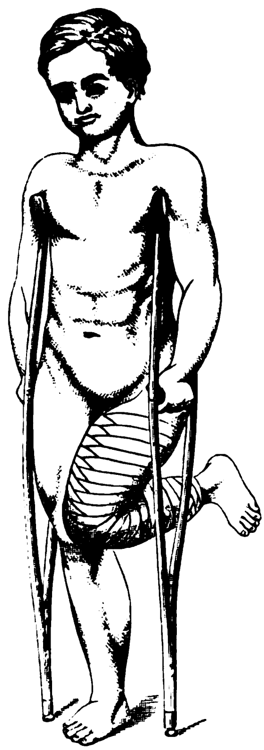
In cases the symptoms of which have never been very severe efficient treatment may sometimes be obtained by a splint from the beginning of the disease. This should allow the patient to use the other leg

FIG. 280.



Thomas's hip splint for fixing the hip joint in tubercular coxitis.

FIG. 281.



Traction exerted by encasign flexed knee and thigh in a sodium silicate splint and using weight of limb for traction weight. (LEVIS.)

and crutches for locomotion, without there being any weight borne upon, or motion permitted at, the diseased joint. Such a splint may be made of gypsum bandages applied to the pelvis and thigh. It must be supplemented by a high sole to the shoe worn upon the opposite foot and a pair of crutches. In this method the diseased hip is fixed; and the corresponding limb hangs so as to make traction on the joint by its own weight, but it does not touch the ground in walking. Various splints made of metal with leather bands accomplish this same purpose. The advantage of the splint treatment is that the patient is able to get out into the open air and gain the benefit that comes from such exercise. Acute cases of coxitis may be treated by a splint after being treated in bed by permanent traction until the activity of the symptoms has subsided.

Continued suppuration, inducing exhaustion of the patient, may require the surgeon to excise the diseased bone and the infected surroundings. This may effect a cure more promptly than persistence in non-operative treatment. In some cases the patient finally dies, despite the most scientific treatment, from the depressing effect of the disease or from other tubercular conditions associated with the hip joint affection. The tubercular osteomyelitis may be so extensive that amputation of the extremity at the hip joint will be required to save life. In all cases except those of a mild grade which have been at once subjected to most careful treatment ankylosis of the hip is to be expected and is the usual result in cured cases. The effort of the surgeon is to be directed to obtaining a rapid cessation of the tubercular involvement of the joint structures and ankylosis in the most advantageous position. Every effort should be made to have the limbs parallel after the subsidence of the disease. Ankylosis may then not interfere very much with the patient's gait because an unusual mobility occurs as a compensation at the pubes and the sacro-iliac joint. If the hip become ankylosed in an inconvenient position, no attempt should be made to correct this by osteotomy or osteoclasis until the last symptoms of disease have long disappeared.

It is possible that excision of the joint does not give quite as good a final result as the non-operative treatment. The latter, however, requires several years for its successful employment, even in cases of moderate severity. Such treatment cannot be obtained by the lower and middle classes. An attempt to enforce this line of treatment among such patients frequently results in their being subjected to constant recurrence of symptoms, because they are discharged from treatment before cure has taken place. It is probably better therefore in such cases to hasten the removal of the diseased bone by excision as soon as it becomes evident that a considerable degree of caries has occurred. In patients whose means are sufficient to insure for them satisfactory treatment through several years, excision may in many cases be dispensed with and non-operative treatment insisted upon.

Ankylosis in inconvenient positions after the disease has subsided may be treated by osteotomy of the neck of the femur by means of an Adams saw or an osteotome. After the bone has been divided the muscles and fascia are cut and the limb put in a position parallel to that of the normal side when the patient lies upon his back. The divided bone may then be treated as a fracture or attempts at establishing a false joint may be made. Success in obtaining a useful false joint is rarely if ever attained. Union in the corrected position is the usual result of the endeavor. Excision of the femoral head will sometimes be better than osteotomy. When pathological dislocation has occurred it is useless to attempt to replace the displaced head in the acetabulum. Cases of coxitis which have been treated with the greatest care and thoroughness nearly always show evidences of the disease in atrophy and shortening of the limb. Except in the mildest cases, stiffness and some deformity are usual. It is satisfactory to remember that cases that seem almost hopeless do at times recover finally, though with deformity and a greatly shortened limb.

TUBERCULOSIS OF OTHER JOINTS.

The knee, ankle, shoulder, elbow and wrist may be the seat of tubercular disease. They demand treatment similar to that adopted in cases of tubercular coxitis. In the knee, splints may be employed similar in their characteristics to those used for the hip, since the important element is to avoid motion and pressure during walking. The problem is less complicated when the affected joint is one of those of the upper extremities.

ANKYLOSIS.

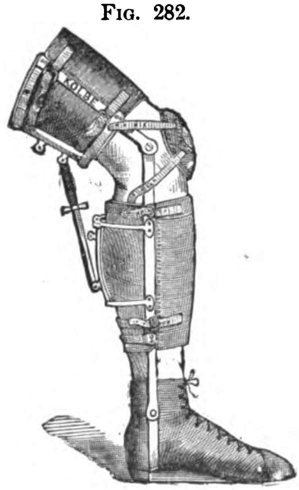
Definition.—The term ankylosis is employed to indicate that the mobility of a joint, which is free from active disease, is restricted or abolished. The term is not applied to immobility the result of pain, or of swelling due to the exudate of acute inflammation. When motion is impossible, ankylosis is said to be complete. When the joint retains some mobility the ankylosis is called incomplete. By false ankylosis is meant that the joint motions are impaired by adhesions of fibrous tissue either within or outside of the capsule. The ankylosis is said to be true when the bones are united by osseous tissue. The latter condition is often called synostosis. It has been suggested that the term true ankylosis should be employed when firm union of the articular surfaces exists, whether the bond of union be bony or fibrous.

Pathology.—Bony ankylosis cannot occur unless the articular cartilages have disappeared over the whole or a portion of the end of the bones, so as to permit the cancellated tissue to unite across the interspace. This removal of cartilage may be the result of disease; or of the surgeon's operative attack upon the joint, as in arthrectomy and excision. Usually the joint cavity is totally obliterated before bony union occurs. The osseous band is within the ligamentous capsule. There may, however, be in addition calcification of the soft tissues outside of the capsule. True ossification of these structures seldom occurs. Fibrous ankylosis may cause complete loss of motion. It is due to organization of inflammatory exudate within or outside of the capsule. It occurs after conditions which do not destroy the cartilages as well as in those which do. Quite often the restriction of motion results from fibrous adhesions and cicatricial contraction outside of the capsule. Bony ankylosis is practically always intra-articular. Interference with articular mobility from muscular spasm and from cicatricial contraction, as from burns and hysteria, should not be termed ankylosis; nor is the term applicable with propriety to the changes that take place in joints the result of muscular contractions following nerve injuries. Continued disuse of a joint such as occurs when patients wear splints for the treatment of fractures does not produce ankylosis. The muscular stiffness resulting from such disuse soon disappears because there is no inflammation of the joint structures. The permanent impairment of motion which not infrequently occurs after fractures involving joints is usually due to imperfect reduction of the fracture. Therefore a permanent change is produced in the surfaces of the bones of the joint. Ankylosis after fracture, when not due to this cause, is the result of a secondary synovitis and not to disuse during the wearing of a splint. Tubercular arthritis and rheumatoid arthritis are probably the most common causes of ankylosis.

The differential diagnosis between bony and firm fibrous ankylosis is often difficult, except under general anæsthesia. If the slightest motion is possible the case is not one of bony union. Fibrous ankylosis, however, may make the joint as immobile as a bony ankylosis. The protective muscular spasm of inflamed joints may be distinguished from ankylosis by the immediate mobility obtained under general anæsthesia.

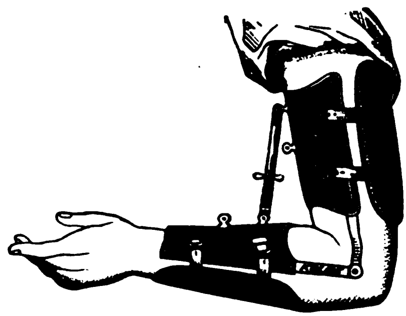
Treatment.—Restoration of motion should be attempted as early as possible, but not while symptoms of active inflammation are present. The passive motions and manipulations which constitute the main treatment in fibrous ankylosis may be undertaken notwithstanding the existence of some swelling. Manipulation of the joint will give some five or ten minutes at one time. The fore-

FIG. 282.



Modified Stromeyer splint for ankylosis of knee.

FIG. 283.



Modified Stromeyer splint for ankylosis of elbow.

ible passive movements, pain in the early stages of the tretament and, therefore, anæsthesia may be demanded. Nitrous oxide may be used for this purpose or the operation may be done under what has been called the primary anæsthesia of ether. The bones should be firmly held and the joint forced to move in its normal directions. These manipulations should be made with a moderate degree of force until the operator, feeling the intra- and extra-articular adhesions breaking, obtains a certain degree of mobility. The manipulations should not be continued more than should be repeated at frequent intervals, but time should be allowed for the irritation caused by them to subside. Massage of the muscles and less vigorous movements of the joint should be made in the intervals. A considerable degree of sudden force may sometimes be required to snap the adhesions and reëstablish motion. Frictions with liniments and baking the joint at a temperature of 300° may aid in relieving the stiffness of the articulation.

The improvement in the position of the joint obtained by forcible breaking up of the adhesions may be maintained by the use of splints, which are often furnished with a screw to enable the patient to carry on a moderate amount of passive motion during the intervals between the surgeon's visits. Tenotomy of contracted tendons and muscles may be required as an adjunct to manipulation. It is sometimes impossible to maintain movement in an ankylosed joint, but in such cases it is not infrequently possible to change the angle to one more convenient for the patient. Thus, the flexed knee may be put in an almost fully extended position so that the patient's foot will touch the ground and enable him to walk without the aid of crutches. On the other hand, an extended elbow may be converted into a flexed elbow, which even without motion gives the patient the use of his hand for many purposes. Passive motion is unavailing in cases of bony ankylosis; but by it the surgeon may be enabled to obtain mobility even in extensive fibrous ankylosis. It is most satisfactory in partial ankylosis due to extra-capsular adhesions. Osseous ankylosis can only be treated by division of the bony tissue, which unites the ends of the bone, with an osteotome, chisel or saw. When there is great deformity and it is desirable to change the joint from a state of flexion to that of extension, it may be necessary to remove a wedge shape piece of bone at the joint or above it. In strong fibrous ankylosis separation of the bones with a knife or osteotome may occasionally be the only method of establishing motion or improving the position. After excision or osteotomy of a joint some form of brace may be necessary to prevent displacement due to muscular traction or the superincumbent weight of the body. Attempts to establish a permanent false joint or ununited fracture after excision of joints have not been very successful.

LOOSE BODIES IN JOINTS.

Pathology.—Small bodies, sometimes called loose or floating cartilages, are not infrequently found in the knee, elbow and other joints. There may be a single one or a great number. Sometimes they are attached to the neighboring structures by a pedicle, at other times they lie loose in the joint. They have various modes of origin and are usually fibrous, fatty or cartilaginous. They may, however, become bony. Condensed fibrous exudate, organized blood clots, detached bony outgrowths, pieces of articular cartilage, hypertrophied portions of synovial membrane, cartilaginous growths from the synovial membrane or articular cartilages and foreign bodies covered with inflammatory exudate may be the origin of loose bodies in joint cavities. Bullets and needles and other foreign bodies free from incrustation or fibrous covering are sometimes found in joints.

Pediculated bodies of any origin may by the movements of a joint finally become detached and float freely. Chronic joint disease, such as rheumatoid arthritis and the hyperplastic form of chronic synovitis, are particularly liable to give rise to these loose bodies. They vary from the size of a small melon seed to that of a large chestnut. The variety in shape is unlimited.

Fig. 284.

Trochlea of humerus, showing formation and connection of loose bodies developing from synovial membrane. (Miller.)

Symptoms.—They may give rise to no special symptom and attract little attention. They, however, cause pain and impede motion when they become caught between the articulating surfaces. Usually the loose body, after becoming caught for a moment between the surfaces of the bones, slips out again. When the joint surfaces are thus forced apart, the ligaments are stretched, the articular cartilages contused or lacerated and the joint locked immovably. Great pain results. When the body slips from between the two bones, the pain and nausea suddenly disappear and no special symptoms remain, except perhaps a slight degree of synovitis. Synovitis, however, does not occur as a rule if the joint is not previously diseased or the entanglement of the loose cartilage of frequent occurrence. Occasionally the joint becomes locked without the production of much pain. The limitation of mobility and the pain occur perhaps more and more frequently until the patient seeks surgical relief. Sometimes the body can be seen and felt through the skin, when it occupies or takes a position in the joint which is superficial. The mobility of the body often makes it difficult to find : but usually the patient has learned by repeated experiences the particular motion or position of the affected articulation, which will cause the cartilage to make its appearance so that the surgeon can see and feel it through the skin. The position in which the locking of the joint takes place is not always the same. This will at times aid in making the diagnosis of the condition under discussion from a dislocation of, for example, a semi-lunar cartilage of the knee.

Treatment.—The patient will often be able to unlock the joint, thereby restoring motion and relieving pain. The inconvenience produced by the unexpected interference with motion and the concomitant pain will finally in many cases lead him to seek treatment. A brace or pad may be adjusted which will prevent the body from slipping between the bones or cause its retention in an unimportant part of the synovial sac. These appliances may also be of service by restricting the particular movements which tend to displace the loose body in such a way as to cause symptoms. The radical treatment, however, is to open the joint and extract the floating portion of fibrous tissue, cartilage or bone. The operation is most satisfactorily done when the loose body is fixed by the fingers or by transfixion with an aseptic needle before the incision is made. If this is not done, it is liable to slip into a distant portion of the joint and escape detection by the surgeon's exploring finger after the joint has been opened. If numerous loose bodies are present they should be removed at the time the joint is opened to extract a single offending one.

CHAPTER XIX.

INJURIES OF JOINTS, CARTILAGES AND LIGAMENTS.

WOUNDS OF JOINTS.

Pathology.—The usual injuries of joints may be divided into contusions, sprains and penetrating wounds. A sprain may be looked upon as a laceration of the ligamentous and other soft structures of the joint. Penetrating wounds may be lacerations, punctures or incisions. These injuries are followed by synovitis or arthritis, and demand treatment in accordance with the degree and character of the synovitis or arthritis so produced. Penetrating wounds, whether produced by gunshot or other external injuries, become serious because of the probability of septic contamination. Subcutaneous wounds of joints, such as are made in dislocations and fractures involving joints, are usually of comparatively little importance, if the presence of putrefactive or pyogenic germs does not complicate the wound. The fact that a joint has been opened by a wound in its vicinity may be made known by the escape of synovial fluid or the exhibition of synovial membrane or cartilage. It must be borne in mind that some joints have bursæ near them which furnish, when opened, a glairy fluid similar in appearance to synovial fluid. The bursæ in front of the patella is a conspicuous example.

Treatment.—Septic wounds of joints are very serious injuries, because the synovial membrane absorbs the toxines of septic inflammation quickly and furnishes an albuminous fluid in which bacteria grow with rapidity. Hence aseptic or antiseptic irrigation and free drainage is essential in penetrating wounds of joints. The first symptom of active inflammation after a penetrating wound of a joint demands that the articulation be freely opened and its recesses thoroughly cleansed with a sterile salt or a weak antiseptic solution. A solution of corrosive sublimate (1–5000) is a proper irrigating wash if the surgeon believes that a sterile salt solution is not sufficient for cleansing purposes. If the wound is probably septic at the beginning, free incision of the joint, irrigation and the insertion of drainage tubes should not be delayed until rise in temperature and pain make the infected character of the wound apparent. In preantiseptic days penetrating wounds of large joints were accompanied by great fatality. Amputation was often the only safety of the patient after the receipt of such a wound. At the present time aseptic operations are constantly done with impunity on the largest joints; and joints the seat of septic inflammation after injury are successfully managed, if the surgeon promptly opens, irrigates and drains the synovial sac.

SPRAINS.

Pathology.—A sprain or distortion is an injury of a joint, due to carrying its movements beyond physiological limits or to attempted motion in an impossible direction, but not to a sufficient extent to cause dislocation. In a dislocation there is a traumatic displacement of the articular end of a bone. A sprain is produced by an indirect violence similar to that which is the usual cause of dislocations. The lesions may occasionally be caused by excessive muscular violence, but traumatism is the usual cause.

As the lesion is due to attempted motion in a direction impossible for the joint affected or to an attempt to produce motion beyond the physiological limit, the hinge joints are more likely to be the seat of sprains than joints possessing a greater variety of movement. The ligaments, capsule and tissues surrounding the joint are stretched or lacerated when sprains occur. Hemorrhage into the joint and the structures around it, inflammatory reaction with its necessary exudate and a consecutive synovitis are the other pathological conditions found in sprains. A ligament may sometimes be torn away from its bony attachment and at other times may be so strong that a small piece of bone is detached from the surface of the bone which constitutes one of the components of the joint. This condition is sometimes called a sprain fracture. In severe sprains the periosteum may be torn loose from the bone for a considerable distance.

Symptoms.—Intense sickening pain, accompanied perhaps by vomiting, and considerable shock or even syncope occur at the time of the receipt of the injury. Swelling, ecchymosis, pain, limitation of motion and marked spasm of the muscles in the neighborhood of the joint are usual symptoms. An acute synovitis, accompanied by distention of the joint cavity and dull pain, supervenes. The point of greatest tenderness will be over the line of the joint and the insertion of the torn ligaments. It may take some time for the black and blue appearance due to the effusion of blood to show upon the surface of the limb. The intra-articular and periarticular swelling depends upon the amount of damage done to the structures. If the synovial membrane and capsule of the joint have been ruptured, the intra-articular swelling will not be great and the pain will be less than if the joint cavity is distended with inflammatory exudate, the result of the acute traumatic arthritis. A sprained joint is apt to assume the attitude characteristic of synovitis of the same joint.

It is frequently difficult to diagnosticate a sprain from a fracture near to, or involving, the joint. In such cases general anæsthesia is necessary to permit a thorough examination. In doubtful cases the injury should be treated as a fracture, until the decrease in swelling enables the surgeon to make a more satisfactory examination. The use of the X-rays will often clear up a doubtful diagnosis.

Treatment.—Great comfort is obtained by immersing the sprained joint in hot water, in which it should remain for twenty or thirty minutes. It is not uncommon to use cold water for this purpose ; but hot water will probably be more comfortable to the patient and is probably more apt to lessen muscular spasm, which is such a frequent accompaniment of the injury. The limb should then be elevated and bandaged with moderate firmness from the distal extremity upward. Massage applied before the application of the bandage will be found very efficacious, if a skilled manipulator can be obtained. The relaxation of spasmodically contracted muscles, the absorption of inflammatory exudate and blood and the relief of pain accomplished by the use of massage is sometimes surprising. When it cannot be used in the early treatment it should be employed in the later stages. Its employment through the entire period of treatment is beneficial. After the use of hot water and bandaging, and between the times at which massage is employed, the joint should be kept at rest and elevated in order to lessen the activity of the synovitis which is sure to occur. Immobilization by means of a plaster of Paris dressing or some form of splint is the usual method of obtaining freedom from motion. The indiscriminate use of such immobilizing apparatus is unwise, for if prolonged it leads to protracted stiffness of the joint. In the early stages rest is important; but later, as in other forms of synovitis, frictions and massage, either with or without the employment of liniments, are more beneficial. In the more chronic cases counter-irritation and the wearing of a rubber bandage or elastic stocking may be serviceable. The patient should not refrain from using the joint for too long a period, since a moderate degree of motion acts very much as does massage by hastening absorption of inflammatory exudate and reëstablishing function.

DISLOCATIONS.

Definition.—A dislocation or luxation is a violent displacement of a bone from its normal relation with another bone or other bones at a joint. The term is sometimes applied to the displacement of a cartilage or an intra-articular fibro-cartilage from its normal position. A dislocation is called complete when the articular surfaces do not touch each other at any point. When portions of the joint surfaces are in contact the dislocation is said to be partial or incomplete. The term subluxation is sometimes employed to designate an incomplete dislocation. Changes in the mutual relation of bones at a joint produced by disease and abnormalities of position due to imperfect development in the fœtus are sometimes called dislocations. These so-called pathological and congenital dislocations should not be classed with the displacements of bones due to mechanical or muscular violence.

Pathology.—The distal bone is the one which is said to be dislocated ; for example, a dislocation at the hip joint is called a dislocation of the femur ; at the end of the clavicle, a dislocation of the scapula ; at the ankle, a dislocation of the tarsus.

The dislocation of the bone may be backward, forward, upward, downward or laterally. The shape of the articular surfaces, the muscular and ligamentous attachments and the direction in which the force is applied determine the direction of the displacement.

Complete dislocations are rare in hinge joints, but are common in ball and socket and arthrodial articulations. Complications, such as great laceration of the soft parts, rupture of large vessels or nerve trunks, fracture, and lesions of internal organs may occur with dislocations. If a wound extends to the seat of the luxation, the dislocation is called open or compound. If no such communication with the air exists, the injury is called closed or simple. If the primary position of the dislocated bone is altered by attempts at replacement, involuntary muscular action or any other cause, a secondary dislocation is said to be present; for example, an iliac dislocation of the head of the femur may become secondarily a sciatic dislocation. Displacement due to disease of a joint is sometimes called a secondary dislocation. As has been previously said the use of the term dislocation for these pathological changes in position is undesirable; since the symptoms and treatment are so different from those which pertain to the injuries under consideration.

In complete dislocations the ligaments are nearly always torn and the surrounding tendons or muscular attachments more or less injured. If the dislocation be one of the typical forms pertaining to the particular joint, the tearing of ligaments will probably be quite limited. Extensive laceration of the ligamentous capsule permits irregular dislocations to take place. The capsule, instead of being ruptured, may be completely torn loose from one of the bones. When the dislocation is incomplete, the ligaments may be simply stretched; and this condition sometimes exists even in complete displacement. In dislocations due to voluntary muscular effort the ligaments are relaxed and the surrounding structures are not, as a rule, injured. Extravasation of blood and inflammatory changes secondary to the injury are accompaniments of dislocations. If, however, the injured tissues are protected from septic infection, repair promptly occurs after the bone has been restored to its normal position. The functions of the joint are usually quickly restored when the articular surfaces are promptly and properly placed in their normal relations. If, however, the displaced bone is permitted to remain in its abnormal situation, changes occur in the shape of the bony surfaces and the muscles and ligaments may become welded together by inflammatory changes so that their function is greatly impaired. Sometimes the margins of the unused socket atrophy and the depression becomes more shallow or is filled up with fibrous material. A new socket may be developed by the pressure of the head of the dislocated bone in an abnormal situation. The new socket is a poor imitation of the original one and the movements of the joint are usually much restricted. At times the changes in the unused bony surfaces are very slight, even after the lapse of many years. A sort of capsule with an attempt at the formation of a synovial membrane between the two opposing surfaces of the bone may sometimes be developed. The head of the bone itself is liable to atrophic changes and flattening. Stiffness of the joint may occur as a result of the abnormal position of the bone or may be due to inflammatory adhesions uniting the disarranged muscles and fascias. These inflammatory adhesions are one of the sources of danger when attempts are made to reduce bones that have long been dislocated; for they may be the means of causing rupture of blood vessels and nerve trunks, which have been bound down in unnatural positions.

Causes.—The predisposing causes of dislocation are relaxation of ligaments, weakened muscles, old lacerations of the ligaments, imperfections in the articular surfaces from injury or disease, and such anatomical peculiarities of the joint as allow separation of the bones to readily occur. Those joints which possess the greatest freedom of motion and are most exposed to injury are most likely to be the seat of dislocation. For these reasons the humerus is more commonly dislocated than any other bone. Certain positions of the bones in relation to each other at the time of the receipt of traumatism may predispose to a dislocation; for example, the lower jaw is more apt to be put out of place by a blow upon the chin when the mouth is open than when it is closed. External blows and muscular contraction are the exciting causes of dislocation. The external violence may be exerted upon the distal bone directly or indirectly. Indirect violence acting through the bone as a lever is the more common method of producing a dislocation. Occasionally the vulnerating force may be directly applied as in a fall upon the outside of the shoulder which may drive the head of the humerus into the axilla. Rotary force applied indirectly is not infrequently responsible for throwing the head of a long bone out of its socket. The action of the muscles in the causation of luxations from external violence is probably considerable. They may act as a fulcrum by holding one portion of the bone steady while the force exerts its influence as upon a lever. Muscular action alone may cause sudden dislocation. This method of production only occurs during convulsive seizures such as epilepsy. Some persons have the ability to cause luxations by voluntary muscular effort. In such persons the ligaments are relaxed. The gradual displacement of bones at a joint occurring in arthritis is another instance of muscular displacement. These displacements are not true dislocations.

Symptoms.—The chief symptoms of dislocation are deformity, restriction of motion, pain, absence of crepitus such as is found in fractures, the absence of any tendency to reproduction of the displacement after reduction of the dislocation, and the evident abnormal position of the dislocated bone shown by the fluoroscope or skiagraphy. The differential diagnosis between a dislocation and a fracture near a joint is often very difficult. The result of the mistake in diagnosis may be so serious that general anæsthesia should be insisted upon in doubtful cases.

The deformity which occurs from mere swelling is of little service from a diagnostic point of view, but the absence of a known bony prominence or the appearance of such a prominence in a new position is very characteristic. In the same manner the unusual presence, or the disappearance, of a normal depression upon the surface of the limb is of great diagnostic value. In most dislocations there is shortening of the limb, and alteration in the long axis of the bone is frequently very perceptible. Certain attitudes or deformities are to be expected in dislocations of many of the joints, because their anatomical construction makes dislocation in certain directions the common form of luxation. The inflammatory swelling is often not great enough to mask the bony deformity; if it is, firm pressure with the hand or a rubber bandage may so displace the inflammatory fluids in the subcutaneous tissue that the bony outlines become evident. An aseptic exploring needle may be thrust through the soft parts in order to demonstrate the situation of a bony prominence. The restriction of motion is not necessarily absolute. The slight range of motion permitted is arrested by an elastic check. There is also an appearance and sensation of rigidity. This is quite different from the helpless relaxation observed in fractures. Comparison should be made between the injured and uninjured sides in determining alterations in configuration or motion.

Crepitus such as is found in fractures does not occur in dislocation unless it be complicated by fracture; but, on the other hand, fracture crepitus is not always obtainable in fractures. A symptom resembling fracture crepitus is sometimes produced by the dislocated bone being rubbed over fibrous or muscular tissues or by the occurrence of an inflammatory exudate upon the surface of the synovial membrane or cartilages. The latter form of false crepitus does not occur until a day or two has elapsed and inflammation has developed. The crepitus, elicited from rubbing the head of the bone against the soft parts or the edge of the other bone, is a more obscure grating than that ordinarily obtained in fractures. If a fracture is sufficiently old to have the sharpness of its spicules diminished by inflammatory exudate or if the fracture is situated very deeply, the crepitus obtained may resemble the crepitus of a luxation. Dislocations accompanied by a chipping off of the edge of one bone may have as symptoms both forms of crepitus. The pain of dislocation is apt to be of a dull throbbing character more unbearable than that ordinarily accompanying fractures. The pain of fractures subjected to motion is, however, very great. The pressure of the rigid luxated bone upon nerve trunks may cause numbness, tingling or paralysis. The manner in which the tensely stretched muscles hold the bone in its abnormal position accounts for the continuous pain. The facts that the dislocated bone remains in position after it has been returned to its normal site and that it is usually replaced with an audible snap are of great diagnostic importance. Dislocation accompanied by great laceration of ligaments may be readily reproduced and some fractures remain in position after coaptation of the fragments; but under most circumstances a fracture requires support to keep the fragments in their proper relation to each other, and the bones of a luxated joint after being readjusted retain their normal relations. The snap with which a dislocated bone is jerked into its socket by the muscles, when it is unlocked from the abnormal situation in which it is held, is different from anything produced during the setting of a fracture.

Prognosis.—An uncomplicated dislocation promptly reduced is followed as a rule by early recovery of the functions of the joint. There may, however, remain a tendency for a similar accident to occur from the application of less force than that which produced the original luxation. Some pain and stiffness may remain for a considerable length of time in rheumatic subjects or if the joint has been immobilized too long during the treatment. Some weakness of the limb, atrophy of the muscles and attacks of pain during damp weather are occasional sequels.

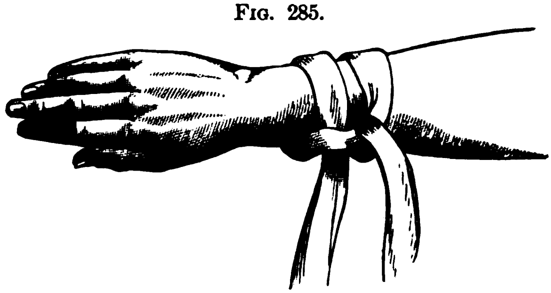
Repeated dislocation of the joint usually means that there is some permanent relaxation of ligamentous or muscular structures. An operation to shorten the capsular ligament or repair muscular damage may be justifiable in such conditions. Open dislocations if rendered and kept aseptic are scarcely more serious than closed ones. Dislocations which have not been promptly reduced are lesions of gravity. The structures surrounding the joints become the seat of inflammatory processes; these may cause adhesions and prevent the full restoration of function, even after the luxation is finally reduced. The reduction, moreover, becomes increasingly difficult with the lapse of time. Attempts to put the bone into place in old dislocations are not infrequently followed by laceration of the great blood vessels, fracture or serious damage to the soft parts. Hinge joints become "old" at an earlier period than ball and socket joints. If pressure is made upon important nerve trunks, such as the brachial plexus or sciatic nerve, by the displaced bone, the trophic changes in the peripheral parts due to neuritis may render the limb almost useless. It may occur that a considerable amount of motion and utility may be attained by dislocated joints that have been permitted to remain unreduced. This occurrence, however, is not sufficiently frequent to justify inactivity on the part of the surgeon.

Treatment.—The replacement of the dislocated bone in its normal position is called reduction. In partial luxations and sometimes in complete ones, spontaneous reduction may take place. This occurs by muscular contraction aided by such movements, during sleep or falls, as puts the bone in a position to be readily drawn into the socket. Spontaneous reduction occasionally occurs after unsuccessful efforts of the surgeon to reduce the dislocation. These attempts have probably broken up adhesions. The treatment of recent dislocations consists in replacing the bone at the earliest possible opportunity. Delay in reduction adds greatly to its difficulty. Most dislocations could be reduced with ease under proper manipulation, if subjected to treatment before inflammation, spasmodic contraction of the muscles and changes in the surroundings of the joint have occurred. The indications for treatment may be summarized thus: Reduce the displacement, secure repair of the torn parts without excessive inflammatory reaction and restore function.

Reduction is accomplished by manipulation aided by such measures as will relax muscular contraction, which in recent dislocations is largely due to pain. General anesthesia is therefore an important part of the treatment. If pain is abolished by anesthesia and the muscles relaxed, a moderate degree of force applied in the proper way will enable the surgeon to replace the dislocated bone. Even without the aid of anesthesia the surgeon may, in the early stages of dislocation, reduce the displacement by surprising, as it were, the muscles. This is to be done by suddenly employing the proper manipulation, while the patient's attention is diverted by an abrupt question so that he will not think about the prospective pain and put the muscles on guard. The primary stage of etherization will often be sufficient to secure the requisite relaxation of the muscular system. At other times profound anesthesia will be required. The ordinary power of the surgeon aided by that of an assistant is all that should be employed. Compound pulleys and other mechanical devices are liable to do harm.

The manipulations employed in the reduction of a dislocation consist of extension and counter-extension, better termed traction and counter-traction, combined with such motions of the displaced bone as will unlock it, as it were, from its abnormal situation and bring its articular extremity in such relation with the ruptured capsule that the attached muscles may by their tension pull it into place. The bone should return to its proper position along the same route by which it made its exit. While it is possible that unskilled pulling and manipulation may in some joints put the bone in position to be drawn into place by muscular action, it is clear that scientific movements made with a knowledge of anatomical requirements are safer and much more likely to be successful. The manipulations should be applied systematically and the proximal bone should be rendered immovable during the time that motion in various directions is given to the distal bone. The first object is to overcome the obstructive muscular tension, which holds the bone in the abnormal position and which is the cause of the usual shortening in dislocations. Then the end of the bone is to be dislodged and brought opposite the rent in the capsule. External pressure or the assistance of the appropriate muscles is then invoked to draw the bone against the articular surface of the proximal bone. The muscles and ligaments are utilized as points of support or as fulcrums during these manipulations, so that the articular end may be compelled to move in certain directions by the application of force to the distal extremity of the bone. Special movements may be required to cause the opening in the capsule or the space between two tendons to gap sufficiently to permit the head of the bone to slip through it. Sometimes a flap of ligament may become entangled between the two bones and necessitate an incision to permit the proper reduction. Muscles, tendons or large nerve trunks may become wrapped round the end of the bone and interfere with proper restoration of the parts. Thus, in certain dislocations of the hip the great sciatic nerve may, by injudicious manipulation of the surgeon or the character of the original dislocation, be displaced so as to pass across the front of the neck of the femur like a strap. To apply the traction and counter-traction which is sometimes required to overcome the muscular spasm, a towel or broad band may be attached to the extremity of the limb by a clove hitch knot. This will give the surgeon or his assistant a better opportunity to make traction and will prevent abrasion of the skin of the limb. If bandages or cloths so used are moistened, they have less tendency to slip. In addition to traction, or extension, movements of flexion and extension, rotation, abduction, adduction and a rocking motion are used to disentangle the bone from its abnormal site and carry it back into its normal relation with the other bone.

FIG. 285.



Clove hitch knot applied. (AGNEW.)

The traction and counter-traction must be applied steadily and not in a jerking manner. If the strength of a man is not sufficient to overcome the obstacles to reduction, it is better to open the joint by the operation called arthrotomy than to blindly use mechanical devices to increase the amount of force applied.

The rules for the application of manipulative force in reducing luxations may be summarized somewhat as follows:

First, The power must be exerted in a proper direction. Secondly, It must be applied continuously and not in a spasmodic or violent manner. Thirdly, The distal bone must be rotated, moved or rocked in such directions as will free its articular end from entanglement with other bones or with muscles or adhesions. Fourthly, When the head of the bone has been brought to the edge of the articulation, an adroit movement of, or proper pressure upon, the bone by the hands of the surgeon should give the muscles an opportunity to pull it into the proper position. At the moment that this last motion or pressure is exerted, the traction, or extending force, should be suddenly relaxed. The general principle may be thus expressed: Carry the limb first in the direction in which its distal end points, to unlock or disengage the head of the bone; then quickly carry it in the opposite direction, to make it clear the edge of the socket. During these movements traction and counter-traction must be maintained.

A dislocation is known to be completely reduced when the joint assumes its normal contour and permits its usual movements to be made by the surgeon. After the muffled snap which indicates that the head of the bone has slipped into place is heard, the operator should institute movements in the various directions which the normal joint permits and seek for complicating fracture. For a few days motion of the joint should be restricted by means of bandages, splints or apparatus. As a rule, no special applications are needed for the treatment of the inflammation due to the injury. Open dislocations must, of course, be treated as other open wounds, by antiseptic irrigation and dressings. In ordinary uncomplicated dislocations the patient may be permitted to use the joint cautiously at the end of a week. Special care should be taken to avoid such movements as would tend to thrust the head of the bone through the torn capsule, the laceration in which will not become firmly united for some weeks. Recurrence of the dislocation may take place, if this precaution is not observed. It sometimes happens that a tendency to habitual dislocation remains in ball and socket joints which have once been the seat of this injury. Massage, electricity, hot and cold douches and hypodermic injections of strychnia may be beneficial, if the muscles have been atrophied or paralyzed as the result of the injury. Restriction of motion after the reduction of dislocation is often continued for an unnecessarily long time.

If the manipulations herein described fail to reduce a dislocation, the patient should be etherized and arthrotomy, or incision into the injured joint, be performed. Division of restricting tendons, section of the neck of the dislocated bone, excision of its head or the ends of both bones or amputation may be required. Subcutaneous division of a muscle or tendon may occasionally be sufficient to permit reduction. An open wound is usually better.

Treatment of Old Dislocations.—Dislocations which have not been reduced because of a mistake in diagnosis or of unavailing efforts are, if a few weeks have elapsed, called old dislocations. Old dislocations are proverbially difficult of reduction. In some joints, such as the elbow, a luxation becomes old and difficult to reduce within two or three weeks. In other joints, such as the shoulder and hip, the possibility of easy reduction by manipulation is existent for a much longer period of time. A careful attempt at reduction of an old dislocation may be judicious at any length of time after the original injury, but the application of great force or excessive prolongation of manipulative efforts is dangerous. The tissues have become adherent by inflammatory exudate and have undergone contraction and atrophy. Rupture of nerve trunks, laceration of large arteries and veins and fracture of the bone have not infrequently occurred as the result of even moderate manipulation in such cases. Such accidents occurring must be dealt with in accordance with recognized surgical principles. Torn vessels must be at once exposed and ligated. Torn nerves should be similarly uncovered and sutured. It is not probable that much can be gained by the use of embrocations or other external applications as a preliminary to the attempt to reduce an old dislocation. Massage, passive motion and traction may be employed, though their use is not likely to be of very great advantage. The manipulations for reduction are the same as in recent dislocations, but are preceded by general movements to break up inflammatory adhesions.

If the disability from a chronic dislocation is great, the wisest course is arthrotomy followed by tenotomy, myotomy and division of all the structures that prevent replacement of the articular end of the bone. If this cannot be accomplished, good motion may often be obtained by excision of one or both articular surfaces of the joint. Neuralgia due to nerve pressure exerted by the displaced bone and other complications are often relieved by such operations. The formation of an artificial joint by osteotomy of the distal bone will sometimes yield good results.

SPECIAL DISLOCATIONS.

Dislocations of the Vertebræ.

Vertebral dislocation is usually accompanied by fracture. The most common site of the lesion is the cervical region, because of its normal mobility. The axis is probably more easily displaced without complicating fracture than the other vertebræ. The manner in which the vertebræ are articulated is a sufficient reason for the common association of fracture and dislocation. As a rule the contiguous bones are not entirely separated and the luxation is therefore properly called incomplete. The symptoms of dislocation of the vertebræ are practically identical with those of fracture and are largely due to coincident injury to the spinal cord and its membranes. The treatment is similar to that in fracture. Reduction by traction and counter-traction aided by pressure may be possible. Incision to permit inspection of the displaced bones is often urgently demanded, since the damage done to the spinal cord may in some cases be lessened or prevented by early restoration of bony contour. The care of the patient to prevent bedsores, and proper attention to the condition of the bladder and rectum are essentials of the treatment.

FIG. 286.

Bilateral dislocation forward of fifth cervical vertebra. (AYRES.)

In dislocations in the cervical region the upper vertebra is usually displaced forwards, though lateral or rotary dislocation may occur.

The lesion is caused usually by indirect violence by which bending or twisting of the neck is produced. The head is bent rigidly forward in anterior dislocations and backward in the rarer posterior luxations. The irregularity in the outline of the spinal column is noticeable at the back of the neck and may also be felt in some cases by the finger introduced into the pharynx. If the injury be above the origin of the phrenic nerve, death is usually instantaneous. The treatment consists in traction with the hands grasping the chin and occiput, while counter-traction is made by holding the patient's feet or shoulders. Manipulation to unlock the displaced vertebra and direct pressure applied over the projecting bone may aid in reduction.

Luxations at the atloaxoid articulation occur in three forms. The odontoid process of the axis may be fractured and allow luxation of that bone backward with coincident pressure upon or division of the spinal cord; the odontoid ligaments may be torn and permit the odontoid process to slip beneath the transverse ligament; the atlas may be rotated to such an extent as to tear the ligamentous attachments between it and the axis and allow it to rest obliquely upon the latter. These dislocations occur from force applied to the head. Similar displacements are likely to occur in tubercular caries of this region. The symptoms of these injuries are vague and the diagnosis unsatisfactory. The lesions usually prove fatal from pressure upon the medulla oblongata. A slight change in the position of the displaced bone is liable to make pressure upon the medulla oblongata and cause sudden death. This danger must be remembered when the surgeon attempts by traction, counter-traction and pressure to reduce the dislocation. After reduction has been accomplished the head should be kept immovable by a plaster of Paris splint or some form of apparatus, lest sudden motion of the patient cause displacement, pressure upon the cord and immediate death. It is probable that an incision to uncover the displaced bones would be more judicious than attempts to reduce without knowing the exact nature of the displacement. With the bones exposed, manipulation could be more satisfactorily and more safely applied.

Dislocations of the dorsal and lumbar regions are caused by extreme flexion or rotation of the trunk as fractures are caused in the same regions. The symptoms are similar to fracture. The diagnosis can only be made by incision through the muscles. Traction and counter-traction are proper after incision.

Dislocations of the Coccyx.

Coccygeal luxation occurs chiefly in women during parturition, but is a rare injury. It may occur from falls or other direct violence to the lower end of the spinal column. The most frequent displacement is forward, though backward or lateral dislocation may occur. The symptoms are pain, and the displacement which is felt best by rectal examination. It may be difficult to discriminate between dislocation and fracture. Manipulation with the finger in the rectum aided by external pressure is the treatment to be adopted. Recurrence of the displacement is rather probable. It would be proper to wire the coccyx to the sacrum if great difficulty were found in maintaining a proper position of the bone. Excision of the bone is a justifiable operation, in cases where deformity remains after unreduced dislocation or pain is produced by a tendency to recurrence of displacement. Neuralgic pain in this region is not uncommon after dislocation and fracture. This coccygodynia may occur without there having been any real bony injury.

Dislocations of the Ribs.

Luxation of the head of the rib from its attachment to the vertebral column is a possible, though rare injury. The displacement is forwards and appears to be more liable to occur to the eleventh and twelfth ribs than the others. Dislocation of the costal cartilage from the anterior extremity of the rib may also occur. Such a dislocatino presents symptoms similar to fracture, and is to be treated in the same manner by an encircling bandage or an adhesive plaster dressing.

Dislocations of the Sternum.

Union takes place between the three pieces of the sternum at about the thirty fourth year. Before that time dislocation may occur between the gladiolus and manubrium or the xiphoid appendix and the gladiolus. Dislocation of the gladiolus from the manubrium occurs only as the result of great force; such as forced extension of the spine backwards, strong flexion forwards of the head and trunk or direct violence applied to the anterior region of the chest. It is said that dislocation of the manubrium may occur from muscular contraction. It seems as if this would be almost impossible. The displacement of the manubrium is either forwards or backwards. The ensiform appendix may be displaced backwards or forwards. It may, as fracture of this portion of the sternum, produce spasm or irregular action of the diaphragm and violent vomiting. It may be so displaced as to make pressure upon the stomach.

The treatment of sternal dislocations is practically the same as that of fracture; and indeed after union of the segments of the bone has occurred dislocation is no longer possible. The injuries just described as dislocations might perhaps with propriety be considered epiphyseal fractures. Reduction should be attempted by bending the body backward or forward over a hard pad or firm pillow, so as to unlock the displaced bone. It would be proper in backward dislocation to make an incision and elevate the manubrium by inserting a lever under it or getting control of it by an instrument shaped like a corkscrew. Similar treatment may be adopted for dislocation of the ensiform appendix. In the event of failure to replace this bony or cartilaginous end of the sternum it may be excised. The use of wire stitches or nails, driven obliquely through the bone, is proper in troublesome cases. The chest should be encircled by a supporting bandage after reduction of the deformity.

Dislocations of the Lower Jaw.

Pathology.—Dislocations of the lower jaw, or mandible, may be unilateral or bilateral ; the bilateral displacement is the more frequent. The injury is said to be more frequent in women than in men. The luxation is forwards. A dislocation backwards is possible but usually only as a complication of fracture, for the condyles are forced through the anterior wall of the auditory canal. The predisposing causes of luxation of the jaw are lax temporo-maxillary ligaments and a shallow glenoid cavity. Exciting causes are attempts to separate the jaws very widely, as occurs in yawning, laughing and sneezing, and blows upon the chin while the mouth is open. The mechanism by which the dislocation forwards occurs is that the internal pterygoid muscles act as a fulcrum, and the muscles of the neck attached to the chin or the blow upon the chin act, as it were, upon the long arm of a lever. This with the help of the external pterygoid gives opportunity for the condyle to tear through or stretch the capsular ligament at the front of the joint and ride over the articular eminence. The masseter and temporal muscles then draw the bone upwards until the zygomatic arch arrests the upward movement. The dislocation sometimes occurs without tearing the capsule.

FIG. 287.

Bilateral dislocation of lower jaw.

FIG. 288.

Deformity resulting from bilateral dislocation of lower jaw. (ASHHURST.)

There is occasionally in persons with relaxed ligaments a tendency to habitual sub-luxation of the temporo-maxillary joint; this displacement causes a snapping sound while eating. This condition usually requires little or no treatment other than some counter-irritation and remedies to increase the muscular tone.

Symptoms.—The mouth is widely open and cannot be closed. The lower jaw is immovable, a vacuity is noticed in front of the ear and the condyles are felt beneath the zygomatic arch. In unilateral dislocation the chin instead of pointing directing forward is turned a little toward the uninjured side. The patient complains greatly of pain and the saliva runs from the mouth.

Treatment.—Reduction can often be accomplished without anesthesia. The surgeon inserts his two thumbs, wrapped with bandages to prevent injury from the teeth closing upon them, upon the last molar tooth of each side, grasping the body and ramus of the jaw with the palms and fingers. Pressure downward is made upon the teeth in order to unlock the condyles from their position in front of the articular eminences. After pressure downward has been made for a few moments the jaw is suddenly drawn forward and the chin elevated a little. This manipulation has a tendency to lift the condyles over the articular eminences. The muscles cause them to snap back into their normal position. There is a possibility of the fingers of the surgeon being bitten if they are not quickly withdrawn at the proper moment. A unilateral dislocation is reduced in a similar manner. A bandage, such as the occipito-mental figure of eight, is then applied to the cranium and chin to prevent the mouth being widely opened. In some subluxations the teeth are closed and the displacement is overcome by simply forcing the teeth apart. In unreduced dislocations a certain amount of mobility of the jaw is likely to be finally obtained, but a complete closure of the mouth is improbable. If reduction cannot be accomplished, excision of the condyles or the establishment of a false joint by osteotomy may give good results.

Dislocations of the Clavicle.

Pathology.—As a result of very great violence the clavicle may be dislocated entirely. The shoulder in such cases is probably pushed inward, which dislocates the scapula beneath the acromial end of the clavicle and the inner end of the clavicle in front of the sternum. The ordinary dislocation of the clavicle takes place at the sterno-clavicular articulation in a forward, backward or upward direction. Violent movements of the arm are the usual cause of clavicular dislocation. Certain occupations may induce a tendency to displacement of this joint which after a time results in a slowly produced dislocation by stretching of the ligaments.

Symptoms.—Local pain and the characteristic deformity without the evidence of fracture show the nature of the injury. When the bone is displaced backward, interference with speech and with swallowing may occur from pressure of the end of the bone upon the trachea and œsophagus. Injurious pressure upon the trachea may also occur from upward dislocation.

Treatment.—To reduce a dislocation forward the shoulder should be drawn outward and backward while pressure backward is made by an assistant upon the sternal end of the clavicle. The surgeon should put his knee against the spine of the patient and place his hands on the two shoulders. A backward dislocation will probably be reduced by a similar manipulation of the shoulder with or without the use of the fingers to lift the sternal end forward. The upward luxation may be reduced by drawing the shoulder outward and making direct pressure downward and outward upon the sternal end of the dislocated bone. The reduction in all forms of dislocation here is usually easy, but it is difficult to prevent recurrence of the displacement. The supine position in bed for several weeks, as in fracture of the clavicle, would perhaps be of advantage on this account after the dislocation is reduced. A bandage with a proper pad should be worn for several weeks if the patient remains out of bed as he usually does. Nailing the bone to the sternum with an aseptic nail will probably be efficient. Wiring may also be performed or the head of the bone may be excised, if it gives trouble from pressure.

FIG. 289.

Dislocation upward of the sternal end of the clavicle. (R. W. SMITH.)

Dislocations of the Scapula.

Pathology.—These injuries are often called dislocations of the acromial end of the clavicle; but, in accordance with the rule that the distal bone is the one said to be displaced, they are better called scapular dislocations. They are caused by direct violence or muscular effort. The scapula may be displaced below, above or behind the acromial end of the clavicle. In complete dislocations the coraco-clavicular ligament is torn to a greater or less extent, as well as the capsular ligament of the joint.

Symptoms.—The subclavicular dislocation is marked by the prominence of the clavicle upon the top of the acromion and the partial rotation of the lower angle of the scapula toward the spine due to the dragging weight of the arm. The pain and attitude of the patient resemble that in fracture at the outer end of the clavicle. Comparative measurements of the two clavicles will aid in determining that a dislocation rather than a fracture has occurred. Supraclavicular dislocation shows the acromion higher than the clavicle which has its outer end hidden beneath the overhanging acromion process. The postclavicular dislocation is rare, and gives a characteristic deformity due to the clavicle being in front of the acromion.

Treatment.—The treatment of subclavicular dislocation is usually not difficult as far as reduction is concerned. This is effected by drawing the shoulder upward and outward or backward, and at the same time making pressure upon the outer end of the clavicle. Reduction of supraclavicular luxation is effected by downward and backward traction upon the shoulder while the arm is parallel to the trunk. Counter-traction may be made by means of a sheet passed around the chest. Similar manipulations, or better, perhaps, drawing the shoulder forward, are indicated in the rare postclavicular dislocation. After reduction the elbow should be kept pushed upward by bandages to prevent recurrence of the deformity. A figure of eight bandage going under the elbow across the seat of dislocation and under the opposite axilla will perhaps give satisfactory support. A long strip of adhesive plaster so applied makes a good dressing. A pad may be placed upon the outer end of the clavicle to aid in maintaining the correct position of the joint. The forearm is to be supported in a sling. Wiring or nailing may be justifiable.

Dislocations of the Humerus.

Pathology.—The shallowness of the glenoid cavity, the loose capsular ligament, the great range of motion and the liability of direct and indirect violence to the humerus make luxation of this bone the most common of dislocations. Violent muscular contraction of epileptic and similar convulsions may cause the lesion. The capsule usually tears at its lower part, which is the weakest. The head of the humerus usually goes either forward or backward. Its final location depends upon the nature and direction of the force, and upon secondary movements of the bone. Occasionally the head is displaced directly downwards, but this is rendered difficult by the strong tendon of the long head of the triceps. For this reason the head of the humerus seldom lies directly beneath the glenoid cavity, but moves either forward or backward.

There has been much discussion as to the classification and nomenclature of dislocations at the shoulder joint. The principal forms may be grouped under three heads: (1) Forward; (2) Downward; (3) Backward.

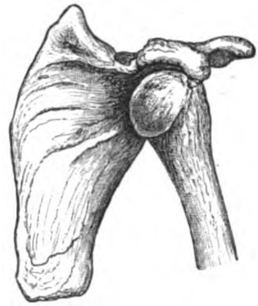
The forward dislocations comprise the axillary, the subcoracoid and the subclavicular. These are common.

The directly downward, or subglenoid, variety is for the reason mentioned above very rare. The axillary variety has sometimes been called subglenoid, and the subglenoid is sometimes regarded as a variety of the axillary dislocation.

The backward dislocations are rare and consist of the subacromial and the subspinous forms.

Symptoms.—The main symptoms of all these dislocations are pain, flattening of the outside of the shoulder, a hollow beneath the acromion which normally is occupied by the head and neck of the humerus, unnatural projection of the acromion, restricted motion of the joint with fixation of the upper arm, evidence of the head of the humerus in an unnatural site, a change in the axis of the arm and the impossibility, except perhaps in the posterior varieties, of bringing the elbow into close contact with the lateral aspect of the chest. The deformity varies to a certain extent with the variety of dislocation, which depends, as has been shown above, on the situation of the head of the bone. The characteristic deformity differs from that of fracture in that it can only be overcome by a definite procedure for reduction. When the dislocation has been reduced the symptoms at once disappear.

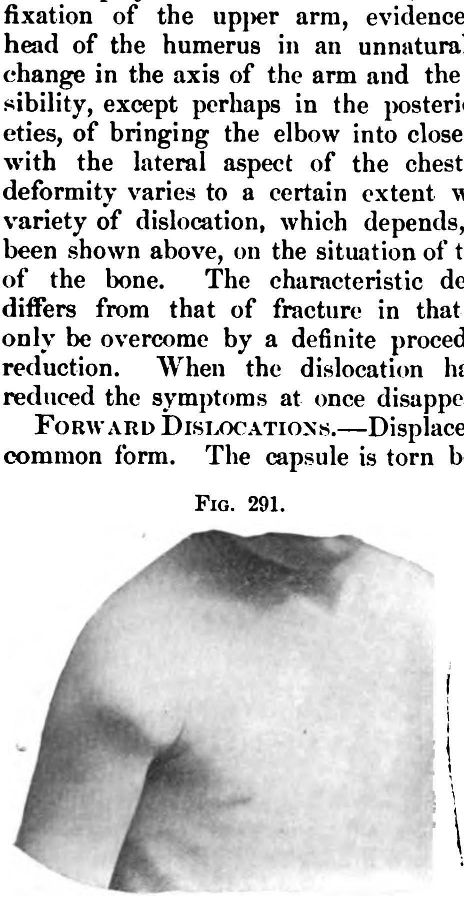
FIG. 290.



Subcoracoid dislocation of the humerus. (TILLMANNS.)

FORWARD DISLOCATIONS.—Displacement of the head forwards is the common form. The capsule is torn between the subscapular muscle and the long head of the triceps. The head may lie in the axilla close to the lower and anterior edge of the glenoid cavity; but usually, because of secondary displacement due to the tension of the muscles, it is drawn upward beneath the coracoid process. This tension of the muscles may be sufficient to draw it to the inner side of the coracoid process and up under the clavicle. The subcoracoid variety is the most common of all forms of dislocation at the shoulder joint.

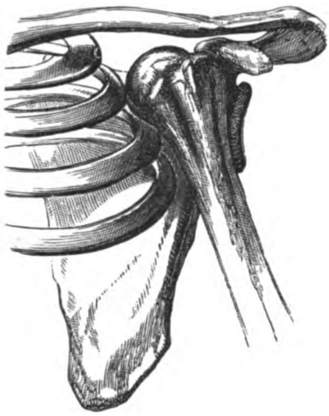
FIG. 291.



Osteoma of upper end of humerus resembling subcoracoid dislocation of humerus. Author's case.

Fracture of the surgical neck of the humerus, severe laceration of the muscles and damage to the vessels and nerves in the axilla may occur as complications. Injury to the circumflex nerve which supplies the posterior part of the deltoid muscle is probably the most common complicating lesion. When the head remains in the axilla, compression of the vessels and nerves is not unusual. In the subcoracoid and the axillary varieties the arm is lengthened. In the subclavicular form it is shortened. The arm is abducted and the hand cannot be

FIG. 292.



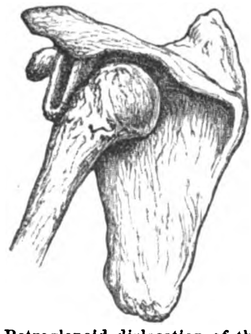
Subclavicular dislocation of head of humerus. (GROSS.)

FIG. 293.

Axillary dislocation of head of humerus. (GROSS.)

put upon the opposite shoulder when the elbow is pushed toward the chest. Rare variations of the forward dislocation occur; as when the head of the bone is pushed through the fibers of the subscapular muscle, when it in the axillary variety remains fixed in such a position that the arm is elevated and lies near the side of the head, and when because of fracture of the coracoid process or acromion the head of the bone is situated above the coracoid process.

FIG. 294.



Retroglenoid dislocation of the humerus. (TILLMANNS.)

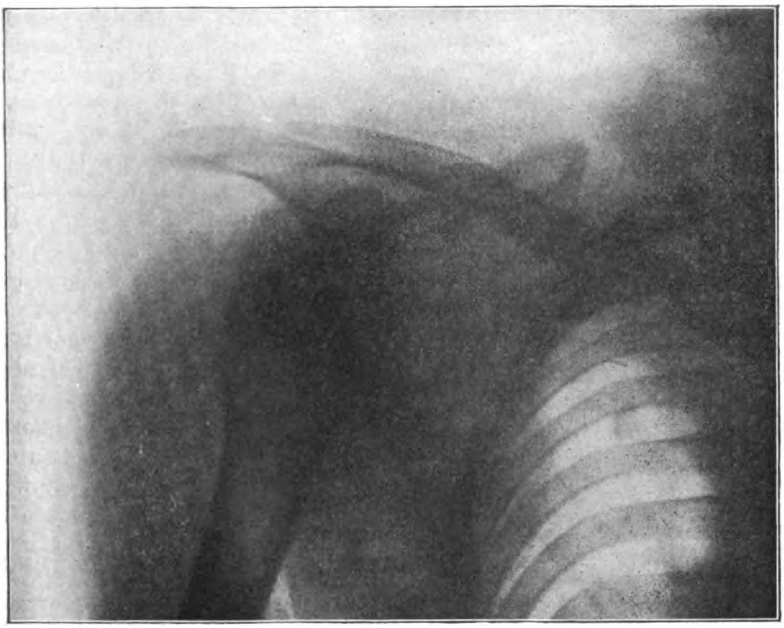
The demonstrable position of the head easily determines the variety of forward dislocation present. The symptoms are those mentioned previously as pertaining to dislocations of the humerus.

DOWNWARD DISLOCATION.—The true downward or subglenoid dislocation is rare for the reason mentioned. This form is unfortunately sometimes confused with the axillary variety of forward dislocation.

BACKWARD DISLOCATION.—This form of luxation is not common. The humeral head lies upon the scapula, beneath the acromion constituting the subacromial variety or far back so as to be called with propriety the subspinous variety. The elbow in this variety is rotated a little forward, though it is abducted as in other dislocations of the shoulder. It is possible in this variety to place the hand of the injured side upon the opposite shoulder while the elbow is close to the chest.

Treatment.—Dislocations of the shoulder are usually reduced without difficulty, if the attempt is made early and the patient etherized so as to prevent pain and relax the muscles. There are many methods, but most of them may be referred to one of two classes: (1) The manipulative or rotation methods, and (2) the extension or traction methods. The following is a successful means of the first class for forward and downward luxations:—Grasp the forearm with one hand, the arm close to the axilla with the other; flex the elbow, abduct the arm, making

FIG. 295.



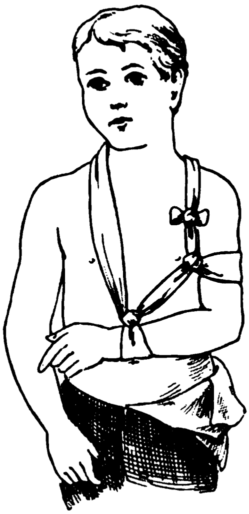
Skiagraph of subcoracoid luxation of humerus. (Case of Dr. T. G. K. Morton.)

at the same time some traction upon it and rotating it a little outwards; then rather suddenly rotate the arm inwards and carry it and the flexed forearm across the chest, while the fingers of the hand holding the upper arm press the upper end of the humerus outward. By these manipulations the head is disengaged from its position inside of, or under, the edge of the glenoid cavity and by a kind of leverage action is suddenly lifted over that edge; whereupon the muscles snap it into place. I have for many years found this method very serviceable. It agrees in the main with the general method of reducing all dislocations which I have long taught: namely, Make traction and counter-traction; move or rotate the limb in the direction in which the distal end of the luxated bone points, in order to disengage the head of the bone from the position in which it is locked; then suddenly move or rotate the limb in the opposite direction, in order to allow the head to be drawn by muscular contraction into the normal position.

In Kocher's method the elbow is flexed to a right angle and the upper arm pressed close to the side of the chest, then outward rotation of the arm is accomplished by carrying the forearm as far from the chest as possible, the elbow is next carried forward and upward, and finally the arm is rotated inward and the elbow lowered.

If these efforts fail, one or other of the traction methods may be tried. In that commonly employed the traction or extension is made downward with the unbooted foot of the surgeon in the axilla. After steady traction has been made upon the wrist for a few moments, the arm is carried across the patient's body so that the heel of the surgeon acts as a fulcrum in the axilla. Another method is by traction directly upward, while the surgeon's foot is placed on the top of the recumbent patient's shoulder, to fix the scapula, and an assistant presses the head of the humerus toward the glenoid cavity. If reduction is impossible, arthrotomy should be done.

FIG. 296.



Knotted sling.

Subsequent to reduction the arm should be kept quiet for five or six days; and extreme degrees of movement should be avoided for a number of weeks. There is no need of closely confining the limb by bandages even at first. A piece of bandage closely knotted around the arm, again around the forearm and then carried around the neck to the starting point on the arm makes an efficient restrictive apparatus. A simple sling is sufficient dressing after the fourth or fifth day.

The posterior luxations are to be reduced by abducting the arm up to the side of the head, rotating inward and making direct pressure on the head during abduction. If this is fruitless, the elbow may be grasped and drawn forcibly upwards while downward pressure is made on the shoulder by the other hand.

Old dislocations may occasionally be reduced by one or other of the methods proposed without difficulty, but will often require arthrotomy. The latter operation is safer than the employment of great force, which may tear vessels, lacerate nerves or break the bone. Arthrotomy permits reduction of the luxation or excision of the head of the humerus.

If fracture of the neck of the humerus and dislocation occur simultaneously, it may be necessary, because of failure to reduce the luxation, to do an arthrotomy and insert a strong hook into a hole bored into the head of the bone. By this hook a direct pull may be obtained, which will lift the dislocated head into the socket.

Conjoint Dislocations of the Radius and Ulna.

Pathology.—The radius and ulna together may be dislocated at the elbow joint backward, forward, inward or outward. There may occur at this joint divergent dislocation of the two bones, as, for example, when the ulna is luxated backward and the radius forward. Again, one bone only may be dislocated; as when the ulna is dislocated backward without any displacement occurring to the head of the radius or when the ulna retains its usual position and the head of the radius is dislocated forward, outward or backward. Of all these dislocations the conjoint dislocation of the radius and ulna backward is the most common. It is usually produced by indirect violence acting upon the forearm when the elbow is extended. The dislocation may be complete, so that the coronoid process lies behind the lower end of the humerus, or incomplete.

Symptoms.—The forearm is flexed upon the arm at about a right angle. The joint is almost or quite immovable, though occasionally considerable flexion and extension and even lateral motion may be possible. The forearm is shortened, the olecranon very prominent and a marked hollow is to be felt above the olecranon unless obscured by swelling. The deformity is somewhat like that of a fracture, but the absence of preternatural mobility and other symptoms of fracture can generally be proved. Sometimes fracture of the coronoid process exists as a complication. The dislocation is usually reduced with ease, if the reduction is attempted at an early period. The injury, however, in the course of a few days becomes difficult to reduce.

Conjoint dislocation forward is unusual, except when complicated with fracture, and is generally produced by direct violence. The forearm will probably be found supinated, lengthened and flexed at an acute angle. The tense tendon of the triceps and the lower end of the humerus are felt at the normal situation of the olecranon. The upper ends of the ulna and radius can generally be felt in the bend of the elbow. The olecranon may be broken off before the dislocation is produced. It is difficult for a complete dislocation forward to occur without fracture of the olecranon.

Conjoint lateral dislocations of the bones of the forearm are usually incomplete. The incomplete outward dislocation is the more common. In it the sigmoid cavity of the ulna lies upon the capitellum, which has been deserted by the displaced head of the radius. This produces some rotation of the bones of the forearm. The lateral diameter of the elbow joint is increased and the internal condyle is markedly prominent. The olecranon is displaced in the direction of the outer condyle, the forearm is partially flexed and pronated and rigidity of the joint is present. In inward dislocation, which is rare, the deformity is the reverse.

Treatment.—Reduction of the backward dislocation may usually be accomplished by making traction and counter-traction, extending the arm upon the forearm as much as possible and then quickly flexing the joint while the pressure backwards is made upon the lower end of the humerus. Another method is to place the knee of the surgeon in the bend of the injured elbow and grasp the wrist of the affected arm. Traction is then made and the elbow sharply flexed against the knee of the operator, which pushes the humerus backward as the bones of the forearm are drawn forward. Re-

FIG. 297.

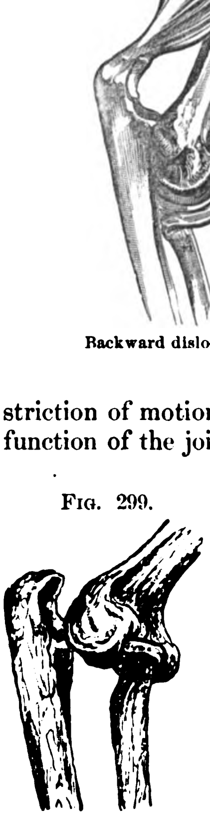
Backward dislocation of radius and ulna. (GROSS.)

FIG. 298.

Reduction of dislocation of radius and ulna backward. (HAMILTON.)

striction of motion for a week or so is then proper. Subsequently the function of the joint becomes practically perfect.

FIG. 299.



Divergent dislocation of the elbow (dislocation of the ulna backward and of the radius forward). (TILLMANNS.)

The luxation forward is to be reduced by traction and counter-traction, followed by hyper-flexion and sudden extension, accompanied by pressure upon the lower end of the humerus. Hyper-flexion, followed by direct pressure backwards upon the upper ends of the radius and ulna, may result in reduction of the luxation. The lateral dislocations are reduced by the same character of manipulation as the backward and the forward.

Divergent Dislocations of the Radius and Ulna.

These dislocations are exceedingly rare. Both bones are dislocated but do not accompany each other. The chief varieties are that in which the ulna is thrown backward and the radius forward, and the transverse, in which the ulna is displaced to the inner side and the radius to the outer side of the condyles. These injuries are to be diagnosticated and treated on general principles.

Dislocations of the Radius.

The head of the radius may be torn from its annular ligament and socket and be displaced either forward, outward or backward. The forward dislocation is the common one. The diagnosis is made by observing that the radial head is absent from its normal position but palpable in its new site, while the other bones hold their normal relations to each other. The reduction is accomplished by traction and counter-traction and direct pressure.

Dislocations of the Ulna.

Dislocation of the upper end of the ulna occurs only in the backward direction. In the complete form there is usually, if not always, a fracture of the radius near its upper portion or a fracture of the lower end of the humerus. A complete dislocation is rare. The forearm is flexed and sharply pronated. Reduction is to be accomplished in a manner similar to that used in dislocation of both bones.

Dislocation of the lower end of the ulna from its attachment to the radius occurs forward, backward or inward. The forward form is caused by violent supination of the hand; the backward, by forcible pronation of the hand. Reduction is accomplished by fixation of the radius and direct pressure upon the displaced ulna.

Dislocations of the Carpus.

This luxation occurs either forwards or backwards and must be distinguished from the very common fracture of the lower end of the radius. Fracture of the lower end of the radius with backward displacement of the lower fragment was long regarded by surgeons as a dislocation. The facts that such fractures are often impacted and that when the fragments are once reduced they retain their position are liable to lead to this mistake in diagnosis. The marked deformity and the discovery by palpation of the curved outline of the carpus as a prominence in an unusual place make the diagnosis of dislocation clear.

Reduction is to be performed by traction and counter-traction, with flexion followed by sudden extension in backward dislocation and extension followed by sudden flexion in the forward dislocation. Direct pressure upon the carpal bones or upon the lower end of the radius during these manipulations will perhaps aid in the restoration of the contour of the joint.

Dislocations of the Carpal Bones.

Dislocation of an individual bone of the carpus from the neighboring bones may occur in a backward direction. The displacement is apt to be accompanied by some rotation which renders reduction difficult. If reduction cannot be accomplished by pressure, an incision should be made and the bone replaced or excised.

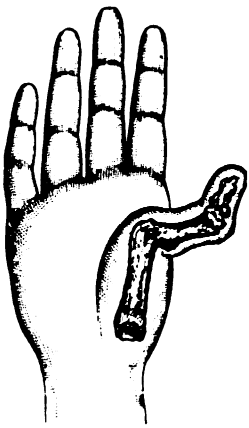
Dislocations of the Metacarpal Bones.

These dislocations are not common, except in the case of the metacarpal bone of the thumb. In that instance forward and posterior dislocations are not exceedingly rare, the forward is the more common. Traction and movement in the direction in which the distal end of the bone points with sudden movement in the opposite direction are to be employed.

Dislocations of the Phalanges.

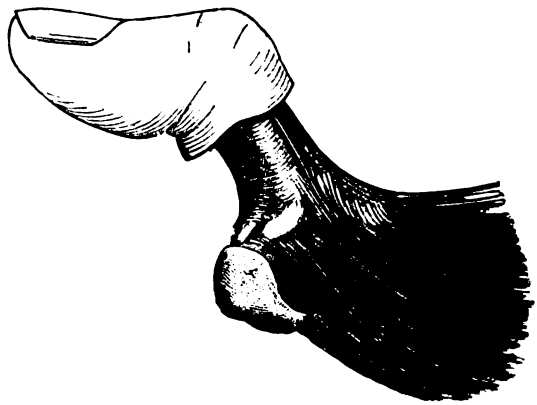
Dislocation at these joints occurs backwards, forwards and laterally. The injuries are not difficult of diagnosis if the examiner is careful to

FIG. 300.



Posterior dislocation of the thumb. (TILLMANNS.)

FIG. 301.



Simple complete dislocation; outer side. (FARABEUF.)

exclude the possibility of epiphyseal fracture. As a rule the luxation is easily reduced by traction and counter-traction with movements similar to those described in carpo-metacarpal dislocations.

The dislocation backwards of the metacarpo-phalangeal joint of the thumb is sometimes difficult to reduce. The characteristic position is that the proximal phalanx is extended and the distal one flexed. The trouble in reduction is due to the head of the metacarpal bone being thrust between the two heads of the short flexor muscle of the thumb and to interposition of the sesamoid bones. Reduction may be accomplished by extending the thumb upon the wrist strongly till it points towards the elbow, so that the base of the phalanx may press upon and separate the heads of the short flexor; and then strongly flexing the thumb. During the last movement pressure should be made upon the base of the phalanx so that it may not slip backwards. If this method fails subcutaneous tenotomy or open incision should be adopted. Some persons have the ability because of lax ligaments to voluntarily produce and reduce an incomplete luxation of this joint of the thumb.

Dislocations of the Femur.

Pathology.—Dislocation of the hip may cause the head of the femur to occupy many abnormal positions; but there are four positions which are so much more common than the others that they have been called the regular dislocations. The others are termed irregular. In the regular forms the ilio-femoral ligament, often called the inverted Y ligament, remains more or less intact and restrains the excursions of the head of the femur; while in the others its laceration permits the upper end of the femur to wander, under the influence of violence or muscular contraction, in almost any direction. The untorn bands of the ilio-femoral ligament are also of importance in the reduction of these dislocations, for they fix the trochanteric region so as to make a fulcrum there. They thus permit power applied to the lower end of the femur to act upon the upper end by a leverage action. The ligament is really a thickening of the capsule and extends from the inferior spine of the ilium to the greater and smaller trochanters. When an injury occurs which by indirect action causes the head of the femur to rate through the capsule and leave the acetabulum, the ilio-femoral ligament is as a rule untorn. If the head escapes posteriorly to it, a posterior or outward luxation occurs; if anteriorly, an anterior or inward luxation. In the posterior group the head may be displaced backwards and upwards and lie upon the dorsum of the ilium, or backwards and downwards and come to rest in the sciatic notch or on the ischium. In the first instance it is called an iliac dislocation, in the second a sciatic or ischiatic dislocation. Similarly an anterior dislocation may be inwards and upwards, when it is called suprapubic or pubic; or inward and downwards, when it is termed infrapubic, obdurator or thyroid. Among the irregular forms are the supracotyloid, infracotyloid and perineal.

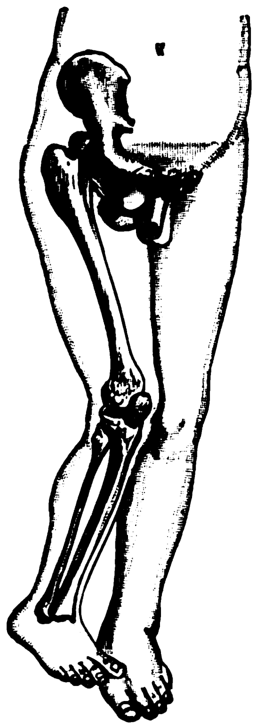
FIG. 302.

Ilio-femoral ligament. (BIGELOW.)

Symptoms.—*The posterior or outward dislocations* occur from violent flexion, adduction and inward rotation of the thigh, which pry the femoral head out of its socket and thrust it backwards. The head may lie below the tendon of the internal obdurator and be an ischiatic luxation or above it and be an iliac or dorsal luxation. The posterior dislocations are more common than the anterior.

In the iliac luxation the thigh is partially flexed on the pelvis and adducted, the knee is situated higher and further front than that of the other leg and may be in contact with the lower and inner portion of the opposite thigh, the foot is turned in and the great toe touches the inner portion of the opposite instep. The hip of the injured side is very prominent, the trochanter is higher than in the normal limb and the head of the bone can be felt on the back of the ilium. The limb is shortened from one to three inches, abduction is impossible, and adduction and flexion, while possible to a limited extent, are soon checked. In this and the ischiatic variety numbness and pain due to pressure on the great sciatic nerve may be present. The luxation may be originally an ischiatic one and become iliac through the movements of the patient.

FIG. 303.



Backward dislocation of the femur. (TILLMANNS.)

In the ischiatic dislocation the flexion of the hip is greater than in the iliac variety, but it may be masked by a compensatory lordosis of the lumbar spine. Inversion and adduction of the thigh are present, abduction is lost, the knee touches the opposite knee at the inner and upper part of the patella and the great toe touches the foot of the other side near the metatarso-phalangeal joint. The shortening is only about a half inch. The shortening is well shown by flexing the two thighs at a right angle with the pelvis. The top of the trochanter is, as shown by the ilio-ischiatic line of Nelaton, not so much displaced upward as in the iliac luxation.

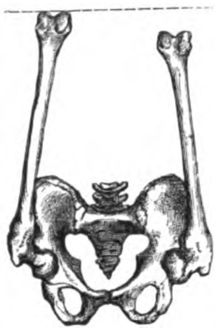
An everted dorsal luxation occurs, but it is rare.

The anterior or inward dislocations usually arise from over-extension of the hip with abduction and rotation outwards. They may, however, occur during flexion.

The suprapubic form has several variations in accordance with the exact spot at which the head rests upon the ramus of the pubes. The symptoms are flexion, abduction and eversion of the thigh, a prominence made by the femoral head on the top of the ramus of the pubes, pain and numbness from the anterior crural nerve being stretched over the displaced bone, marked shortening of the limb, flattening of the gluteal region, the trochanter absent from its normal site but found further toward the median line and near the acetabulum, the joint almost immovable and the foot turned outward with the heel raised.

In the infrapubic, obturator or thyroid form there is slight flexion of the hip, abduction and eversion. These deviations are less marked than the suprapubic in form. The leg has the appearance of being lengthened a little, the foot is everted, the hip flattened in the region of the great trochanter, and the head palpable under the adductors or by the finger in the rectum. The amount of motion, active or passive, is very slight, though it is said that the patient may be able to walk on the limb. Pain from pressure on the obturator nerve is to be expected. It is believed by some that the thyroid form is a common form and that it is sometimes converted into a posterior by secondary influences; since at times the capsule is torn in front of the ilio-femoral ligament, and yet a posterior luxation is present. If the displacement of the head is very great inwards the rare perineal dislocation is produced.

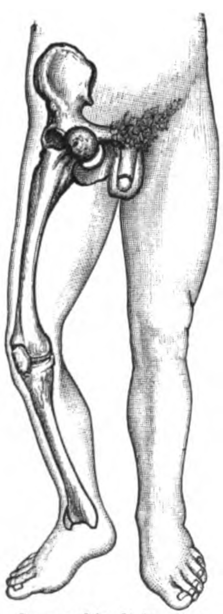
FIG. 304.



Allis's test for shortening in backward dislocation of femur.

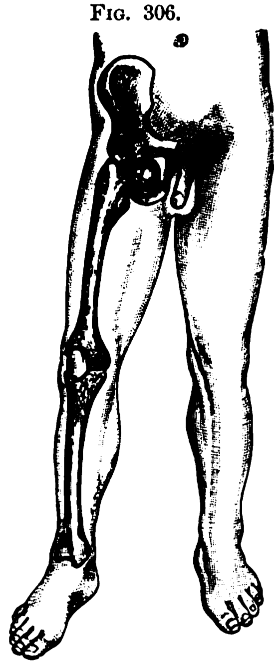
The diagnosis between fracture of the neck of the femur and dislocation of the ilio-femoral joint is very important, and is discussed

FIG. 305.



Suprapubic dislocation. (TILLMANNS.)

FIG. 306.

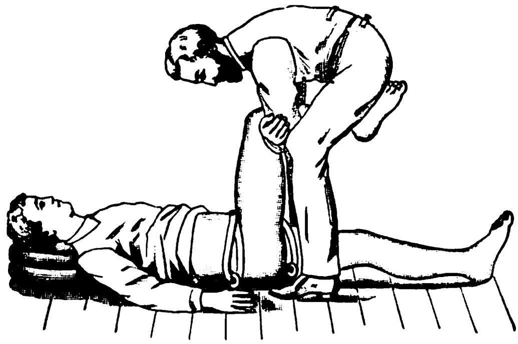


Infrapubic dislocation. (TILLMANNS.)

under fractures. Skiagraphy is of great value in differentiating luxations from fractures, and the different luxations from each other.

Treatment.—In reducing dislocations of the hip it is of the first importance that the pelvis should be fixed. This is perhaps best done by laying the patient supine upon the floor and fixing the pelvis with bandages to three strong rings or staples, inserted into the floor on each side of the pelvis and close to the perineum. It is hardly possible for an assistant to hold the pelvis steady during the necessary manipulations of the heavy thigh and leg.

FIG. 307.



Reduction of a backward dislocation of the hip by upward traction on the leg which is flexed at a right angle. (TILLMANNS.)

Allis, who has given a great deal of attention to dislocations of the hip, reduces the posterior dislocations by kneeling at the side of the patient, seizing the ankle with one hand and placing the bent elbow of the arm beneath the popliteal space; he then turns the foot and leg outward, so as to cause inward rotation of the thigh, and lifts the injured extremity upward toward the ceiling; he then turns the leg inward to cause outward rotation of the thigh and finally brings the leg and thigh down in extension. Reduction may sometimes be suc-

FIG. 308.

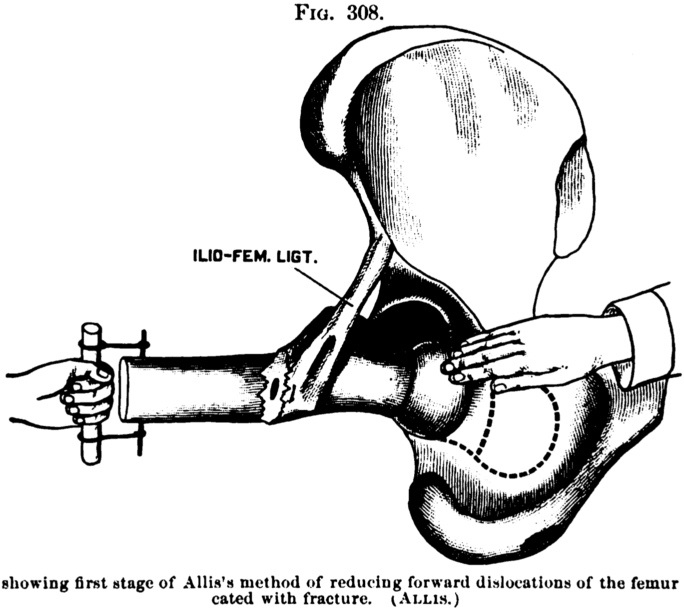


Diagram showing first stage of Allis's method of reducing forward dislocations of the femur complicated with fracture. (ALLIS.)

cessfully accomplished by upward traction of the thigh while it is in a position of right angle flexion with the trunk. The leg is finally abducted and extended.

The method proposed by Kocher is very similar to that advocated by Bigelow. He rotates the thigh inward, flexes the hip to a right angle, draws the thigh upwards, rotates outwards and extends. The purpose of these movements is to first relax the capsule and ilio-femoral ligament and lift the

FIG. 309.

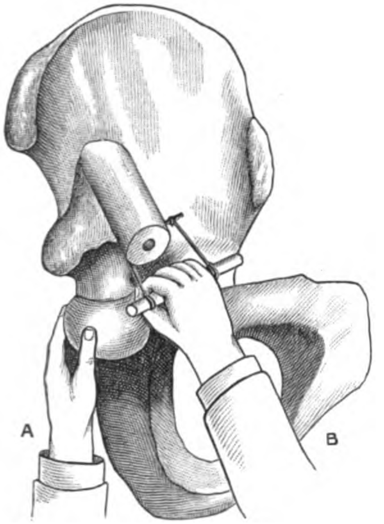


Diagram showing second stage of Allis's method of reducing forward dislocations of the femur complicated with fracture. *A*, hand of assistant ; B, hand of operator. (ALLIS.)

FIG. 310.

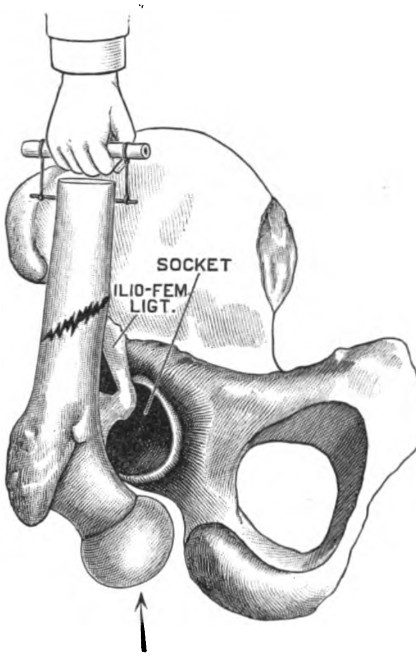


Diagram showing first stage of Allis's method of reducing posterior dislocations of the femur complicated with fracture. The arrow represents the direction of the pressure made by the assistant. (ALLIS.)

head from the posterior surface of the pelvis and make it movable by the inward rotation. The flexion of the thigh to a right angle brings the head downward to the tear in the lower part of the capsule. The upward pull puts the ilio-femoral ligament and the capsule on the stretch and the head is lifted close to the border of the acetabulum. The outward rotation makes tense the ilio-femoral ligament and allows the head to be thrown into the socket by the leverage upon the other extremity of the thigh. These manipulations correspond with the general statement already given for the reduction of dislocations ;—to rotate or move the bone in the direction toward which the distal end points in order to disengage the head of the bone and then move it in the other direction to throw the head of the bone into the socket.

The anterior, or inward, dislocations are reduced, according to Allis, by the following manœuvres. Flex and abduct the femur, make traction outward, fix the head by digital pressure made upon it by an assistant and adduct the femur. He states that adduction should not be made until traction outward has been applied. Bigelow's instructions are to flex the limb towards the perpendicular, abduct a little to disengage the head from the bone, then rotate the thigh inwards, adducting it and carrying the popliteal space down to the floor. The anterior luxations may sometimes be satisfactorily reduced by placing the patient with his hips on the margin of a table; making hyper-extension of the thigh; following this by flexion with simultaneous pressure upon the head of the bone and finally rotating inward.

FIG. 311.

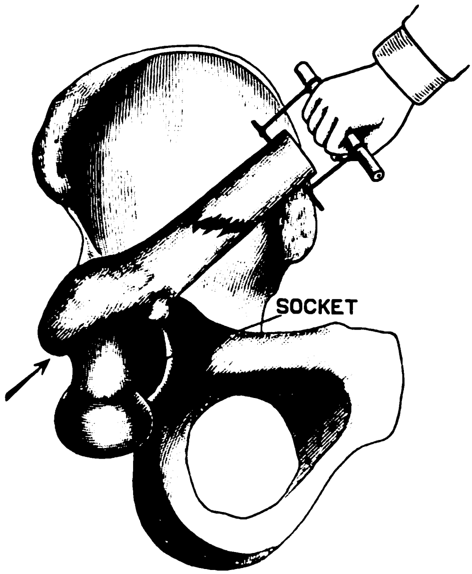


Diagram showing second stage of Allis's method of reducing posterior dislocations of the femur complicated with fracture. The arrow represents the direction of the pressure made by the assistant. (ALLIS.)

The rare everted dorsal dislocation should be converted into the ordinary dorsal before reduction is attempted. The conversion effected by flexion and inward rotation with perhaps adduction.

If the efforts at reducing a dislocation at the ilio-femoral joint cause the sciatic nerve to be hooked up in front of the neck of the femur, the immediate effect, according to Allis, will be flexion of the thigh upon the pelvis and of the leg upon the thigh, owing to the sudden shortening of the nerve. This will also cause a cord-like structure, to be seen or felt in the popliteal space, which can be made to rise and disappear by extension and flexion of the leg on the thigh. To remedy this condition Allis proposes to redislocate the femur, cut down upon the nerve in the middle third of the back of the thigh and draw it out of the wound with the finger. The dislocation is then reduced, the nerve allowed to slip back into the wound and the incision closed.[1]

A formidable complication of dislocation of the head of the femur is fracture of the shaft. Allis reduces the dislocation accompanied by fracture by using the connection between the fragments, which is partly periosteal, partly tendinous and partly muscular, to make traction upon the upper fragment. He calls attention to the fact that rotation, circumduction and leverage through the agency of the lower fragment

[1] An inquiry into the difficulties encountered in the reduction of dislocations of the hip. By Oscar H. Allis, M.D., Philadelphia. 1896.

is impossible. He reduces forward dislocations accompanied by fracture by making traction outward, with pressure upon the head by the hand of an assistant. If this is unsuccessful the head must be held in position beneath the socket to which it has been drawn, while the surgeon reverses the direction of traction and makes it inward or obliquely inward and downward.

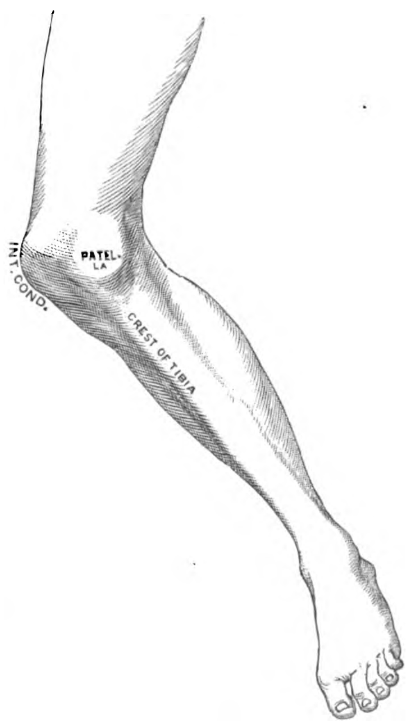
In the posterior dislocations the principle is the same. Here the traction is directly upward followed by traction upward and inward and accompanied all the time by pressure of the hand of an assistant upon the head of the trochanter to keep the upper end of the bone from slipping backward.

After reduction of dislocations of the hip the patient should remain in bed for a couple of weeks. If a fracture be present as a complication, the time of treatment must be extended accordingly.

Old Dislocations of the Femur.

Luxations which have been allowed to remain unreduced have been successfully replaced a long time after the injury. Careful attempts should therefore be made at reduction even if the length of time is a number of months. Great care must be taken, however, that damage is not done to the soft parts or fracture of the neck of the bone caused by the manipulation. Arthrotomy, followed by excision of the head of the bone, or an osteotomy of the neck is better than using great force or persisting for a long time in the efforts at reduction.

FIG. 312.



Incomplete lateral dislocation of the tibia. (Author's case.)

Dislocations of the Tibia.

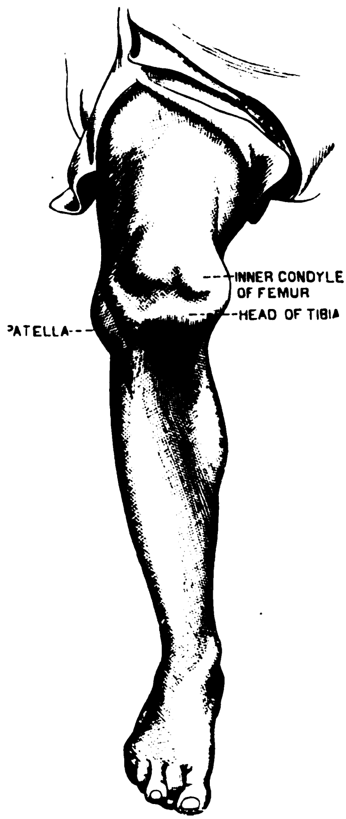
The tibia may be dislocated forwards, backwards, outwards and inwards at the knee. A rotary dislocation may be produced by a twisting force. Complete dislocations of the knee are apt to be associated with great damage to the soft parts. The popliteal vessels and nerves are liable to be stretched or ruptured. Thrombosis may occur in the vessels from injury, insufficient to actually rupture them, and cause gangrene. The deformity is usually very great and the diagnosis in the complete dislocations easy. A lateral dislocation can hardly be complete without rupture of the soft parts sufficient to make it an open dislocation. Reduction is accomplished by

FIG. 313.

Author's case of ancient backward luxation of the tibia with ununited fracture of patella.

traction and counter-traction, with pressure upon the end of the bone. Flexion of the knee may aid in the replacement. Hyperextension is dangerous because of a possibly injurious tension being put upon the popliteal vessels, though it would otherwise seem to be a valuable adjuvant.

FIG. 314.



Author's case of unreduced dislocation of patella.

Dislocations of the Patella.

The patella may be dislocated outward or inward, it may be rotated upon its axis so as to stand upon one edge, or it may be turned entirely over so that the cartilaginous surface is directly under the skin. The outward displacement is more common than the inward, because of the oblique manner in which the muscular and tendinous fibers of the extensor muscle are attached to it and because of the size and shape of the articular surface of the external condyle. The other dislocations of the patella are rare. Muscular contraction as well as direct violence may cause the luxation.

The symptoms are change in shape of the joint and absence of mobility. In reducing a dislocation of the patella the quadriceps extensor muscle should be relaxed as far as possible by flexing the hip and extending the knee. Direct pressure may then be sufficient to replace the luxated sesamoid bone. Rapidly succeeding partial flexions and complete extensions of the leg, with manipulation of the bone and pressure in a direction opposite to that of the dislocation will sometimes be effective when other means fail. Incision so as to give direct access to the bone is proper when manipulation has been unavailing.

Dislocations of the Semilunar Cartilages.

Dislocation of the intra-articular cartilages of the knee may occur as the result of excessive flexion or a sudden wrench of the joint. The displacement is generally backwards, but it may be forwards. The inner cartilage is more apt to be displaced than the outer one. When the displacement is towards the periphery the cartilage may project as a ridge at the upper border of the tibia. A relaxed knee joint or previously injured crucial ligaments may be predisposing causes. The cartilage when pressed out of place may become crumpled or bent upon itself and wedged between the femur and tibia. During stooping, kneeling, or excessive flexion of the knee during gymnastic performances or otherwise, a sudden intense sickening pain is felt in the joint. The joint becomes locked in extreme flexion and cannot be extended. The patient may be thrown down by the sudden pain occurring under such circumstances. Sometimes the accident occurs in knees predisposed to the injury, when the joint is only partially flexed. The tibia and femur are sometimes seen to be separated and the displaced cartilage may be felt in the interval. If the displaced cartilage is not replaced, synovitis of the joint soon occurs.

Quite often the patient himself is able to reduce the dislocated cartilage, relieve the pain and restore the motions of the joint. Reduction is almost always quickly accomplished by hyperflexion of the joint, accompanied by traction and sudden full extension. The joint should be immobilized for about three weeks in a gypsum dressing or splint after the cartilage has been replaced. It is well for the patient to wear some sort of supporting bandage or knee cap which will prevent him flexing the joint fully.

When there is a tendency for the accident to recur it is proper to open the joint and sew the semilunar cartilage to the fascia and periosteum at the head of the tibia. Arthrotomy is also proper if it is impossible to reduce the cartilage properly on account of it being bent or crumpled. Under such circumstances it may be wiser to remove the cartilage entirely.

Dislocations at the Tibio-Fibular Joint.

The upper end of the fibula may be dislocated from its articulation with the tibia forwards and backwards. The deformity is easy of detection. Reduction is to be obtained by flexing the knee and making pressure on the displaced bone. Recurrence is to be averted by a plaster of Paris splint; or the bone may be nailed to the tibia. An upward luxation may take place when the bone is detached at both the lower and upper articulations and pushed bodily upwards. Dislocation at the lower tibio-fibular joint is even more rare than at the upper, unless it occurs in connection with fracture.

Dislocations at the Tibio-Tarsal Joint.

The foot may be dislocated from the tibia and fibula backwards, forwards and laterally. The lateral dislocations are accompanied by fracture of one or both malleoli and are probably best considered as fractures permitting displacement of the joint surfaces. The posterior luxation of the tarsus causes marked lengthening of the heel ; the anterior luxation causes shortening of the heel. These dislocations are reduced by flexing the knee to relax the calf muscle, making traction and suddenly flexing or extending the foot upon the leg. If necessary, the tendon of Achilles may be cut subcutaneously to lessen muscular resistance. The astragalus with the attached foot may be dislocated upwards between the ends of the tibia and fibula without fracture of these bones. Traction and manipulation and excision of the astragalus are possible methods of treatment.

Dislocations of the Tarsal, Tarso-Metatarsal, Phalangeal and Inter-Phalangeal Joints.

Dislocation of the calcaneum and scaphoid from the astragalus may occur and is called subastragaloid dislocation. Some writers speak of this luxation as a dislocation of the astragalus. Other dislocations may occur among the tarsal bones. Reduction may be attempted by pressure, after relaxing the muscles by flexion of the knee and manipulation of the ankle. If this fails, arthrotomy and excision are proper.

The metatarsal, phalangeal and interphalangeal luxations resemble the corresponding lesions of the hand and require similar treatment.

OPERATIONS UPON JOINTS.

Aspiration.

Aspiration of a joint is performed with a sterile aspirating needle thrust into the articular cavity at a point where the synovial sac is near the surface of the limb. It is valuable to relieve tension and pain in acute synovitis, to withdraw the articular effusion and blood accompanying fracture of the patella ; and to make certain that the fluid in a distended joint is purulent. If purulent fluid escapes through the aspirator, incision into the joint cavity must be done at once. Septic fluids in joints are very dangerous and lead quickly to pyæmia.

Arthrotomy.

Incision into a joint is called arthrotomy, whether it be done for establishing drainage, removing foreign bodies, permitting exploration or for any other purpose. The incision should be large enough and made where the cavity of the joint is near the surface. The cut should be similar to that described for excision of the special joint. For establishing drainage in purulent and septic cases there should usually be two or more incisions, through which drainage tubes should be placed to permit daily irrigation with sterile salt solution or very weak antiseptic solutions (corrosive sublimate 1:5000).

Arthrectomy.

Erasion, or arthrectomy, consists in cutting away or scraping away with the curette the synovial membrane, cartilages and superficial portion of bone which are diseased. Only the diseased tissue is removed, and much of the joint function may be preserved. It is used almost exclusively in tubercular arthritis, and requires arthrotomy to be done first.

Excision or Resection of Joints.

These terms are now used as synonyms and mean, when applied to joints, that the articular surfaces of one or both bones, with the synovial membrane and cartilages, are cut away. If the end of one bone only is removed it is a partial excision. If the joint has been destroyed by arthritis and a bony ankylosis remains, cutting away the bone at the seat of the synostosis is still called an excision of the joint. The object of excision is to remove the diseased or injured bone and soft parts of the joint, to correct the deformity of ankylosed articulations, to establish a false joint or sometimes to obtain a stiff limb by obtaining bony ankylosis instead of a movable joint. The last object is at times desirable when the usefulness of a knee or ankle is impaired by paralysis and a stiff joint will give better use of the leg. Tubercular arthritis is probably the most common cause of excision. Excision may often be employed instead of amputation in gunshot and other injuries to joints.

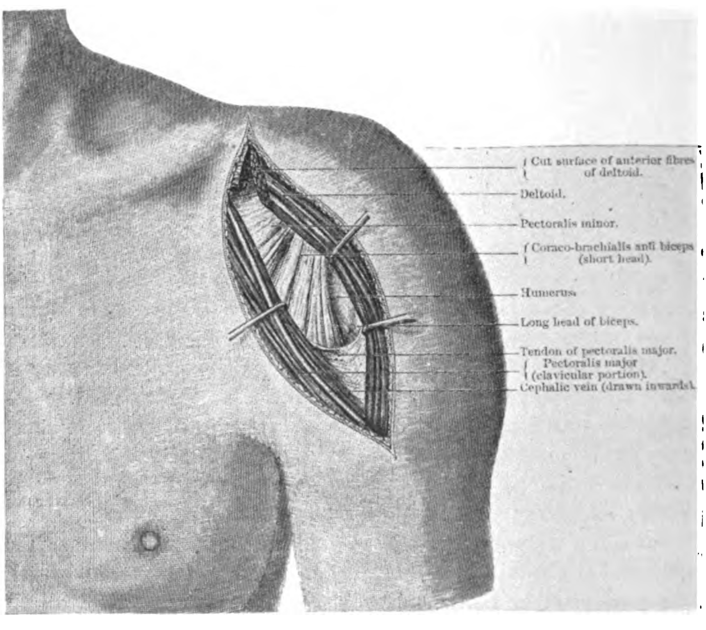
The incisions should be made so as to preserve as far as possible the soft parts external to the joint, to avoid important vessels and nerves, to give room to thrust the bone ends through the cut and permit the use of the saw or chisel, and to preserve the attachments of the tendons. The joint is exposed by an appropriate incision or incisions, the capsule divided, the bone ends cleared of soft parts and thrust through the wound and sawed off. The removal of bone in the young should avoid if possible injury to the epiphyseal cartilage, lest the growth of the bone be impaired. A limb is necessarily shorter than normal after excision; and if the lower extremity, it should be lengthened by wearing a shoe with a high sole or metal extension. An excised joint in the lower limb needs for a long time after operation a brace, to enable it to bear the weight of the body and to prevent muscular displacement of the bones. It is not, as a rule, necessary to suture, nail or screw the bones together, because union takes place as in fractures if the osseous structures are kept in apposition by gypsum splints or other devices for a few weeks. When it is desired to have a false joint, or pseudarthrosis, established a considerable portion of each component of the joint is removed and no attempt is made to obtain union by the protracted use of retentive apparatus or splints. If muscles or tendons are divided during the operation, they should be united with sutures of chromicized or formaldehyde cutgut. The Esmarch apparatus for producing artificial anæmia may or may not be used. Sometimes better access is given to the bone and the surgeon is better able to strip the soft parts from the bones by making two incisions. It is not worth while to endeavor to retain the periosteum covering the portions of bone to be removed. Subperiosteal excisions, as these operations with retention of the periosteum are called, are theoretically desirable ; but practically they are often impossible and sometimes, as in tubercular arthritis, undesirable. Some authorities preserve, not only the periosteum, but try to protect the ligamentous capsule as far as possible from incision and laceration by chiselling loose the bony attachments of the ligaments rather than cut the ligaments.

EXCISIONS OF SPECIAL JOINTS.

Excision of the Temporo-Maxillary Joint.

This articulation is easily exposed for excision by an incision an inch

FIG. 315.



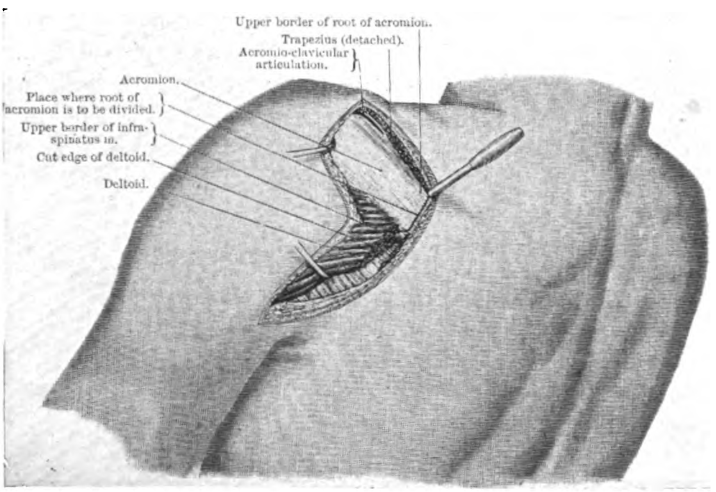
Resection of the head of the humerus by the anterior oblique incision. (KOCHER.)

and a half long running vertically downward from a point just behind the middle of the zygoma. The neck of the mandible is divided with saw, forceps or chisel and the ligaments incised to allow the removal of the condyle. Osteotomy of the neck may be just as efficient, in cases of ankylosis, as excision.

Excision of the Shoulder Joint.

This operation is satisfactorily accomplished by an oblique incision in front, when the humeral head alone is diseased; and by a posterior

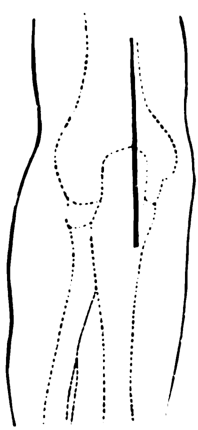
FIG. 316.



Arthrotomy and resection of the shoulder joint by the posterior curved incision. The acromio clavicular joint is opened; the trapezius is detached; the posterior border of the deltoid is divided the root of the acromion is chiselled across. (KOCHER.)

curved incision with osteoplastic section of the acromion, when the glenoid fossa of the scapula is also involved. The anterior incision begins at the clavicle above the coronoid process of the scapula and runs downwards and outwards along the anterior edge of the deltoid muscle, avoiding the cephalic vein which is displaced inwards. The fibers of the deltoid are divided close to the clavicle, but in the rest of the wound the muscle is drawn outwards. The sheath of the long head of the biceps is opened, the capsule incised longitudinally and the muscles detached while rotating the head of the bone in appropriate directions.

FIG. 317.



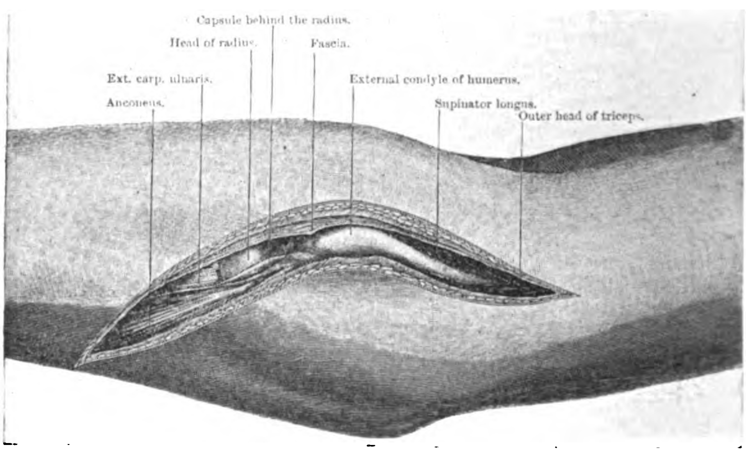
Excision of elbow joint. Line of incision.

The posterior method is begun by a cut starting at the acromio-clavicular joint, carried over the top of the shoulder along the upper edge of the acromion to the base of that process and thence downwards and outwards in a curved direction to a point two inches above the posterior fold of the axilla. The acromio-clavicular joint is opened, the acromion cleared of muscular attatchments at its base, the posterior fibers of the deltoid cut and the saw or chisel applied to the root of the acromion. Then this detached process and the deltoid are turned forwards and the capsule opened longitudinally. The acromio-deltoid flap is replaced after the joint surfaces have been sawed or chiselled away. The acromion may or may not be sutured. A retentive dressing or a gypsum splint is then applied.

Excision of the Elbow Joint.

It is important in excision of the elbow to avoid injury to the ulnar nerve, which lies in the hollow behind the internal epicondyle, and to preserve the tubercle of the radius and the base of the coronoid process to which are attached the biceps and the anterior brachial muscles respectively. A longitudinal incision on the back of the joint, a little inside of the middle line of the olecranon gives in most cases sufficient

FIG. 318.



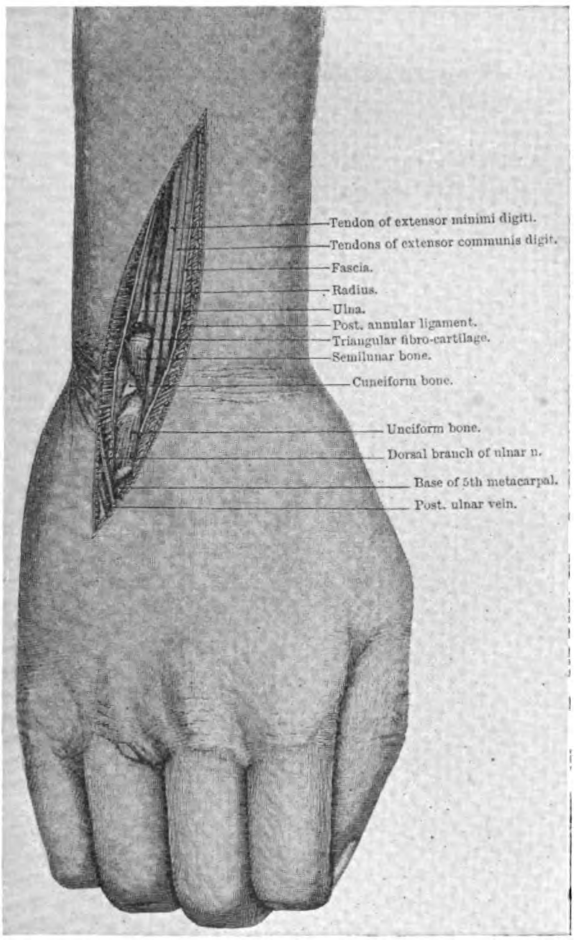
Arthrotomy of the elbow by the dorso-radial angular incision, which extends between the supinator longus and outer head of the triceps above and along the outer border of the anconeus, and between it and the origin of the ulnar extensor of the carpus below. (KOCHER.)

room. The cut should be about four inches long. Instead of this incision, one may be made on each lateral aspect of the joint :—a long one on the radial, a short one on the ulnar side,—or an angular wound may be made on the dorsum and radial surfaces. The angular incision is begun at the external supra-condyloid ridge, about two inches above the line of the articulation, and is carried downwards nearly parallel with the axis of the humerus to the head of the radius. Then its course is altered and it runs to a point over the posterior border of the ulna about three inches below the tip of the olecranon. In the latter part of its course it follows the line of the outer border of the anconeus. After the attachments have been sufficiently severed, the forearm is drawn inwards so as to cause protrusion of the upper ends of the radius and ulna through this wound. Splints should usually be applied so as to have the elbow slightly flexed and the hand pronated. The right angle position of the elbow is more likely, it is said, to cause a flail-like limb and interfere with the formation of a satisfactory false joint.

Excision of the Wrist Joint.

The advantages of retaining the fingers and hand, whenever possible, in the operative surgery of the upper extremity make excision of

FIG. 319.



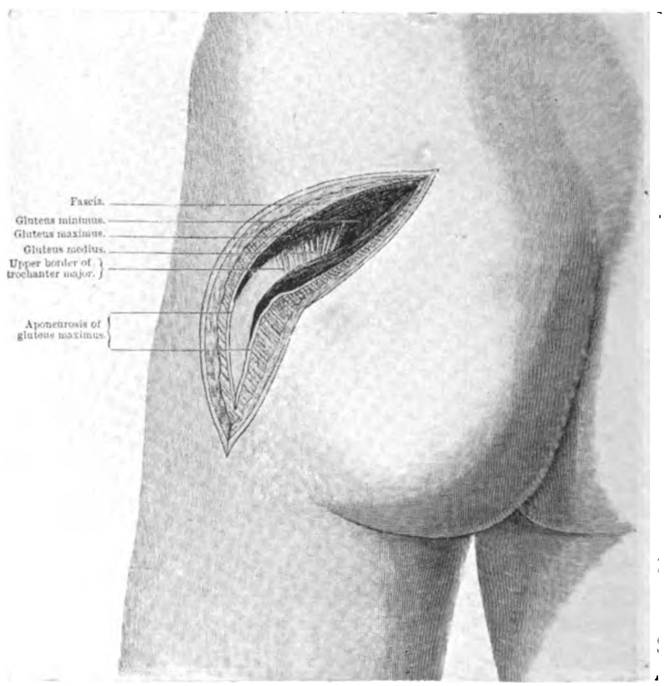
Resection of the wrist by the dorso-ulnar incision carried through the capsule. (KOCHER.)

the wrist a desirable and important operation. Complete excision consists in the removal of the lower ends of the radius and ulna and the first row of carpal bones with the exception perhaps of the pisiform. Sometimes the bones of the second row and even the bases of the metacarpal bones may be excised. A dorsal incision four or five inches in length is made, running from the middle of the metacarpal bone of the middle finger upwards over the middle of the wrist joint. It corresponds to the interval between the tendons of the common extensor of the fingers and the extensor of the index on one side and the extensor of the second phalanx of the thumb on the other. The cut may be made nearer the ulnar side of the wrist, if the operator prefer. The tendons are displaced laterally or detached. If it is necessary to divide any, they are marked to avoid confusion and subsequently sutured.

Excision of Metacarpal, Metacarpo-Phalangeal and Inter-Phalangeal Joints.

These joints are excised through longitudinal incisions on the dorsal surface: The bone cutting forceps is a useful instrument with which to divide the bone.

FIG. 320.



Resection of the hip by posterior angular incision. The skin, fascia and aponeurosis of the gluteus maximus have been divided. The lower border of the gluteus medius and the outer surface of the great trochanter are exposed. (KOCHER.)

Excision of the Hip Joint.

When the hip is excised, the femoral head alone is usually removed; though at times it may be necessary to scrape or chisel away the acetabulum. The smaller trochanter to which the ilio-psoas muscle is attached should be preserved if possible. Usually this may be done. A longitudinal incision behind the posterior border of the great trochanter or a posterior angular incision further back will be found satisfactory for resection of this articulation. The longitudinal cut is begun one and a half inches above and a little behind the greater trochanter and continued downward in a vertical line for five or six inches. The capsule is opened and the femoral neck divided by an osteotome or saw. The head is then seized with forceps and removed after dividing the round ligament within the joint. The acetabulum is then dealt with, if need be, with gouge or curette.

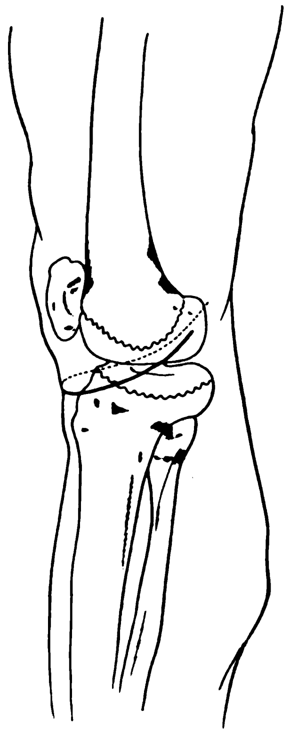
The posterior angular incision is made by inserting the knife at the base of the greater trochanter, on the outer surface of the hip, and cutting upwards to the anterior superior angle of that prominence; then the incision changes its direction and extends upwards and inwards in a line parallel with the fibers of the great gluteal muscle. A gypsum splint or traction apparatus will steady the limb after the operation.

As fibrous or bony ankylosis is usually expected and wanted, passive motion is not performed. It may be well to keep the limb slightly abducted, as adduction is likely to occur. A high soled shoe is worn to give length to the limb.

Excision of the Knee Joint.

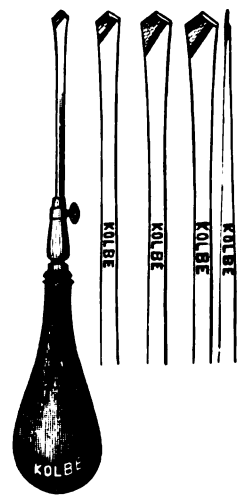
In knee joint resection the popliteal vessels and nerves must be preserved from injury. The object of the operation is to obtain ankylosis in the extended, or rather in the almost completely extended, position. There is a tendency to posterior dislocation of the tibia or flexion of the joint after excision of the knee, due to the action of the powerful flexor muscles. This is to be avoided by wearing a metal brace to support the joint, until the tendency no longer remains and the ankylosis is firmly established. It is also prevented to some extent at least by sawing the femur so as to make it convex and the tibia so as to make it concave. A curved incision, with its concavity upwards, across the leg just below the patella is the best method of opening the joint. In most cases it is best to remove the patella as well as the ends of the femur and tibia. This transverse curved incision must have its ends far enough behind to encircle two thirds of the circumference of the limb. The skin and fascia are dissected upwards, leaving at first the ligament of the patella and the bone itself uninjured. The aponeurosis of the quadriceps, in which the patella is imbedded, is cut loose from that bone; the ligamentous capsule, the synovial membrane, which runs far up under the quadriceps, and the semi-lunar cartilages, as well as the patella and the ligament of the patella, which is now divided, are then dissected out. This is a better method probably than that which divides the ligament of the patella when the cutaneous incision is made. The ends of the femur and tibia are readily protruded after the ligamentous capsule has been removed, and the saw is applied so as to avoid injury to the epiphyseal cartilages. Sutures or nails may be employed to hold the bones in apposition but are not necessary, if a good splint of gypsum, metal or wood is adapted to the limb. A high soled shoe is worn to compensate for the removal of bone.

FIG. 321.



Resection of the knee. (KOCHER.)

FIG. 322.

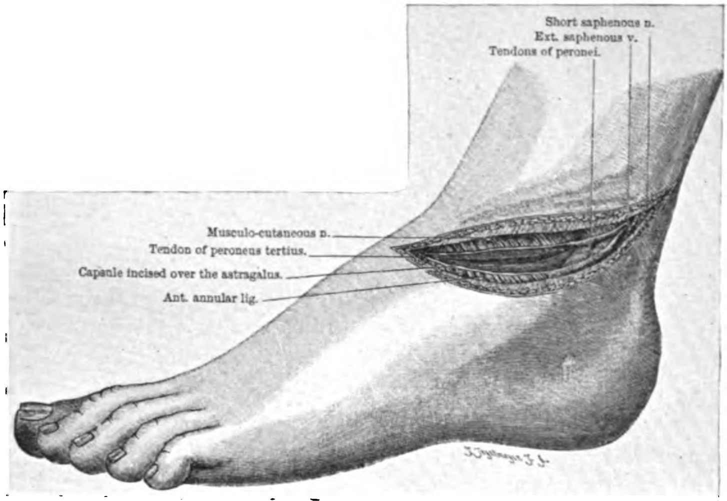


Bone drill for use in suturing bones after excisions.

Excision of the Ankle Joint.

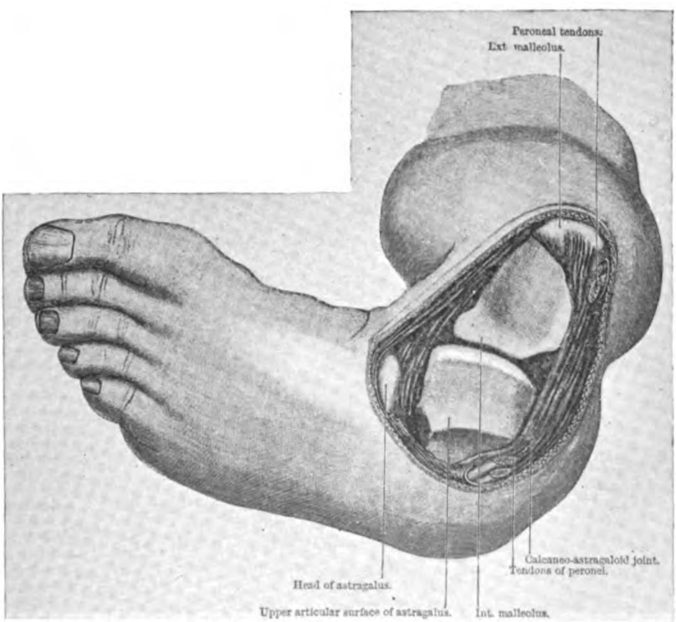
This operation is satisfactorily performed by a semilunar incision on the outside of the joint, extending from the anterior aspect of the joint around under the external malleolus and upwards along the external edge of the tendon of Achilles. The long and short peronei muscles may require division; but in some cases they can be displaced backwards. If they are cut, they are subsequently sutured. The lower end of the fibula is cleared of soft parts, the external ligaments cut and the foot bent strongly inwards so as to expose the joint thoroughly. The necessary amount of bone is then removed.

FIG. 323.



External transverse curved incision for arthrotomy and resection of the ankle joint. (KOCHER.)

FIG. 324.



Resection of the ankle joint by the transverse curved external incision. Second step: dislocation of the foot inwards. Peroneal tendons cut across. (KOCHER.)

FIG. 325.

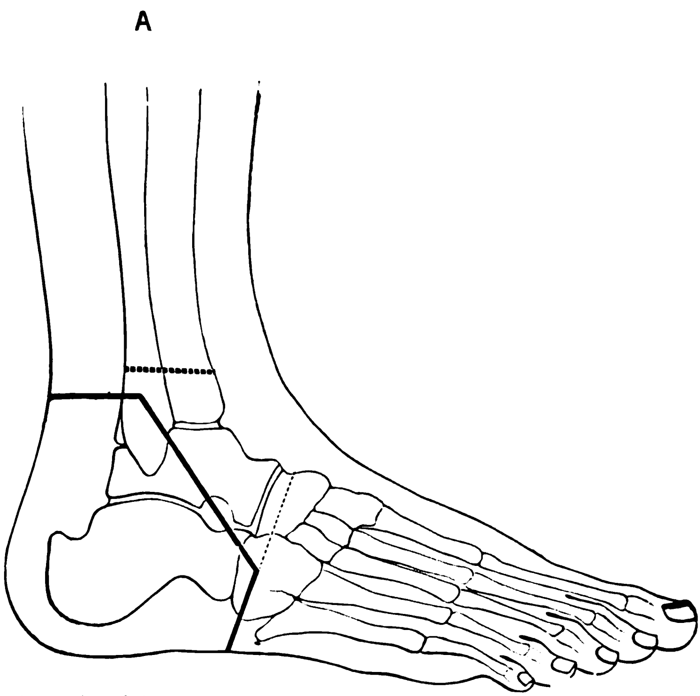
Results of an osteoplastic resection of the foot by the method of Mikulicz. (PARK.)

Excision of the Tarsal, Metatarsal and Interphalangeal Joints.

These joints are excised by dorsal or lateral incisions in a manner similar to that adopted in the hand.

Various resections have been devised, to give length to the limb and avoid the necessity of an artificial leg or foot, in cases of bone disease or incurable ulceration. Among the most interesting is that for removing the heel and much of the tarsus illustrated in the cuts.

FIG. 326.



Osteoplastic excision of the foot. The dotted lines show the sections through the bones. The solid lines show the incisions in the soft tissues. (MIKULICZ.)

CHAPTER XX.

SURGICAL DISEASES OF THE RESPIRATORY ORGANS.

DISEASES AND INJURIES OF THE NOSE.

Foreign Bodies in the Nose.

SMALL stones, beads and peas are occasionally pushed into the anterior nostrils by children and become fastened in the nasal chambers. Very rarely small seeds or fruit stones may get into the posterior nostrils during vomiting. Such foreign bodies, if allowed to remain, set up inflammation of the mucous membrane of the nose and give rise to an offensive discharge which sometimes is mistaken for grave disease of the nasal structures. Foreign bodies should be removed from the nasal cavities by a small hook, such as comes in pocket cases, a strabismus hook or some similar instrument. It is usually necessary for the surgeon to illuminate the nasal cavities by means of a forehead mirror. When foreign bodies cannot be removed in this manner they may be washed out of the nostrils by means of a douche. The tube of the douche is placed in the nostril opposite to the one which is occluded, while the patient's head is bent forward with the mouth open. The stream of water then passes around the posterior border of the septum and into the closed nostril behind the foreign substance. This is then washed out by the current coming from behind. The foreign body might be pushed back into the pharynx and thus removed, but there is danger of it falling into the glottis and of producing asphyxia. It is better, therefore, to extract such substances from the anterior nares.

Rhinoliths, or nose stones, are concretions of phosphate of lime and mucus which sometimes form in the nose, having for their nuclei small crusts of secretion or foreign bodies. These rhinoliths should be removed in the same manner as foreign bodies. If they are large they can be crushed previously with a pair of forceps.

Epistaxis.

Pathology.—Bleeding from the nose may be the result of injury, or it may occur as a symptom of fibroid or malignant tumors in the nose or pharynx. It occasionally occurs spontaneously; and is due in such cases to congestion of the mucous membrane, which may be associated at the time with congestion of the brain, cirrhosis of the liver, granular kidneys, heart disease, scurvy or some of the essential fevers. It is due occasionally to an impoverished condition of the blood, and is, as is well known, an early symptom of typhoid fever. Bleeding is said to occur at times from small ulcers upon the mucous membrane.

Epistaxis is usually exhibited by an escape of blood from the anterior nostrils, but it may run backward into the pharynx and, getting into the stomach, be subsequently vomited, giving the appearance of hæmatemesis. It may get into the larynx and be coughed up in a red, frothy state resembling hæmoptysis. Such errors are avoided by examination of the pharynx and fauces in a good light. When the blood comes from the nose it will be seen trickling down the posterior wall of the pharynx.

Treatment.—The treatment of epistaxis involves the consideration of the causes which lead to its occurrence and repetition. The visceral factor in such bleeding should be treated by appropriate medical means.

FIG. 327.

Method of plugging the nares from in front.

Traumatic epistaxis, as a rule, ceases spontaneously and needs no treatment. It should be remembered also that in cases of plethora, in which there is congestive headache or other symptoms of cerebral engorgement, bleeding from the nose may be a salutary symptom. Internal remedies, such as gallic acid and preparations of lead, opium and ergot, are given to diminish the tendency to nose-bleeding, but are of little value at the time of its occurrence. In cases of moderate severity the patient should be made to lie down, with his head considerably elevated and with iced cloths applied constantly on the nose. He should then grasp the cartilaginous portion of the nose with his thumb and forefinger in such a way as to keep the nostrils tightly closed. The firm pressure by the fingers prevents the access of air and gives an opportunity for the clots to close the bleeding orifice. It has been suggested that pressure with the finger upon the facial arteries will limit the amount of blood flowing through the nose and aid in stopping hemorrhage.

When these simple measures are not sufficient to arrest the bleeding and the patient shows signs of great exhaustion from the loss of blood, it is proper to plug the nose upon the side which is bleeding. The proper method of doing this is to tie a piece of antiseptic sponge, about as large as a good size marble, to the end of a piece of silk ligature. The sponge is then pushed along the floor of the naris until it reaches the posterior opening of the nasal cavity; the string will hang out of the anterior nostril. A similar piece of sponge with a hole in the middle should now be threaded upon this string and crowded back by means of the forceps into the nasal chamber. By thus packing with successive pieces of sponge the whole nasal chamber from the anterior to the posterior opening, bleeding is absolutely prevented by the pressure of the sponge. The sponge may be allowed to remain in place for from twenty four to forty eight hours. If the nose has been thoroughly washed out previously with an antiseptic solution, which of course must be of the non-poisonous kind, and if the sponge and silk are thoroughly antiseptic, there is little danger of putrefaction even when the packing is allowed to remain for a longer time. Usually, however, from thirty six to forty eight hours is sufficient to preclude the possibility of recurrence of the hemorrhage. This method is far superior to the use of any method by which a string is brought out of the mouth after being attached to a plug thrust up behind the soft palate.

Nasal Catarrh.

Pathology.—The term nasal catarrh is used to indicate inflammation of the mucous membrane of the nasal cavities. It usually shows little or no ulceration. There are three forms.

1. Simply nasal catarrh, in which there is a thin mucous or muco-purulent discharge without thickening of the mucous membrane and without incrustation of secretion or fetid odor.

2. The hypertrophic form, in which the mucous membrane, especially that over the turbinated bones, is swollen and infiltrated with inflammatory deposits, and in which there is a change of voice and formation of crusts within the nose.

3. The atrophic form, often called dry catarrh, in which there is atrophy of the glands of the mucous membrane, so that the nasal cavities are enlarged beyond the normal condition, and are, of course, larger than is the case during the existence of hypertrophic catarrh, in which the mucous membrane is swollen. The atrophic form is accompanied by great fetor, and seems to be a stage following the hypertrophic condition.

Offensive odor does not seem to be a characteristic of hypertrophic catarrh, unless atrophy has begun in some portion of the diseased mucous membrane.

The term ozæna is often indefinitely used by surgeons to indicate the existence of a fetid nasal discharge. The term should be discarded, however, because such fetid discharge may occur in atrophic catarrh and in tubercular or syphilitic disease of the nose, as well as from foreign bodies impacted in the nostrils and from other causes. A head mirror, speculum and rhinoscope are necessary for the correct determination of these various conditions.

Treatment.—The treatment of nasal inflammations, except when due to syphilis or gonorrhœa, is not very satisfactory, except in the hands of a specialist. Various forms of sprays thrown into the nose by means of an atomizer are valuable; and local treatment of various kinds applied directly to the diseased area are the most efficient means.

Constitutional treatment is required to aid these local measures, since nasal disease may depend upon syphilis, tuberculosis and other conditions leading to bad health ; but too much stress cannot be laid upon the necessity for efficient local treatment. Hypertrophied tissue may be removed by the snare or by the application of the galvano-cautery, or the curette.

Nasal Polyps.

Pathology.—Tumors occurring within the nasal cavities, as sessile or pedunculated masses, are called polypi or polyps. The most common form of polypus is the myxoma, although fibroma, sarcoma, and carcinoma are not very infrequent.

FIG. 328.

Vertical section through nasal cavity, showing nasal polypi. (SEILER.)

The myxoma is the one meant when the term polypus is ordinarily used. These polypi are soft, gelatinous, semi-translucent, pinkish or yellowish-white masses, which have their attachment to the mucous membrane in the neighborhood of the upper or middle turbinated bones; although they may arise in the antrum and other cavities connected with the nose. They seldom grow from the roof or septum of the nasal chambers, are generally covered with ciliated epithelium and are multiple, although one or two of the group generally exceed the others in size. In shape, they may vary from the globular to the pyriform or ovoid form.

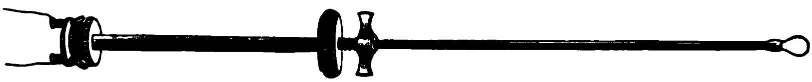
Symptoms.—The respiratory obstruction due to the condition causes a change in the tone of the voice, giving it the so-called nasal sound. The interference with respiration is increased in damp weather, because the tumor swells from absorption of moisture. An increased feeling of stuffiness in the nose therefore occurs under such circumstances. There is considerable nasal discharge, which is usually not offensive ; some frontal headache at times, and, possibly, impairment of the sense of smell. The patient is apt to be continually snuffling, because of the interference with respiration and the flow of mucus. Obstruction of the tear-duct may occur secondarily, and the bones of the nose may be pushed out of place, so that the bridge of the nose is widened by the pressure of the internal tumors. Reflex cough and asthma have been attributed to nasal polypi.

Diagnosis.—Inspection of the interior of the nose will usually make the diagnosis clear, since hypertrophy of the mucous membrane and the other forms of nasal polypi show redness of the surface, very different from the yellowish pearly color of a mucous polypus.

If the tumors occupy a high situation or if they are not very largely distended by the absorption of moisture, it may be difficult to see them, unless a speculum is used in the anterior nares or a rhinoscope employed for the examination of the posterior nares. The surgeon, by introducing his finger into the mouth and carrying its tip behind the soft palate, may sometimes be able to feel a mass protruding from the posterior nares into the pharynx.

Treatment.—Extirpation of the tumors is the proper treatment and may be done with the snare, or by avulsion with forceps. Pain can be obviated by painting or spraying the interior of the nose with a solution of cocaine. When the surgeon desires to pull out a myxo-

FIG. 329.



Jarvis snare.

matous polypus with the polypus forceps, this instrument should be introduced into the nose in such a manner that the blades open vertically; they should then be pushed up until the gelatinous masses can be seized near their pedicles and pulled from their attachments by twisting. The base may be cauterized with the galvano-cautery or some chemical agent. If the polypus protrudes from the posterior nares, a forceps introduced by the mouth may sometimes be effective.

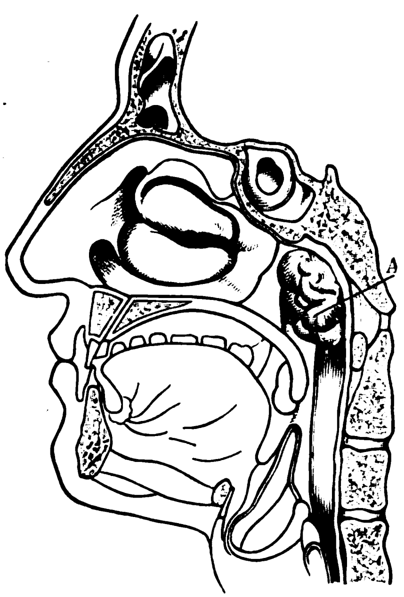
Intra-nasal fibroid polyps usually arise from the posterior part of the septum or from the superior turbinated bone, and may project into the pharynx, antrum or pterygo-maxillary fissure. It may occur that the growth will force its way into the orbit, into the cranium or out upon the cheek, having previously caused absorption of the bony walls of the nasal cavity. Such fibroid tumors may develop in the pharynx and grow into the nasal cavity or they may extend from the nose into the pharynx, thus obtaining in both cases the name of naso-pharyngeal polypi. When such a growth has obtained considerable bulk it may be impossible to determine whether it has had its origin within the nose or in some of the adjacent cavities.

Obstruction due to fibroid polypus is more marked than that due to the myxomatous variety; and the tumor is distinguished by its hardness, redness and tendency to bleed and by the fact that its bulk is not changed by damp weather. This form of polypus occurs most commonly in young adults. It is treated by avulsion, ligation or excision. The galvano-écraseur may be found very useful in removing moderate sized fibroid polyps.

When these growths have obtained considerable size it becomes necessary, if removal is desirable, to separate the nose from the face and turn down the organ, or to gain access to the tumor by splitting the upper lip and turning the ala out of the way. The upper jaw may in other instances be cut loose and turned outward, so as to give access to the naso-pharyngeal cavity, or the soft and hard palate may be split with the aid of a saw or chisel. These operations may be undertaken because of the obstruction which the growth causes, or because of bleeding from it which threatens the patient's life. It is justifiable to adopt such radical measures because of the non-malignant character of the tumor; whereas if it was known to be a malignant tumor such operations would perhaps be improper, since complete removal would be scarcely possible.

It is stated that such growths sometimes atrophy in patients reaching middle life and that an operation which simply cuts away a portion of the tumor is preferable to the major operations. Ligation of the two external carotid arteries has been practiced in order to cut off the blood supply to the fibroma within the nose and thus assist in its shrinkage.

Fig. 330.



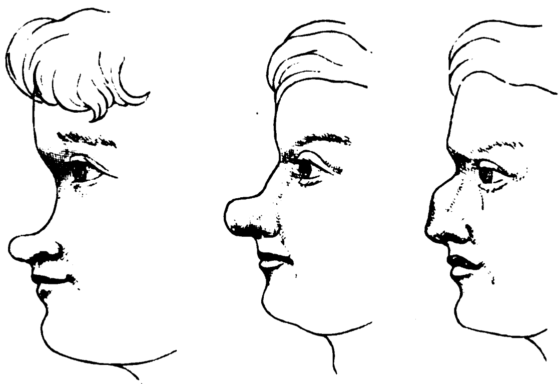
Position of adenoid vegetations as commonly located in the upper pharynx. (Park.)

Malignant polyps, which are sarcomatous or carcinomatous, increase rapidly, soon infiltrate the surrounding tissue, which undergoes ulceration, and produce involvement of the lymphatic nodes. If operation is not undertaken very early, it is usually futile. Recurrence is frequent, even after prompt interference.

Adenoid Vegetations in the Pharynx.

In the vault of the pharynx there occur during childhood growths of adenoid tissue somewhat similar to the hypertrophy of the tonsils, which is not uncommon at a similar age. This pedunculated, sessile, or fringe-like growth obstructs the breathing, impairs the quality of the voice and interferes with the hearing. It is also apt to be associated with nasal and pharyngeal catarrh or enlargement of the tonsils. The hypertrophic masses may be felt with the finger passed into the pharynx and are apt to bleed when manipulated. The obstruction to respiration causes the child to breathe through the mouth, and leads to symptoms pertaining to mouth respiration. These adenoid vegetations may atrophy as the child increases in age, but it is often necessary to remove them with forceps or curette because they induce deafness. The rhinoscope or head mirror may be necessary in these operations. Astringent applications may be of some service in mild cases.

FIG. 331.



Common deformities of the nose.

Deformities of the Nose.

Deformity of the nose may be congenital or the result of injury. Occasionally, as a result of injury, a blood tumor forms between the mucous membrane of the septum and the cartilage or bone forming that partition. These submucous collections of fluid resemble abscess of the septum and appear as soft swellings of the mucous membrane. Abscess is similar in appearance, but, as a rule, it follows signs of inflammation. Abscess of the septum should be treated by incision. These bloody extravasations, however, are usually slowly absorbed.

FIG. 332.

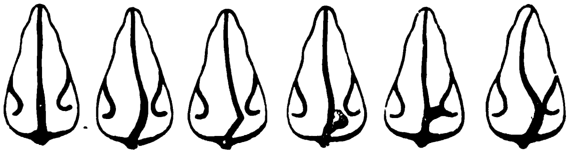


Diagram of deformities of nasal septum.

Occasionally bony or cartilaginous tumors grow upon the septum; they are usually near the floor of the nostrils. Such growths may even extend across the nasal chamber and come in contact with the lower turbinated bone, forming a sort of bridge within the nose. It is not unusual for the septal cartilage to be more or less deformed, either congenitally or as a result of traumatism. Such deviation of the septum, as well as the cartilaginous and bony tumors above spoken of, may lead to injurious obstruction which will require operation.

FIG. 333.

Syphilitic deformity of the nose.

Deformity due to syphilitic necrosis of the intra-nasal structures is apt to show itself in depression of the bridge of the nose which causes the tip of the nose to appear as a small elevation or knob upon the anterior portion of the face. The entire nose, or a very large portion of it, may similarly be lost from syphilitic ulceration. Portions of the nose may be also removed by wounds, and, therefore, require reconstruction.

Improperly or carelessly treated fractures of the nasal bones and cartilage often give rise to very unsightly deformities of the nose, causing it to have a bent or twisted appearance or be the site of some unbecoming projection. The surgeon is often required to treat such malformations, and may, by judicious measures, restore the deformed outline. It is possible also to improve the appearance of a nose in which the bridge is sunken as a result of bone disease or of congenital deficiency in development. This may sometimes be done by slipping a piece of celluloid or metal under the skin through a lateral incision. The foreign material must be so shaped as to fill up the hollow on the dorsum of the nose and support the skin so that the nose will be straight on the top. No irritation follows the insertion of the aseptic foreign body which remains indefinitely in the tissues.

FIG. 334.

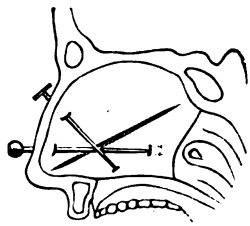
Incision for syphilitic deformity of nose, showing how the tip may be brought down and a new bridge constructed to fill the gap.

A cartilaginous or bony tumor growing from the septum should be chiselled or sawed away, as the obstruction leads to breathing through the mouth, a disagreeable tone of voice and often to nasal catarrh. If the septum is deviated to any marked extent it should be put into place, by fracturing it with a strong forceps or by incisions made into it with a small knife, and subsequently be retained there by pins. If the deviation involves a large portion of the septal cartilage, the cartilage should be made flaccid by a number of incisions cut in it with a stellate nose punch before it is pinned into its new position. The point of a pin, which should be from one and a quarter to one and a half inches long, is then introduced into the more open nostril, after the septum has been broken or cut and made flaccid, and its point thrust through the anterior part of that portion of the septal cartilage which the surgeon wishes to control and keep in its new relation to the other portions. This part is pressed into the desired position and the point of the pin is then thrust onward through the other chamber of the nose and its point firmly buried in the tissues at the back part of this second nostril. By this device the divided septum is firmly held in its new position as shown by the diagram. The head of this pin will be just inside of the anterior naris and must be allowed to remain for a week or ten days before it is withdrawn. It is often well to introduce a second pin from the external surface of the front of the nose just below

FIG. 335.

Lateral deviation of nose.

FIG. 336.



Author's method of pinning nasal septum.

the nasal bone. This aids in keeping the septal cartilage and bone in proper place. The second pin should have a flat head so that it may lie close to the surface of the nose; and may be covered with a small square of court plaster or a little cotton and collodion.

Submucous resection of the septal cartilage and bony septum is the best method of curing nasal obstruction when due to a limited deflection of the partition between the nares. The mucous membrane is incised and lifted up from the septum, so that a tenotome or small saw can be used to cut out the deflected cartilage and bone. The flap or curtain of mucous membrane is then allowed to drop over the opening in the septum.

If the organ is greatly distorted by reason of old fracture, the soft tissues may be pared loose from the bones with a tenotome, and the external nasal structures be twisted into place, after the septum has been divided and before the pin has been introduced. By proper pinning, the nose can often be kept in the median line and a fairly normal contour reëstablished.

This operation is always very bloody and requires etherization. The pinning method is probably better than the use of plugs to retain the parts in position, since they do the work effectually and leave the nostrils free so that an antiseptic solution can be used for washing out the nose during the period of inflammation after operation.

The reconstruction of portions of the nose which have been lost is called rhinoplasty. The most common cause of such conditions demanding such operative procedures is loss of the nasal structures from syphilis. A columella may be made by cutting a piece from the center of the upper lip and turning it up, so that it may be sutured to the septal cartilage and the tip of the nose between the two nares. An ala may be made by turning into the gap a flap dissected up from the cheek or upper lip. A tip of the nose or even a new bridge may be constructed from the point of a finger which has previously been freshened and sutured to the nose. The finger must be kept in position by gypsum bandages around the arm and head for several weeks.

Total rhinoplasty may be effected by turning down a large flap from the forehead. This is called the Indian method of rhinoplasty in contrast to the Italian method, in which a large flap is taken from the upper arm.

Abscess of the Antrum.

Pathology and Symptoms.—Suppuration within the antrum may be incidental to dental irritation, to tumor, to syphilitic necrosis and other conditions. One or more of the upper teeth may have their roots penetrating the antral cavity; hence caries of such teeth, may lead to inflammation and suppuration of the mucous membrane lining the antrum. Suppuration occurring here within a normal cavity is properly called a purulent effusion. The pus escapes, as a rule, through the nose or through the diseased tooth-socket; hence, symptoms due to retention of pus in the quasi-abscess cavity are not very common. When the pus cannot escape, swelling of the cheek, protrusion of the eyeball, occlusion of the tear-duct, stoppage of the nostril and bulging downward of the hard palate arise from this condition of the antrum, as in tumors occupying it.

Sometimes the walls of the antrum are so thinned by the inflammatory process that pressure upon the cheek may develop crackling similar to that which occurs in cystic tumors of the lower jaw as well as in tumors of the upper jaw. Fluid within the antral cavity may sometimes be diagnosed by percussion on the cheek over the diseased bone, which will develop a percussion note different from that found over the bone on the opposite side. When antral pus does not find vent through a tooth-socket or through the opening into the middle meatus of the nose, pointing may occur upon the cheek or in the roof of the mouth.

Treatment.—The treatment consists in puncturing the bone through the gum above the canine tooth or in extracting the tooth, if it is badly diseased, which seems to have its fang extending upward into the cavity of the jaw. The antral wall is so thin that it can be perforated with a strong knife. The cavity should then be washed out with a weak carbolic acid solution. The opening in the bone should be kept patent by frequent washing by means of a syringe, and, possibly, by the continuous wearing of a metal stile or plug so as to prevent occlusion of the orifice made for drainage. During eating, a little piece of cotton may be put into the opening in order to prevent the entrance of food, if the retention of a stile or plug is not enforced.

Suppuration, similar to that which occurs in the antrum, may at times occur in the mucous sinus of the frontal bone and require evacuation by trephining the bone at the root of the nose.

DISEASES OF THE AIR PASSAGES.

Œdematous Laryngitis.

Swelling of the mucous membrane of the larynx or of the folds between the epiglottis and the arytenoid cartilages, due to inflammation, or to dropsy resulting from Bright's disease of the kidneys, may give rise to serious obstruction. The œdema of the glottis, when of an inflammatory kind, may arise from the inhalation of steam, the swallowing of acids and other irritating substances, from insect stings, or from idiopathic laryngitis.

The treatment of this condition, when asphyxia is too immediate to allow delay for medical remedies, such as inhalations, is scarification of the swollen mucous membrane by means of a curved knife introduced through the mouth. The tongue may be held down during the operation by means of a tongue depressor or by the finger of the surgeon. The application of a solution of cocaine may lessen the swelling. Intubation will be of the greatest value in saving life in many instances, though opening the larynx in the crico-thyroid space may be required to prevent suffocation in other cases.

Fractures of the Larynx and Trachea.

The laryngeal cartilages and rings of the trachea may be broken by blows upon the throat, as from a base ball, or in attempts at homicidal throttling. It is usually the thyroid cartilage which is severely fractured. In such injuries the vocal cords may be dislocated and death ensue at once from asphyxia, due to spasm of the glottis. Suffocation may likewise occur from hemorrhage, as a result of laceration of the mucous membrane lining the larynx. Such laceration will probably be indicated by the coughing up of bloody mucus. It is wise to perform tracheotomy in all cases of bad fracture of the larynx and trachea, because of the great danger of sudden death being caused by rapid inflammatory swelling of the intra-laryngeal structures, or by emphysema under the mucous membrane and in the tissues of the throat. The broken cartilage may at times be held in place by the application of adhesive plaster on the outside of the throat. Better apposition, however, may be obtained by cutting down upon the injured cartilages and uniting them properly by means of catgut or silk sutures.

Foreign Bodies in the Air Passages.

Pathology.—Foreign bodies can gain entrance to the larynx and trachea only when the glottis is opened. Contact with the margin of the glottis induces instant spasm, which closes the chink and prevents admission of any intruding substance; hence, foreign bodies can only pass into the air passages when the glottis is, as it were, surprised. Accordingly, foreign substances usually get into the air passages when a sudden, violent inspiration is made at a time when the patient is holding a pebble, a bean or some such substance in the mouth. Coins thrown up in the air to be caught in the mouth sometimes slip through the chink of the glottis. Food and intestinal worms, which have been regurgitated or vomited into the upper part of the pharynx, may occasionally find their way into the larynx and trachea. Bodies so inhaled into the air tract may be caught between the vocal cords and detained in the larynx or, after passing beyond this point, may lie loose in the trachea or even get down into the bronchus. The right bronchus, being in a more direct line with the windpipe than the left, is the tube in which foreign bodies, going lower than the trachea, usually become lodged.

Symptoms.—Foreign substances impacted in the larynx give rise at once to violent spasm of the glottis, by which the patient may be immediately suffocated. The lividity of countenance, the gasping for breath and the shrieks of the patient are followed by foaming at the mouth, insensibility and sudden apnœa. If the foreign body is small enough to permit the passage of air alongside of it, death may not occur even if it is impacted in the larynx; and the first spasm of respiration, which has just been described, may subside and the patient regain consciousness. Aphonia is characteristic of the impaction of such small foreign bodies in the laryngeal cavity. Spasm of the glottis in such cases occurs at irregular times, in any one of which death may take place. A period of irritation succeeds the obstructive period, and is characterized by pain, coughing and expectoration of blood stained mucus. These irritative symptoms are especially prominent if the body has sharp edges; and occur when the foreign body is in the trachea and bronchus, as well as when it is impacted in the larynx. Bodies loose in the trachea are liable to be coughed up against the lower surface of the vocal cords and cause spasmodic asphyxia, in which the fatal end may occur, or they may at such times become impacted in the larynx. The patient is often more comfortable in the sitting posture than in the recumbent one. There is, perhaps, feebleness of respiratory sounds on auscultation, and this is especially marked on one side of the chest when the corresponding bronchus contains the foreign body. From the occurrence of secondary bronchitis various râles may be heard in the lungs. In some instances a peculiar whistling or flapping sound may be perceived, when the stethoscope is placed over the larynx or trachea, due to vibrations in the current of air produced by the foreign body.

The diagnosis in cases of obscure history may be made by auscultatory signs, and by the fact that foreign bodies are liable to cause difficulty in expiration, while croup and other obstructive diseases of the larynx cause more difficulty in the performance of inspiration. Laryngoscopic examination will often reveal the presence of a foreign body entangled in the folds of the mucous membrane lining the interior of the larynx. Coins and other objects which produce shadows when subjected to the Roentgen rays are readily located by the use of this means of diagnosis; though it may be a little difficult to determine by this method alone whether the foreign body is in the trachea or œsophagus.

Treatment.—It is not usual for foreign substances within the respiratory tract to be spontaneously expelled. They may remain for many months and cause, as a secondary result, hemorrhage, ulceration, abscess, chronic disease of the lungs and fatal exhaustion. The danger of fatal spasm of the glottis occurring suddenly renders it important that the trachea should be opened, as a precautionary measure, as soon as it is determined that a foreign body is lodged therein. Perhaps intubation might be substituted for tracheotomy as a precautionary measure against laryngeal spasm, while preparations for more radical means of treatment were being made. The habit indulged in by some of inverting the patient and slapping him upon the back, in order that the offending substance may be expelled, is dangerous, and should never be attempted until after the trachea has been opened, since the impact of the body upon the lower surface of the glottis may cause immediate asphyxia. Anything impacted in the larynx may possibly be removed by the laryngeal forceps with the aid of a laryngoscope. In such instances, of course, tracheotomy is not required, although the surgeon should be prepared to thrust his knife into the crico-thyroid space and admit air to the suffocating patient, in case his manipulations cause spasm of the glottis.

Where extraction through the larynx and mouth is impossible, the thyroid cartilage should be laid open by a median incision, carried upward after a puncture has been made in the crico-thyroid membrane. The offending body should then be removed with the least possible laceration of the mucous membrane. A tube should be left in the wound for a day or two until all danger of inflammatory swelling within the larynx has passed. When the body lies in the trachea or bronchus, tracheotomy should be performed instead of laryngotomy, subsequent to which the mucus in the tube should be coughed up by the patient or sucked out by a syringe or aspirator in the hands of a surgeon. The patient should then be inverted and permitted to cough in the hope that the foreign body may be expelled.

Search for the foreign body may be made by means of forceps carefully introduced through the wound. If it is not found the sides of the wound should be stitched to the skin, in order that extrusion may be permitted by subsequent effort at coughing. The patient should be kept in a room whose temperature is not less than 80° F., and the air of which is kept moist by a steam atomizer or similar device. The foreign substance may be so fastened in the trachea or bronchus that its expulsion may not take place until several days have elapsed; at which time it is not impossible that masses of exudate, similar to that found in croup and diphtheria, may also be expelled. When the foreign body has made its exit, it is wise to leave the wound open for a few days lest inflammatory swelling should impede respiration. This is scarcely necessary, however, except in those cases in which the foreign body has become impacted in the larynx, because a considerable amount of swelling may take place in the trachea without obstructing respiration. In rare cases a body lodged in the larynx may be removed better by opening the pharynx between the hyoid bone and the top of the larynx. If the foreign substance has lodged in a bronchus surgical aid is difficult. Bronchotomy, accomplished as it may be by resection of the ribs near the posterior border of the scapula, is a very formidable operation.

Tumors of the Larynx and Trachea.

Pathology.—Tumors of the trachea, as primary growths, are exceedingly rare; but in the larynx various primary tumors occur, and are sometimes called laryngeal polypi. Laryngeal tumors cause symptoms similar to those induced by the presence of foreign bodies in the larynx. The forms most commonly found are papilloma, epithelioma, fibroma, adenoma and myxoma. These may be pedunculated or sessile, and, if malignant, ultimately involve the lymphatic nodes and other structures of the neck. Tuberculosis of the larynx occurs, and at times resembles epitheliomatous disease. Laryngeal tumors grow slowly and attain considerable bulk, for the location, before marked symptoms occur. Their presence is to be detected by the laryngoscope.

Treatment.—Laryngeal growths may, if small, be removed by the forceps, snare, cautery or laryngeal guillotine. In cases where there is great tendency to spasmodic dyspnœa, due to irritation from the intralaryngeal condition, precautionary tracheotomy may be required, as when foreign bodies are impacted in the glottis. When a tumor located within the larynx cannot be removed through the mouth, in the manner described, it becomes necessary to do the operation called thyrotomy.

Thyrotomy, or splitting the thyroid cartilage in the middle line, is accomplished by incision of the skin over the larynx, by which the thyroid cartilage and crico-thyroid membrane are exposed. The crico-thyroid space is then opened with a knife and the incision carried upward through the thyroid cartilage almost to its upper margin. It is important not to split the entire cartilage into its two halves, but to leave a portion of it at its upper border intact, in order that the lateral halves may retain their relative position after the tumor has been removed and the sutures applied. During this operation the head of the patient should be thrown well back, in order to make the laryngeal region prominent. When the larynx has thus been opened by external incision, its interior may be examined and any growth removed by means of forceps and scissors. The cartilaginous tissues are then sewed together with fine catgut, and the external parts sutured and dressed in the ordinary manner. A solution of cocaine should be used to prevent pain during the removal of such growths through the mouth; and it may even give sufficient anæsthesia for the operation of thyrotomy, if it is injected under the skin about the line of the proposed incision.

A pharyngotomy between the hyoid bone and the larynx may, at times, afford a good route for the extirpation of laryngeal tumors.

Epithelioma of the larynx requires removal of the larynx, called laryngectomy, which should be done in all cases, in which the diagnosis is clear, at an early stage of the disease. The larynx is removed by means of an incision in the middle line of the neck from the hyoid bone to the third ring of the trachea. The thyroid body should be drawn downward away from the field of operation. The trachea is then separated from the surrounding structures and divided transversely at the level of the second ring. The lower portion of the windpipe is next plugged with a tampon of gauze or sponge, through the middle of which passes a large tube by which the air and ether vapor are admitted to the lungs. This plugging prevents the blood flowing from the seat of operation into the air passages. The larynx must now be freed from the tissues on either side, separated from the hyoid bone above and the pharynx behind, and thus totally removed. After the superior laryngeal arteries and other vessels have been tied, the dressing, consisting of antiseptic gauze, is packed into the cavity left by the removal of the larynx. Subsequent to the operation the patient is nourished by enemata or through an œsophageal tube until the wound has cicatrized, while respiration is carried on through the lower portion of the trachea. After cicatrization has been accomplished, an artificial larynx can be adopted and the patient given a certain amount of speech.

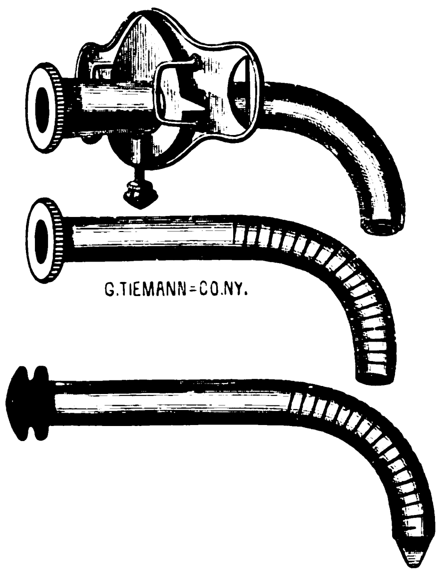
Tracheotomy.

Tracheotomy, or opening the windpipe, may be required to prevent suffocation in cases of obstruction in the larynx. Such obstruction occurs in the membranous inflammation which takes place in croup or diphtheria, in the occluding swelling of œdematous, tubercular and syphilitic laryngitis, and in the spasm of the glottis which arises from foreign bodies or tumors in the air passages. Cicatricial narrowing of the larynx may remain after the cure of syphilitic ulcers and may cause obstruction demanding tracheotomy. When there is danger of asphyxia, it is wisdom on the part of the surgeon to open the windpipe before the patient's strength has been exhausted by dyspnœa. The operation, if properly done, is not at all a serious one, provided it is performed at a time when the symptoms do not require haste. Many of the accidents which accompany the performance of tracheotomy are due to its postponement until the patient is moribund.

When the surgeon divides two or three rings of the trachea, the operation is called tracheotomy; when he divides the crico-thyroid cartilage and the crico-thyroid membrane or only one of these structures, the operation is termed laryngotomy. If the lower portion of the larynx and the upper part of the trachea are opened, the operation is called laryngo-tracheotomy.

Etherization may be dispensed with in some cases, since the painful part of the operation is in the cutaneous incision, which may be rendered painless by freezing with ethyl chloride spray or ice and salt, or by hypodermic injections of cocaine. The sense of pain is practically absent, moreover, in conditions of imminent suffocation from prolonged laryngeal obstruction. General anæsthesia may be desirable especially in infancy, since movement of the child, even if it suffers but little pain, interferes with the operation. When the trachea is to be opened, the patient's shoulders should be raised, by thrusting a pillow under them, and the head thrown back so as to put the neck on the stretch. A median incision is then carried from the crico-thyroid space almost to the sternum. Its length depends upon the thickness of the neck and the consequent depth at which the trachea is situated. The veins, swollen because of interference with respiration on account of the patient being in a state of asphyxia at the time of operation, should be avoided if it is practicable. Their division, however, is not a matter of serious moment, since they stop bleeding as soon as respiration is reëstablished. The dissection is continued in the middle line, through the deep fascia and between the sterno-hyoid muscles, until the thyroid gland is exposed. The isthmus of this body should be pushed downward, or drawn upward, according as the surgeon intends to open the trachea in the upper or lower part. When the isthmus, on account of its size, cannot be displaced, a ligature should be tied around it on each side in order to prevent hemorrhage and it should be divided midway between these ligatures. The windpipe can be recognized by its white color. A tenaculum is hooked into the tracheal wall to steady it, a sharp pointed knife is thrust into the windpipe, and two or three rings are divided in an upward direction. It is very important that no blood should get into the trachea by the first inspiratory effort after the opening is made. Such inhalation of blood may suffocate the patient. In some cases it may be impossible to stop all bleeding before the tracheal cut is made; then, the patient should be turned upon his face with his head over the edge of the table and retained in this position while the opening is made. The blood will then flow out of, instead of settling in the bottom of, the wound. The danger of its being sucked into the air passages will thus be averted.

FIG. 337.

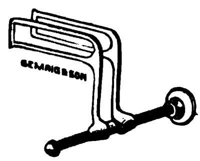


Double tracheal canula. The inner tube has a flexible end and is introduced by means of a stylet.

As soon as the rings have been divided, it is well to thrust a pair of forceps into the trachea in order to hold the lips of the wound apart.

In this manner a supply of air is at once given to the patient, and the false membrane or mucus which has obstructed the respiratory passage can be removed. It may be necessary to wipe out such obstructing material, with a feather or camel's hair pencil passed into the windpipe, or to suck it out by means of a catheter to which an aspirator or a syringe has been attached. In diphtheritic cases it is dangerous and foolish for the surgeon to suck out such membrane with his mouth, since fatal infection of the operator has often followed this practice. After the trachea has been cleared, a tracheal tube may be inserted in order that the respiration may go on without obstruction from falling together of the lips of the wound. A tracheal tube consists of a double canula, the inner one of which projects at the internal end a little beyond the outer one. The object in having two tubes is to enable the attendant to remove and clean the inner tube, as it becomes plugged with mucus or dried secretions, while he leaves the outer one in the wound in order to make replacement of the inner tube easy. The outer tube has flanges upon each side, by which it is held in place by tapes tied around the neck or by sutures carried through the neighboring skin with a needle. There are several forms of tracheal dilator made which are preferred by some operators to the canula.

FIG. 338.



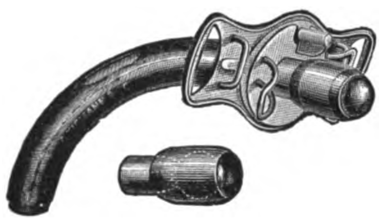
Tracheal dilator.

In diphtheritic patients less skilled nursing is required if, instead of introducing the canula, the surgeon cuts out a small rectangular portion of the trachea and stitches the edges of the tracheal opening to the skin. The tube requires more constant watching, and must be kept free from obstruction by dried membrane, secretion or blood, by the frequent passing of a feather through it. In diphtheritic cases the inner tube should be removed and cleaned about every two hours, and both tubes should be removed if there are any evidences of serious obstruction.

The patient, whose windpipe has thus been opened, cannot talk unless the orifice in the throat is closed by placing a finger over the tube, or in some way preventing respiration through the anterior orifice. In four or five days after the operation for diphtheria it is proper to make an attempt to dispense with the tube; but if symptoms of laryngeal obstruction still remain, the tube must be reinserted for a few days longer. It is essential that the patient upon whom tracheotomy has been performed be kept in a hot room with a moist atmosphere until the symptoms for which the operation was done have subsided, since bronchitis or pneumonia is very liable to occur from inspiration of cold, dry air. Inhalation of dust should be prevented, if possible, by keeping a piece of mosquito netting in front of the opening in the throat. This, however, is often impossible in operations for diphtheria where there is frequent necessity for cleansing the tube. The temperature of the room should be kept at about 80° F., and the air should be kept moist by means of an atomizer or by a wet blanket suspended in the room before a fire. The interior of the trachea and the wound may be mopped with a solution of sodium carbonate in glycerin or with a solution of pepsin or of trypsin, in order to facilitate detachment of the false diphtheritic membrane. It has been suggested that, after tracheotomy for diphtheria, the windpipe above the seat of operation may with benefit be plugged with sublimate gauze (1:2000).

A quick tracheotomy may be done in emergency cases by grasping the larynx between the thumb and forefinger of the left hand and steadying it in this manner, while a rapid incision is made with the right hand in the middle line. In still greater emergency air may be admitted to the lungs by plunging the blade of a pocket knife through the crico-thyroid space, which is easily felt as a depression about three quarters of an inch below the most prominent point of the Adam's apple. An opening thus made will permit air to enter in sufficient quantity until a more systematic operation can be done. Where it is impossible to obtain a proper tracheal tube, a piece of drainage tube will temporarily answer the purpose. If the patient has stopped breathing by the time the surgeon has gained an entrance to the windpipe, artificial respiration may possibly be started by blowing into the tube with an ordinary syringe or a pair of bellows. It is wise always to introduce the largest size canula that the trachea will hold. An occasional alteration as to its length or shape and also its removal from time to time are desirable, because the pressure exerted by its internal end may induce ulceration of the lining membrane of the windpipe.

FIG. 339.



Tracheal tube with valve.

In cases of stenosis of the larynx in which the tracheal tube must be constantly worn, a tube with an opening in the intratracheal portion will enable the patient to expire through the larynx and to talk with comparative ease. If the tube has not this opening, and it fits tightly so that no air passes above the wound, speech is impossible.

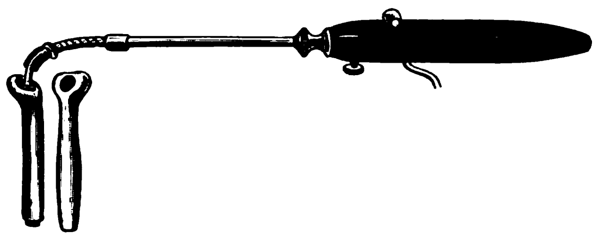
The point at which an opening in the air passages should be made depends upon the condition for which the operation is done. In diphtheria it is best to go as low down as possible; hence, a point below the isthmus of the thyroid gland is probably the best place under such circumstances. In tracheotomy for chronic disease of the larynx, a high tracheotomy above the thyroid body is efficacious and makes a less difficult operation.

Intubation of the Larynx.

The introduction of a metal tube into the chink of the glottis and its retention there for a period varying from several hours to several days is called intubation, and is in certain cases a good substitute for the more serious operation of tracheotomy. Though especially employed in cases of diphtheria and œdema of the glottis, it is possible that it may be of advantage in cases of foreign bodies in the trachea, because it will probably prevent fatal asphyxia from spasm of the glottis, due to such foreign body being coughed up against the lower surface of the vocal chords. In such a condition intubation would seem to be of service as a temporary measure until arrangements can be made to open the trachea for extraction of the foreign substance.

Intubation, which is seldom required in adults, is performed with the child held in the nurse's arms or lying upon a bed, without being

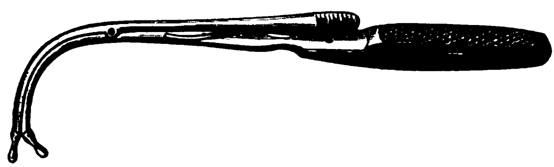
FIG. 340.



Intubation tube and introductor.

etherized. A gag is placed between the teeth on the left side of the mouth, in order to hold the jaws apart, and an assistant holds the patient's head well back. The surgeon introduces his left forefinger into the mouth to press down the tongue and locate the glottis. He then guides the tube with his right hand into the glottis. After it has been so introduced the detachable handle or obturator is removed. The patient then breathes through the tube, which is kept in place by reason of its shape. At the top of the tube is a flange to prevent the instru-

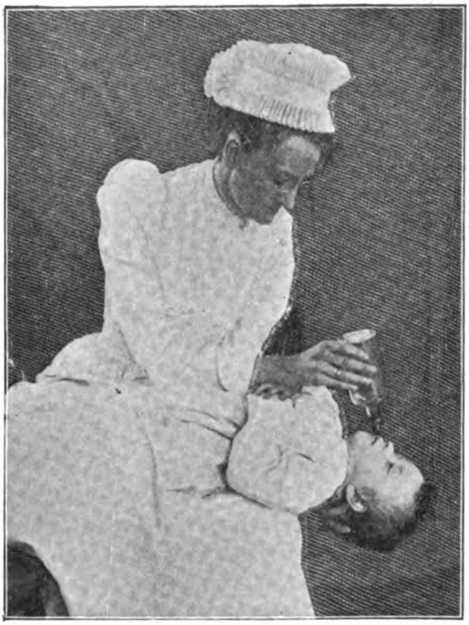
FIG. 341.



Intubation tube extractor.

ment slipping into the trachea, and in this flange is a small hole through which a long thread is passed before any attempt at introduction is made. The ends of this thread hang from the mouth and are used to remove the instrument from the pharynx, if it is found not to be placed in the larynx when the detachable handle is withdrawn. If, however, the surgeon finds the patient breathing well and the tube properly placed, the string is withdrawn and the instrument left in position. If all goes well the tube may be left in position for several days. When its extraction is desired an instrument called by Dr. O'Dwyer the extractor is introduced. This instrument is operated by expanding two blades or jaws after its point is introduced into the caliber of the tube, thereby giving the surgeon control of the latter and enabling him to withdraw it quickly. During the introduction and withdrawal of the laryngeal tube respiration is entirely arrested for a moment.

FIG. 342.



Feeding a case of intubation of the larynx. (WHARTON.)

An advantage of intubation is that the consent of the patient's family can be more readily obtained for the performance of the operation than is the case in tracheotomy, which causes bleeding, and therefore seems to them more undesirable and dangerous.

The objections to intubation are that the tube may slip into the trachea, that it may be swallowed and that food gets into the air passages, causing at times secondary pneumonia. The child should be fed with the head thrown far back. It has been supposed by some that there is danger that the false membrane of diphtheria may be pushed down into the trachea by means of the tube, thereby increasing the respiratory obstruction. This objection, however, applies equally to the insertion of a tube after tracheotomy. Intubation, moreover, does not prevent tracheotomy being performed later, if the necessity for it arises. Attempts have been made to correct the difficulty of feeding after intubation, by attaching a sort of artificial epiglottis to the upper end of the tube.

DISEASES OF THE CHEST.

Injuries of the Lungs.

Pathology and Symptoms.—Contusions and abscesses of the chest wall require no special description other than to say that the abscess of the chest wall is occasionally secondary to purulent effusion in the pleural cavity or to abscess of the lung.

Contusion or rupture of the lung tissue may occur without laceration of the pleura. These lesions probably take place because the lung is subjected to blows or concussions when the vesicles are filled with air and the glottis closed, so that the air within the lung tissue cannot be forced out at the time the force is applied. The symptoms of this condition are spitting of blood, diaphragmatic breathing, dyspnœa, cough, bronchial râles and signs of localized pneumonia or pleurisy. These symptoms vary with the extent and location of the injury. Emphysema may occur between the lung and the pulmonary pleura, and the air so extravasated may find its way into the mediastinum and upward into the cellular tissue of the neck and back. If the pleura is torn by the injury, blood and air may escape into the pleural cavity and produce hæmo-thorax or pneumo-thorax with their characteristic physical signs.

Pulmonary abscess or gangrene and mediastinal abscess are occasional sequences of lung injuries. Gunshot and stab wounds of the lung are not infrequent; and laceration of the periphery of the lung may happen as a complication of fracture of the ribs. Laceration may occur from puncture of the lung by one of the fragments at the time the fracture of the rib is received, though subsequently no displacement of bone may be discoverable; because the resiliency of the chest wall has brought the fragments of bone into apposition.

The symptoms of such wounds of the pulmonary tissue are similar to those described above as occurring from contusion and rupture of the lung. Subcutaneous emphysema is a very common concomitant of fracture of the ribs when one of the fragments has injured the lung. In such instances the air in the vesicles escapes into the pleural cavity and then during expiration is pumped through the opening in the costal pleura into the subcutaneous cellular tissue.

It must be remembered that the lung extends downward at the lateral and posterior aspects of the chest to about the level of the tenth rib, while the pleural cavity extends as far downward as the twelfth rib. In a wound of the chest below the tenth rib, therefore, the pleura alone will probably be wounded, and not the lung. If a penetrating wound extends sufficiently deep to traverse the pleural sac, puncture the diaphragm and enter the abdominal cavity, the organs contained in the abdomen may suffer injury from the bullet or knife, in addition to the damage sustained by the pleura. The arching upward of the diaphragm renders it possible for a penetrating injury, even higher than the tenth rib, to produce lesions of both the thoracic and abdominal viscera. When the wound of the chest wall is a comparatively large one, its communication with the pleural sac is often to be recognized by the sucking and hissing sound produced by the air entering the chest during respiration. If a large vessel in the lung is wounded, the bronchial tubes may be so filled with blood as to actually drown the patient.

The subcutaneous emphysema which is sometimes present in lung injuries, is recognized by the elastic swelling of the skin, which crackles when pressed upon by the fingers. This tumefaction, which is free from any discoloration such as occurs in cutaneous inflammations, occurs during the first few hours after injury, and afterward subsides gradually without treatment.

Pulmonary wounds heal like other wounds if protected from suppuration and putrefaction. The air entering the pulmonary tissue through the trachea is freed from pathogenic germs to a great extent by the filtering process which it undergoes before it reaches the seat of the wound; hence, if the chest wound be kept aseptic, there is little danger of suppuration or septic pneumonia or pleurisy. Protrusion of a lung may occur at the cicatrix of a large wound in the chest wall.

Treatment.—The external bleeding in chest wounds is usually not very severe, and needs no special treatment. If the blood comes from the lungs it will probably be frothy and in greater quantity during expiration than inspiration. The flow of blood into the pleural sac, which occurs at the same time or before escaping from the chest through the external opening, will probably soon make sufficient pressure upon the lung to stop the bleeding from the pulmonary tissue. The blood so entering the pleural cavity will, if kept aseptic, subsequently be absorbed; if not kept aseptic, it will break down into pus and cause traumatic empyema.

Severe hemorrhage may supervene from wounds of the intercostal and mammary arteries. The intercostal arteries lie in grooves at the inner and lower margins of the ribs. Hemorrhage from one of these vessels may be stopped by seizing the bleeding point with a hemostatic forceps, which may be left in position for several hours. If arrest of hemorrhage by this means be impossible, the surgeon may perhaps be able to scrape off, with a blunt instrument, the periosteum from the bottom of the intercostal groove. This procedure separates the vessel from the bone and makes its ligation practicable. Another method is to push into the wound the center of a square piece of antiseptic gauze, and, after distending it like a small bag within the chest, to stuff the pouch so made with small pieces of antiseptic sponge or gauze. By seizing the projecting corners of the square of gauze and drawing the intrathoracic mass firmly against the internal surface of the ribs, pressure is made upon the intercostal vessel and bleeding prevented. Resection of a portion of the rib is seldom necessary to gain control of the vessel from which hemorrhage occurs.

The internal mammary artery runs parallel to the border of the sternum, and from a quarter to half an inch external to this margin. Bleeding from a wound in the internal mammary artery should be treated by ligation or by seizing the bleeding point with a hemostatic forceps, which should then be left in position with antiseptic dressing packed around it.

As a rule, little information is obtainable by the introduction of probes into a chest wound. There is no objection to their use, if they are employed with caution and antiseptically. When the wound is large enough to admit the surgeon's finger, which, of course, must be aseptic, a clear understanding of the nature of the injury is often obtained.

Antiseptic cleansing of the wound, the introduction of sutures and the application of dressings fulfill the local requirements of thoracic wounds. In order to keep the chest at rest as much as possible, a firm bandage should then be applied. If suppuration occurs in the pleural cavity, the wound must be thoroughly opened, a drainage tube inserted, and antiseptic irrigation carried on in the manner discussed under Pleural Effusion. If the traumatic pneumonia is very acute and extensive, venesection may be the only means to preserve life. In other cases secondary pneumonia and pleurisy should be treated by ordinary medical means. The diagnosis of the inflammatory conditions within the chest is made by the ordinary rules of auscultation and percussion.

Bullets and other foreign bodies, unless their location is definitely determined by skiagraphy or other means and they are accessible to the knife without adding much to the original injury, should be allowed to remain imbedded in the tissues. They often become encysted, and do no harm. If subcutaneous abscess or a sinus indicates their position, the surgeon is justified in undertaking operative search, which may require more or less extensive resection of ribs.

Surgical Treatment of Pleural Effusions.

Aspiration of the pleural cavity, or thoracentesis, is performed for hydrothorax or serous effusion into the pleural cavity. Incision of the chest wall with the introduction and retention of a drainage tube into the pleural sac is the proper surgical treatment in cases of pyothorax or purulent effusion into the pleural sac. In hydrothorax aspiration should be done comparatively early, or as soon, at least, as medicinal remedies do not produce any marked diminution of the quantity of fluid in the cavity. Incision and drainage should be performed as soon as the existence of pus is determined. Aspiration should be done with a hollow needle and one of the forms of aspirating pumps. Care should be taken that no air enters the chest and that the lungs and other structures of importance are not injured by the point of the needle. If an aspirator is not obtainable, an ordinary trocar and canula is used. A long rubber tube, however, should be attached during the first flow of serum, immediately after the trocar has been withdrawn, and the end of this tube placed below the surface of a solution of carbolic acid (1 : 40). This precaution is taken to prevent the sucking up of air into the chest when the flow of serum becomes intermittent as the cavity is nearly evacuated.

Thoracentesis does not require general anæsthesia. If the patient is very sensitive to pain, the skin at the point of the proposed puncture may be made anæsthetic. The best position for the patient is a semi-recumbent one, which can be changed during the operation to a recumbent one, if he becomes weak. The place to insert a puncturing instrument is in the sixth interspace close above the upper border of the seventh rib and in a line with the middle of the axilla. If careful auscultation and percussion indicate local pleural adhesion or the presence of a localized pleural effusion, it may be necessary to select another spot; since it is evident that a cavity containing fluid should be tapped near its lower wall, as this gives the best opportunity for entire evacuation of its contents. The escape of fluid should be at first somewhat controlled, in order that sudden evacuation of the contents of the pleural cavity may not lead to syncope. It is also wise occasionally to stop the flow for a moment. The occurrence of cough is an indication to desist temporarily; while a discharge of blood through the needle means that the lung or some vessel has been injured, and suggests the partial withdrawal of the instrument. When the fluid ceases to escape the operation is concluded by drawing out the needle, unless it is believed from the physical signs that the caliber of the aspirator has been plugged by a mass of lymph sucked into the tube. This complication is, as a rule, indicated by a sudden, rather than a gradual, cessation of the flow. It may be possible by changing the current in the aspirator, if the instrument permits such a procedure, to force the lymph back into the chest. If this is impossible, it may be necessary to withdraw the needle, remove the obstruction and puncture in a new place. An antiseptic pad should be placed over the opening after the operation has been performed, and the patient treated by medical means as previously.

Drainage of purulent effusions in the pleural cavity is accomplished by making a two inch incision in one of the intercostal spaces, just above the upper border of one of the ribs and parallel to the rib. The sixth interspace in the axillary line is, as a rule, a good place for incising the pleura. If there is any evidence of the pus collection being localized, the surgeon would naturally make his incision a little below the center of the area of dulness. The cutaneous incision should be sufficiently large to permit a good size tube to be introduced. If the space between the ribs is not sufficient, a portion of the lower rib should be excised. It is not often necessary to remove a section of the entire width of the rib, as a semicircle cut out of the bone with bone forceps or saw will usually give sufficient space for the tube. Excision of the rib for this purpose is seldom required. If, however, it seems necessary to remove a section of the entire width of the rib, the operation should begin by an incision over the middle of the rib; after which the periosteum should be detached and about an inch of the rib sawed out. The intercostal artery in such an operation should be secured before the pleura is opened.

After the dissection has been carried down to the pleura and hemorrhage stopped, if there be any, the pleura should be laid open to the full extent of the external wound. The surgeon's finger can then be inserted, the interior of the chest explored and any bands of lymph that divide the pleura into separate cavities broken up. Etherization is not essential in this procedure, as the pain is not very much greater than that of aspiration. Local anæsthesia is sufficient. A rubber drainage tube without side holes and with a caliber of about one quarter of an inch should be introduced about an inch into the pleural cavity and stitched to the skin by wire or silk sutures. After the extremities of the wound have been drawn together with sutures, a voluminous antiseptic dressing should be applied. The pleural cavity should be washed out with a weak solution of carbolic acid (1:100), salicylic acid or boric acid or a sterile salt solution, once in twenty four hours. These disinfectant solutions are introduced by hydrostatic pressure, obtained by attaching to the drainage tube another tube or pipe coming from a reservoir held about two feet above the patient. As soon as distention of the cavity by the fluid produces pain the supply tube should be detached or the reservoir lowered, so that the mingled pus and antiseptic solution may escape. One or two pints of fluid may be introduced into the chest at one injection, and it may be repeated until the outflow is very little stained with pus. Irrigation and drainage in this manner should be continued for several weeks, and should not be discontinued until it is evident that the cavity within the chest has greatly contracted and that there is very little purulent collection. When this occurs the drainage tube may be withdrawn and the wound allowed to heal by granulation. Too early withdrawal of the tube may permit re-accumulation of the pus and necessitate a second operation, in order to relieve the septic symptoms which are liable to occur. If the fistulous opening, left after the drainage tube is withdrawn, remains for many months, further treatment will be required. The condition is, in rare instances, due to a broken portion of the tube having been left within the chest; but is more apt to happen because the drainage has not been complete or because the tube has been withdrawn too early. Dilatation of the fistulous track, by the introduction of a sponge tent or a piece of compressed sponge, will often permit reëstablishment of irrigation and thereby induce cure. In other cases it may be necessary to lay open the sinus and resect a portion of a rib in order to obtain free drainage. In some cases healing of the pleural cavity is prevented by the fact that the pus sac will not collapse because of inflammatory thickening and adhesions. Under such circumstances it has been advocated that two or three inches of several contiguous ribs be excised (thoracoplasty), in order that the chest wall becoming flaccid may fall inward and, by coming in contact with the pulmonary wall of the pus sac, cause the cavity to become obliterated. In performing this operation it is well to dissect away the thickened costal pleura.

Pulmonary Abscess and Gangrene.

The operative treatment of pulmonary abscess consists in cutting into the lung, after having incised the chest wall and pleura, in order to evacuate the pus confined in the lung tissue. Before such an operation is attempted the most careful physical diagnosis must locate the abscess, and even then it is wise to confirm the physical signs by introducing an aspirating needle or trocar into the lung. When such abscess has been discovered, incision of the external tissues and lung is proper, and should be followed by the insertion of a large drainage tube so that irrigation may be carried on. Excision of a gangrenous portion of the lung has been attempted after opening the chest. The difficulties in diagnosing the position of the gangrenous area are similar to those met in diagnosing the position of an abscess.

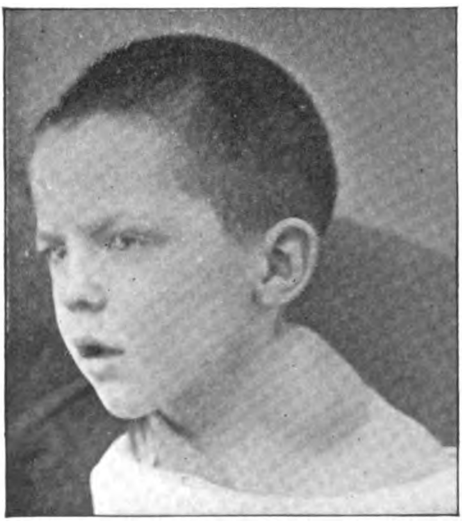
Mediastinal Tumors and Abscesses.

Pus in the anterior mediastinum may be evacuated by an incision between the costal cartilages or by trephining the sternum. Such a possible condition should be given consideration when the surgeon is investigating any obscure case of thoracic disease. Tumors of the mediastinum should also be remembered in this connection.

Diseases of the Neck.

Wounds of the neck should be treated as other wounds. If the trachea or glottis is opened, the parts should be brought together and sutured and provision made for drainage. Severe wounds of these structures are often made in suicidal attempts. After the parts have been sutured an œsophageal tube may be required for feeding the patient. If the tongue or epiglottis has been cut loose from its attachments, it may cause asphyxia by falling upon the opening of the glottis. Sudden œdema of the glottis may arise as a complication of wounds of the larynx. These complications may render it necessary for tracheotomy to be performed, lest between the visits of the surgeon death may occur from sudden swelling or other obstruction of the chink of the glottis. Emphysema of the neck may supervene after such wounds by reason of air escaping from the respiratory tract into the subcutaneous tissue. Diffuse cellulitis of the neck may follow wounds; and septic poisoning, secondary to ulcerations in the mouth or pharynx, to scarlet fever and to diphtheria, is not uncommon. If the cellulitis assumes a suppurative character, free incision to prevent burrowing of pus, and antiseptic irrigation of the cavities in which this is located are urgently demanded.

FIG. 343.



Branchial cyst or hydrocele of the neck. (DENNIS.)

The congenital cysts, called branchial cysts or hydroceles of the neck, are due to the embryonic branchial clefts not becoming entirely closed. A cavity is consequently left which is filled with fluid. Sometimes there is a mere fistulous track or sinus left as a result of imperfect closure of the branchial clefts. Similar sinuses and cysts may occur on the front of the neck from incomplete pre-natal obliteration of the thyroglossal duct.

A most common surgical condition in this situation is glandular enlargement due to chronic lymphadenitis. These chronic lymphatic swellings are often the result of tubercular infection and are very liable to become caseous and to break down into puriform fluid. Lymphadenitis often arises as a result of infection through carious teeth. A lymphatic glandular enlargement situated over the submaxillary or parotid salivary gland sometimes acquires considerable bulk; it is liable to be mistaken for tumor or malignant disease of the salivary gland. Chronic tubercular enlargement of the lymphatic nodes of the neck should be treated by constitutional remedies, such as tonics, cod liver oil, potassium iodide, a residence at the seashore and attention to hygienic surroundings. Locally the treatment should consist of counter-irritation by means of tincture of iodine or the ointment of the red iodide of mercury. If after such measures they continue to enlarge, it may be proper to excise the glands before they have undergone puriform change. This is desirable because they may become the primary focus from which general tubercular infection may arise. If cheesy or puriform degeneration has taken place, it is proper to incise the skin over the softened mass, to scrape away with a curette all the glandular tissue and diseased structure around it, and to dress the wound with iodoform. The depressed scar left by such early incision is less deforming than the irregular and puckered superficial cicatrix which usually remains after spontaneous evacuation of the puriform collection.

The unsightly scars left by the occurrence in youth of such cervical tubercular lesions may be made almost imperceptible by a small plastic operation. An elliptical incision is made around the depressed cicatrix, the skin is dissected loose for some distance on each side, and the edges are then drawn together by sutures over the intervening depressed portion of skin, which has previously been made raw by scraping with a knife edge. Thus the cutaneous structures are elevated to a level with the surrounding skin, and the irregular scar converted into a straight white line.

DISEASES OF THE THYROID BODY.

The function of the thyroid gland is probably control of the mucinoid substances in the tissues, the regulation of albuminoid metabolism and the manufacture of blood corpuscles. Its atrophy or entire removal or great diminution in its function, because of goitrous changes, is apt to be followed by the condition called myxœdema. In myxœdema the subcutaneous tissue of the patient becomes swollen. This causes a condition resembling serous œdema, except that the tumefaction is harder. The patient's lips and eyelids become puffy, his mind heavy, his speech thick, the temperature usually subnormal and his intelligence deficient almost to a condition of imbecility. There is loss of the red and increase of the white corpuscles of the blood. The condition has been attributed also to changes in the sympathetic nervous system. The treatment consists in the administration of the extract of the thyroid gland of the lower animals. The defective mental state called cretinism, found at times with goitre, is probably due to the goitrous affection causing atrophic interference with the function of the thyroid body. Acute inflammation or even suppuration of the thyroid body may occur.

Bronchocele or Goitre.

Definition.—Bronchocele is an enlargement of the thyroid body. Tumors of the thyroid body are usually included under the head of bronchocele or goitre, although in a strict sense that term should be employed for enlargements of the gland and not to its infiltration or substitution by morbid growths.

Pathology and Symptoms.—The thyroid gland not infrequently becomes enlarged in women from congestive swelling during sexual excitement, pregnancy and menstruation. The congestive enlargement so occurring may remain after the causative factor has passed away.

Thyroid enlargement may include both lobes of the gland as well as the isthmus or it may involve either lobe or the isthmus alone. At times pulsation occurs in the enlarged gland and is so evident as to simulate aneurism. In one variety of congestive goitre there is protrusion of the eyeballs and irritability of the heart associated with the enlargement of the thyroid body. This condition is a distinct general disease called exophthalmic goitre. In this affection the thyroid gland is swollen, perhaps tender on pressure, and may pulsate. The eyeballs protrude from between the eyelids, probably as a result of vascular congestion in the post-ocular tissue, and the heart's action is irregular and feeble. Often there is a murmur heard at the cardiac base. The patient is weak, anæmic and often subject to anorexia and amenorrhœa. Gradual improvement usually takes place under effective treatment lasting through many months. Cases, however, do at times end fatally.

In addition to the congestive enlargement of the thyroid body, which has been described, simple hypertrophy of the stroma and glandular elements of the organ may occur. Fibrous and cystic changes also take place in this organ, giving a form of goitre corresponding to these alterations. Simple hypertrophic goitre, which is really a fibro-adenomatous change, may follow the congestive form. The patient presents symptoms not unlike those of exophthalmic goitre, except that the ocular and cardiac symptoms are absent. Interference with swallowing and respiration may occur, as the position of the growth may result in pressure upon the trachea and œsophagus. Giddiness may be induced by similar interference with circulation through the large vessels of the neck going to and coming from the brain. In fibrous goitre the stroma of the organ increases more markedly than does glandular tissue, though the pathological alteration is similar in other respects to the simple hypertrophy just described. The thyroid enenlargement may be soft and vascular if the growth is rapid, or hard and dense if the change is more chronic in its course. The fibrous form very often affects but one lobe. Its displacing pressure is very likely, therefore, to cause lateral deflection of the trachea and œsophagus. As the thyroid gland lies below the deep fascia, any enlargement gives rise to injurious pressure upon the other organs of the neck, as has been indicated above. Such pressure is more apparent when caused by a hard, rapidly growing fibrous goitre than when the change is one of the other varieties of bronchocele. Flattening the caliber of the trachea or interference with the normal movements of the tracheal rings during respiration may cause a tendency to dyspnœa. The anatomical attachment of the isthmus of the thyroid body to the trachea causes the gland to rise and fall during swallowing. This furnishes a test in the diagnosis between thyroid enlargement and other cervical tumors. The rise and fall of the mass during deglutition of a little water or food indicate at once the thyroid nature of the growth, since enlargement of the lymphatic glands in the cervical region or other tumors of the neck would in most cases not be affected by tracheal movements. One or more of the acini of the gland may be converted into a cyst or cysts, filled with colloid, serous or bloody fluid, and constitute the cystic variety of goitre. While the wall of such cysts may be very vascular it may also at times become calcified. In extreme cases the whole thyroid body may be converted into a series of cysts. Goitre is endemic in certain regions of the world, especially in some parts of England and in the Tyrol, and is there often associated with a peculiar deterioration of the brain called cretinism which is a condition similar to, but perhaps not identical with myxœdema. This has been attributed to the atrophy of the gland which accompanies such thyroid tumors. The different varieties of goitre found in these persons attain at times enormous bulk.

The treatment of exophthalmic goitre belongs to the domain of medicine and consists in the administration of iron, digitalis and similar remedies. The treatment of congestive goitre is not unlike that of exophthalmic goitre, and consists in the use of digitalis and tonics internally, and counter-irritation by means of tincture of iodine, red iodide of mercury ointment and similar preparations externally. Ergot, ammonium chloride and potassium iodide have been advocated in this form of goitre, and are probably of value if given in large doses.

In fibrous goitre the remedies recommended for congestive and exophthalmic goitre may be applied. The benefit obtained, however, is not so evident in this form of bronchocele. When the growth is large and causes pain and other symptoms of pressure and cannot be removed, the surgeon should make a cut through the deep cervical fascia, which will permit the tumor to bulge forward, thereby relieving pressure on the important structures beneath it. The incision may be open or subcutaneous, according to circumstances. When this procedure is not effectual, the isthmus of the thyroid gland may be divided in the middle line after two strong ligatures have been applied at each side of the proposed incision to prevent hemorrhage. Cystic goitres should be subjected to evacuation by puncturing with a trocar and canula, if removal by thyroidectomy is improper.

The administration of the extract of the thyroid body of the sheep or feeding the patient with sheep's thyroid bodies has been of apparent benefit in bronchocele. Excision of the sympathetic ganglia in the neck has been performed in exophthalmic goitre.

Excision of the thyroid gland is done in cases where the size of the growth and its pressure symptoms have rendered the operative risk of such an operation justifiable. Excision of both lobes must not be performed, since removal of the whole body will lead to myxœdema, and because excision of the isthmus or of one lobe will usually remove the urgent symptoms.

The operation is in many cases an easy one, and should be done before the goitre becomes very large. The best incision is a curved one across the lower part of the goitre, with the concavity upwards. The gland should then be enucleated and displaced laterally so as to give access to its deep attachments and avoid injury to the recurrent laryngeal nerve.

CHAPTER XXI.

DISEASES OF THE MOUTH AND ŒSOPHAGUS.

Fissures of the Lips.

Pathology.—Harelip is a term applied to congenital fissure in the upper lip due to imperfect coalescence of the corresponding branchial arches. It may be single or double. The fissure, however, is nearly always a little to one side of the middle line, in a position corresponding with the suture between the inter-maxillary bone and the upper jaw of the corresponding side. When harelip is double, a small portion of the lip lies between the fissures. This central lobule may be very poorly developed. The inter-maxillary bone, which carries the incisor teeth, may be separated from the upper maxillary bone of the same side by a cleft which corresponds with the cleft in the lip. This is one of the forms of cleft palate. A cleft iu the lower lip is a rare congenital deformity, as are clefts running from the upper lip obliquely up to the orbit and clefts increasing the orifice of the mouth laterally.

Cleft of the palate is a congenital defect, corresponding in character with harelip, occupying the hard or soft parts of the palate or both. All of these conditions are due to defect in coalescence about the ninth week of fœtal life. When the alveolus is cleft and the inter-maxillary bone is separated from the other portions of the jaw by such congenital defect, the harelip is often complicated by protrusion forward of the incisor and inter-maxillary structures, which thus extend forward below and in front of the nose as a sort of snout. The nostril on the side corresponding with the harelip is usually broadened and flattened, by reason of the ala being carried outward.

FIG. 344.

Congenital lateral cleft of mouth and deformity of ear. (Author's case.)

FIG. 345.

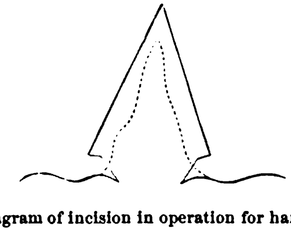


Diagram of incision in operation for harelip.

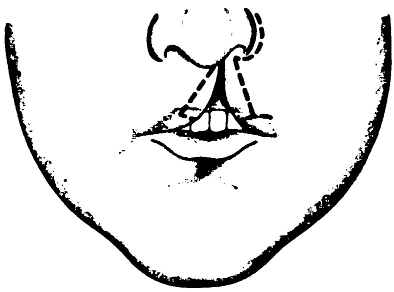
Treatment.—Harelip, if at all extensive, prevents the infant sucking well. This circumstance, as well as because it is difficult for the child's lips to be kept at rest after it has learned to speak, renders it proper to operate when the child is between six weeks and three months of age, provided, of course, that the general health is good.

The plastic operation for harelip consists in separating the upper lip from the gum; in paring the edges of the fissure, and in bringing them together with sutures in such a way as to leave no defect in the vermilion border of the lip. Union by first intention is usually obtained, if the operation is well done and the parts so arranged that there is no tension upon the sutures. Ether is usually given. A straight, narrow knife is then used to transfix the tissues on each side of the cleft and to pare away the borders beginning high up in the nostrils at the angle of the fissure. Sufficient tissue must be removed to make a wide raw surface on both edges of the cleft, so that when the lip is brought together there will be a wide surface of contact to cause union. The strip cut off may be entirely removed or a portion may be retained at the lower part in order to make the free margin of the lip bulge a little when the sutures are placed. It is often well to carry the lower end of the incision a little away from the cleft and then turn the knife toward the middle line so as to leave a tag of tissue covered with mucous membrane.

The accompanying diagram (Fig. 345) shows this incision, which is made in order that the parts which are brought together may pout a little, and prevent the occurrence of a slight notch in the edge of the reconstructed lip. If this incision is not adopted an incision concave toward the cleft is a good one, because when the concave edges are brought together in a straight line a similar pouting on the margin of the lips is accomplished. A suture of silk or other material is then carried through the two portions of the lip and across the gap just beneath the wing of the nose. The flattened condition of the nostril is thus corrected by the same stitch which brings the upper part of the gap in the lip together. A second suture is introduced about the middle of the cleft, and care is taken to pass it between the mucous membrane and the coronary artery, in order that the pressure made shall arrest bleeding. A few fine catgut or silk sutures are used along the margin of the lip and upon the internal surface, in order to bring the mucous membrane into accurate apposition. It is very important that the mucous membrane and the skin should be accurately matched at the muco-cutaneous border, as deformity is sometimes produced by having the mucous membrane run up higher on one side of the repaired cleft than upon the other. This is a very unsightly deformity after union has taken place. The lip is usually shorter on one side of the cleft than the other; and the plastic operation may be imperfect cosmetically because the surgeon fails to correct this inequality. The flattened nostril on the side of the cleft should also be improved. These objects may be attained by an incision carried around the ala, and proper suturing. The length of the lip may be further increased by a horizontal incision carried outward from the incision of denudation.

The wound is dressed with iodoform and collodion, and the child is fed either at the breast or with a spoon. The sutures are taken out upon the third or fifth day. The operation for double harelip is similar. Both clefts are pared and corrected at once. The sutures are passed through the flattened edges of the lip and through the central lobule if it be large enough to be of any service in filling the gap. The edges of this central lobule are, of course, freshened; but if it is very short, it may be necessary to preserve the parings from the lateral margins of the cleft and to use them in filling up the gap below the central portion of the lip when the final sutures are applied. In these operations ordinary sutures are better than pin sutures.

Fig. 346.



Method of lengthening short side of cleft in harelip and decreasing flattening of nose by incisions, one extending outwards along muco-cutaneous junction and one around ala of nose. (Author's method.)

In case of absence of the nasal columella as a complication it may be wise to turn up the central process of the lip to reconstruct the deficiency in the nose. If the inter-maxillary bone or its alveolar portion protrudes, it may be cut away with bone forceps or bent up into place after fracturing its attachments. The vomer, which is sometimes hypertrophied when this protrusion is present, may be retrenched by excision of a V-shaped portion behind the inter-maxillary bone. No attempt is made, as a rule at this early age, to correct the cleft in the alveolar process, since the defect is covered by the lip and can be remedied, when the child becomes older. If union by first intention fails in attempts at curing harelip, it may be necessary to do a secondary operation, in order to get a perfect result.

Cleft Palate.

Pathology.—Cleft palate, which is similar in its origin to harelip, is much more difficult to repair by plastic procedures. The cleft is in the middle line except when it is in the anterior portion of the hard palate, when it may be a little to one side of the middle line. The fissure may sometimes be double in front with the incisivė bone lying between the two clefts. It is more common, however, to have only the soft parts of the palate fissured. The operation for the repair of the soft palate is called staphylorrhaphy, while a similar operation on the hard palate is called uranoplasty. Cleft palate interferes with deglutition and speech, because it is usually impossible for the patient to close the posterior nares, which is essential in proper deglutition and speaking. In infants deglutition is often very difficult and the milk is regurgitated into the nasal cavities. These conditions are, of course, greater when the cleft is a large one or involves both the hard and soft palates.

Treatment.—In the milder form the child, when beginning to talk, should be especially trained in articulation; as by special development of the muscles he may be able to overcome this defect in speech to a great extent. In more severe cases benefit may be derived by applying to an oral surgeon for the adaptation of an artificial palate. Artificial palates, however, are not sufficiently satisfactory to prevent the adoption by many of operative proceedings in these palatal defects.

The operation for cleft palate to be most successful should be done before the child has fully acquired the art of speech. About the third year is the proper time. If the patient is young he should be etherized, but in adults the use of cocaine will render general anæsthesia unnecessary. The mouth must be held open by means of a gag. The edges of the cleft should be carefully pared, in the operation of staphylorrhaphy, from the angle of the fissure backward to the free margin of the velum, after which the two sides of the velum must be brought together by silk or wire sutures passed by means of a curved needle. Before passing the sutures in the operation of staphylorrhaphy it is well, in cases where the cleft is large, to cut the two elevator and tensor muscles of the palate, in order to diminish tension on the soft palate, which is about to be drawn together. This is done by passing a tenotome through the soft palate on the inner side of the hamular process, which can be felt at the outer side of the roof of the mouth, and carrying the edge of the tenotome upward and then downward, thus dividing the muscles. The flaccid and immobile condition produced by the division of these muscles will prove that the division has been successful. The sutures are then passed and tied. During the after treatment the patient should be prevented from coughing or talking, and fed on liquid food.

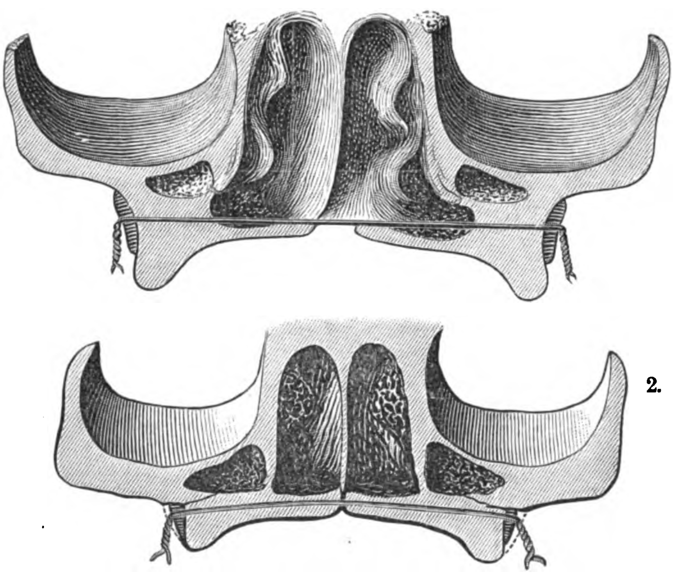
FIG. 347.

Fissure of soft and hard palate. (SMITH.)

In the operation of uranoplasty, or closure of cleft in the bony palate, two strips of mucous membrane with the underlying periosteum are separated from the hard palate on each side of the fissure and drawn toward the middle line, where they are held together by sutures. The incisions for raising the muco-periosteal flaps are made antero-posteriorly near the alveolar process, and along the edge of the cleft. The flaps are then dissected up, but are left attached at both ends. The middle portions of the strips are then pushed laterally toward the middle line and sutured, while the raw surfaces left by their removal heal by granulation. The soft palate is repaired as described above. Some surgeons prefer to cut entirely through the hard palate with a chisel and displace the detached portions of bone toward the median line. Sometimes the upper jawbones have been sawed or cut from the malar attachment and displaced towards the median line to aid in closing the gap.

If preferred by the operator, the patient's head may be allowed, in operations on the palate, to hang over the end of the table, so that the roof of the mouth is below the operator. The blood then runs into the nose and does not obscure the field of work. It is perhaps wise to divide the operation into two stages; by first closing the gap in the soft tissues and operating on the hard palate a few months later.

FIG. 348.



No. 1. Manner of placing sutures. No. 2 shows gain in closing defect after cutting malar process.

Operations for the relief of cleft palate, even when extensive, are often quite successful, but at best they make a rather poor substitute for the normal roof of a mouth. Subsequent to their use, careful training of the child in articulation is very important.

Epithelioma of the Lip.

¶ **Symptoms.**—Herpes, ulcerations of the non-malignant kind and inflammatory fissures or cracks in the lip belong to medicine. Epithelioma of the lower, however, is so common an affection, especially among men, that it deserves special attention at this point. It is possible that smoking a clay pipe and similar long continued irritations may be factors in the causation of this malignant disease. The upper lip is occasionally the seat of epithelioma. At first the variation from health in the tissues is so slight that it is overlooked; but after a time the patient notices a small hard nodule, which subsequently ulcerates, or an intractable ulcer or fissure appears upon the lip and refuses to heal. Induration about the base of the lesion steadily and gradually increases in size; and a little later, involvement of the submaxillary and cervical glands gives evidence that the disease is a malignant one. Epithelioma of the lip does not cause much pain; when ulcerated a thin discharge is secreted. Death may take place from exhaustion or hemorrhage or from secondary involvement of the internal organs.

Epithelioma and lupus of the lip are sometimes similar in appearance, but the latter does not involve the cervical and submaxillary glands. The diagnosis between epithelioma and chancre of the lip is exceedingly important. Chancre occurs at any age, while epithelioma is more common after the age of forty years. Chancre begins as an ulcer, as a rule, whereas epithelioma ordinarily begins as a nodule. In the syphilitic affection the lymphatic glands are involved earlier; the sore, even when it attains its maximum, is not so extensive in its progress as the malignant affection; and in addition there may be some syphilitic fever. Syphilitic eruptions may also appear and assist in the diagnosis; and finally the syphilitic sore promptly yields to mercurial treatment. Before secondary involvement of the internal organs occurs, epithelioma of the lower lip usually involves the lymphatic glands under and behind the jaw. The original site of disease and the involved glands slowly ulcerate, and destruction of the tissues about the mouth and throat is finally very extensive.

Treatment.—Labial epithelioma should be treated by prompt and radical operation, except when the disease has extended as indicated; then prolongation of the patient's life by anodynes and supporting measures is all that can be done. Excision of epithelioma of the lip is accomplished by the removal of a V-shaped portion of tissue with the base of the wedge at the margin of the lip. During the operation the lip is held everted by an assistant's fingers, which also press upon the coronary arteries at each side of the proposed incision. The excision should be done soon enough to insure entire removal of the malignant mass. The divided lip must then be brought together by two or three sutures, so passed as to make pressure upon the coronary arteries and prevent bleeding. Along the edge and inner surface of the lip the mucous membrane should be united by fine catgut sutures. The wound should then be dressed with a little aseptic gauze or absorbent cotton, held in place by collodion painted upon it. It may be necessary in more extensive infiltration to cut a larger portion of the lip away and to construct a new lip from the tissues covering the chin by slipping up one or two large cutaneous flaps.

Excision of a portion of the jaw is required if the disease has involved the bone tissue. Enlarged lymph nodes under the jaw and in the neck should be removed at the same operation. The prognosis after excision of epithelioma of the lip is usually quite good, if the portion attacked permits of free removal. If the growth returns, it should be removed a second time. Much more favorable results will be obtained if the original operation is extensive and includes removal of the submaxillary lymphatic nodes.

Tumors of the Mouth.

Tumors of various kinds may be found upon the buccal surface of the cheeks and in the floor of the mouth. The most common form, perhaps, is the cystic tumor, occurring beneath the tongue and usually upon one side of the frænum, to which the term ranula is frequently applied. Ranulæ contain a more or less transparent, gelatinous fluid, resembling saliva. They are sometimes dilated ducts of the submaxillary or sublingual glands, and at other times occur as dilatations of the ducts of the mucous glands in the floor of the mouth. True hydatid cysts have been found here, and the bursa above the hyoid bone has been known to become enlarged and resemble ranula. These cystic tumors are soft, elastic swellings, which gradually increase in size. They sometimes become so large as to push out the tissues of the neck below the jaw and make a distinct bulging upon the exterior of the throat. Adipocere and rice-like bodies have at times been found in ranulæ.

The treatment of these non-malignant growths consists in puncturing the sac so that evacuation of fluid takes place, and then setting up sufficient irritation of the lining membrane to cause obliteration of the cavity. This last object may be obtained by scraping the interior of the sac with the trocar and canula, with which its fluid contents have been withdrawn, or by laying open the sac with a knife and mopping out its interior with chloride of zinc or carbolic acid solution. Some surgeons prefer to operate by making an opening in the cyst wall, and keeping the orifice patulous by turning a portion of the wall inward and stitching it with its external surface toward the interior of the sac. A seton may be passed through the sac, so as to evacuate its contents and give rise to plastic adhesion of its walls. Large cysts projecting externally may require to be attacked by incision in the neck. After evacuation, the cavity of the cyst is then stuffed with antiseptic gauze. It is occasionally possible to dissect out the cyst by means of external incision.

Alveolar Abscess.

Abscesses of the alveolar process may be superficial, when they are called gum-boils, or deep, as when the pus originates in the tissues around the root of a tooth. These abscesses are usually due to disease of the teeth. The pus in superficial abscess is not confined by bony tissue, as in the deeper form, and is, therefore, the seat of but moderate pain. In those cases in which the pus is confined in the dense walls of the tooth sockets the pain is excruciating and is only relieved when the pus is evacuated either spontaneously or by drilling the bone or the tooth. Removal of a filling which has been previously placed in a carious cavity in the crown of the tooth by the dentist may afford exit to the confined pus. Escape of the pus gives instant relief from pain. When the pus does not thus find its way through the tooth or the bone in which the tooth is lodged, it may finally be evacuated alongside of the tooth after it has reached the upper edge of the socket. Occasionally, the suppurative process gives rise to a fistulous opening in the cheek or in the roof of the mouth, and may even cause destruction of the palate bone and penetrate into the nasal cavity.

The treatment of alveolar abscess consists in the use of leeches locally to the gum; painting the gum with tincture of aconite root; the application of heat and moisture, which is best accomplished by the use of a hot fig or raisin applied to the gum; incision of the gum, and, in deep abscesses, boring of the bone or tooth, in order to permit the escape of pus. In many instances the tooth should be seen by a competent dentist, since removal of the filling and treatment of the abscess cavity through the tooth may hasten cure and preserve the structure.

Acute subperiosteal abscess may occur in connection with alveolar inflammation and lead to more or less extensive destruction of the bone by necrosis. Early and thorough incision is the proper treatment.

Tumors of the Jaw.

Growths involving the alveolar process of the jaw, but not the bone very extensively, have long been given the name epulis. This term, however, should be discarded, since it has no strict definition. Many cases of so-called epulis would be better understood and more effectively treated, if called tumors of the jaw and described by their proper adjective as fibromatous, sarcomatous or carcinomatous. The common growth to which the term epulis is applied is a fibrous mass, usually if not always arising from the periosteum or bone and presenting itself as a smooth, firm, elastic growth alongside of or between the teeth. It may become ulcerated. These fibromas are more common in the lower than in the upper jaw, and they appear to be due to the irritation caused by decayed teeth. Such fibromas should be removed by operation within the mouth in order that the scar may not appear upon the cheek. They are ordinarily easily cut away with a strong knife or gouge, though it may be necessary to extract one or more teeth in order to make the extirpation complete. They are not apt to return.

Malignant tumors of the jaws, whether occupying the alveolus, and therefore being a form of epulis, or arising from the central portion of the jaw-bone and gradually extending to the surface, should be removed by very free incision through the soft tissues and bone. Such malignant growths require total or partial excision of the jaw. The amount of bone to be removed depends upon the time at which the operation is done.

Non-malignant growths of the jaws, as has been stated, may require only partial excision of the bone or possibly may be enucleated without taking away much of the bone tissue. Malignant disease, however, whether it involve the upper or lower jaw, should if possible be removed by very free incisions and by enucleating any of the corresponding lymphatic glands. Where it is impossible to get beyond the recognized limits of the disease, operation may be unjustifiable, although some instances seem to indicate that removal of the major portion of the growth by means of a knife and the application of chloride of zinc solution to the surface left may be followed by prolongation of life. Actinomycosis shows a predilection for the jaws, because of the ease of infection by the mouth. The tumor caused by actinomyces resembles malignant disease and syphilitic necrosis. The yellowish bodies characteristic of the presence of the ray-fungus will suggest the diagnosis. Microscopic examination will be conclusive. Excision is the proper treatment.

Cystic, as well as solid, growths may develop within the antrum, or cavity of the upper jaw bone. Such tumors occasion great deformity as the growth pushes the walls of the antrum into the neighboring fossæ or outward upon the face. By this means the eyeball may be protruded because the floor of the orbit is raised; the nasal chamber may be occluded; the hard and soft palate may be pushed downward, and the face may be deformed by protrusion of the cheek. Difficulty in breathing and difficulty in swallowing may result from such antral growths. Cerebral complications may also occur, as well as blindness and profuse nasal hemorrhage. Solid growths in the antrum are to be distinguished from cystic growths by their firmness, and by the fact that in the latter case fluid is evacuated when the antrum is tapped from within the mouth above the canine tooth. Cystic tumors within the antrum may owe their origin to the abnormal development of a tooth within the antral cavity. Such dentigerous cysts are not uncommon. Odontomas, or tumors having a structure like the teeth, are found in the jaws.

Necrosis of the Jaw.

Necrosis of the jaw is not uncommon in those exposed to the fumes of phosphorous acid in the manufacture of matches. It is probable that this disease, called phorphorus necrosis, occurs only when the patient is the subject of diseased teeth. The necrotic portion of bone should be removed by operation within the mouth so as to avoid a scar. This should not be done ordinarily until the sequestrum has became detached, because it is desirable to retain the integrity of the arch of the jaw bone which in earlier attempts at removal may be fractured. Where the sequestrum is very large it may be necessary to make an external incision. The application of artificial dentures to the defective bone after the removal of such large portions may give a useful lower jaw. Workmen in match factories should be scrupulously attentive to the condition of their teeth. The use of the tooth brush twice a day and proper treatment of caries by a dentist render phosphorus necrosis improbable.

Necrosis also occurs secondarily to some of the essential fevers, and as a symptom of tuberculosis, syphilis, injuries, diseased teeth and excessive mercurialization.

DISEASES OF THE TONGUE.

Tongue-tie.

When the frenum of the tongue is abnormally short, preventing the protrusion of the tip beyond the teeth and limiting its movements within the mouth, tongue-tie is said to be present. This condition sometimes prevents a young child from suckling and in older children interferes with perfect articulation. Tongue-tie, however, does not prevent speech and make a child dumb, as is sometimes supposed by the laity.

When tongue-tie exists to any marked extent it should be remedied by clipping the edge of the frenum with the scissors. The incision should be about one eighth of an inch deep. The surgeon's finger can then tear the tissue and establish lingual movements. The ranine arteries lie in the frænum close to the lower surface of the tongue. Division of these vessels is avoided by keeping the point of the scissors turned downward. A suture may be applied so as to bring the edges of the mucous membrane together and prevent union in the original position; or the finger may be used daily to keep the tongue free, until repair by granulation occurs.

Inflammation of the Tongue.

Glossitis, or inflammation of the tongue, may be acute or chronic, simple or specific. Simple or superficial inflammation of the mucous membrane of the tongue occurs in connection with stomatitis or inflammation of the mouth. Stomatitis is applied to inflammation of the mucous membrane lining the cheeks, lips and other oral structures. It may arise from digestive disorders, the administration of iodine, mercury and other drugs and as a lesion of secondary syphilis. Mucous patches and erythema are the pathological conditions of the mouth most prone to follow syphilis. It must be remembered that chancre itself may be found in the mouth. Syphilis may be exhibited by mucous patches, gummy deposits or ulceration in the tongue. General parenchymatous inflammation of the body of the tongue of an acute kind occasionally occurs and is quite a serious condition. It may be due to wounds or to insect bites, or it may occur without apparent cause. The tongue is swollen and red and shows a smooth surface. Pain, which is great, is perhaps increased during efforts at taking food. The flow of the saliva is abundant and the interference with respiration may be marked. The condition is occasionally followed by sloughing.

Syphilitic glossitis requires constitutional treatment and local stimulating applications. Acute parenchymatous glossitis should be treated by leeches applied under the jaw externally and the use of cracked ice in the mouth, while the patient is nourished with liquid food. If these means do not relieve the swelling and the inflammatory symptoms, incision should be made in the tongue to the depth of one half inch along each side of the middle line, beginning well back upon the dorsum of the tongue and extending nearly but not quite to the tip. The relief from tension and swelling given by this incision will usually be immediate. Antiseptic mouth washes should be freely used thereafter.

Injuries to the tongue and the impaction of foreign bodies in the organ give rise at times to acute or chronic suppurative inflammation, or abscess, of the tongue. If the puriform fluid lies deeply in the organ, the chronic abscess may be surrounded with infiltrated tissue sufficiently hard to cause resemblance to a tumor imbedded in the lingual muscles. Such abscesses of the tongue are treated by incision and the removal of more or less inspissated puriform fluid with the curette. Chronic abscess is probably tubercular in its etiology. Tubercular inflammation may cause a condition resembling epithelioma.

In addition to these forms of glossitis there occurs a chronic superficial inflammation to which the names leucoma, psoriasis and ichthyosis have been applied.

Epithelioma of the Tongue.

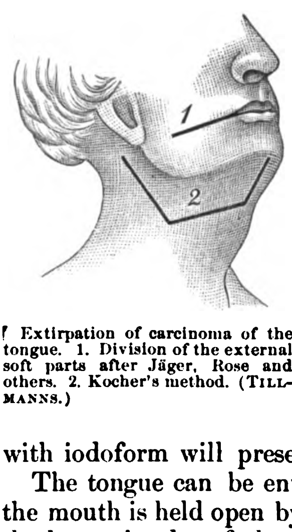
Pathology and Symptoms.—Benign and malignant tumors may occur in the tongue, but the most common of all is the epithelioma, which is a disease with distressing symptoms. It is more frequent in man than in woman, is a disease of rather advanced life and apparently may arise secondarily to superficial glossitis. Smoking, the immoderate use of spirituous drinks and of condiments and irritation from jagged teeth, as well as syphilis, have been suggested as possible predisposing causes.

Epithelioma of the tongue appears usually on one side of the middle line toward the root of the organ. Superficial ulceration with indurated base and edges is an early evidence of the disease. The pain is at first slight, but the discomfort increases during eating and other movements, until it becomes very great. The saliva flows more freely and the breath becomes fetid. The floor of the mouth and fauces become involved, as do also the lymphatic nodes below the angle of the jaw. Slight or profuse hemorrhage may occur. Impaired nutrition, due to the difficulty in feeding and the swallowing of foul secretions, is soon evident. If one of the lingual arteries is opened by ulceration, fatal hemorrhage is liable to supervene, while death may also occur from septic pneumonia, due to inhalations of the secretions from the malignant growth.

The diagnosis between epithelioma of the tongue, ulcerative syphilitic gumma and tubercular ulceration is at times difficult; but the doubt can easily be cleared up as to syphilis by the use of mercury and potassium iodide in full doses. Specific disease under this treatment will soon show evidence of improvement. Tubercular glossitis sufficiently grave to simulate epithelioma may require similar operative removal.

Treatment.—The only effective treatment for epithelioma of the tongue is early and complete removal of the whole tongue and of the lymphatic nodes below the jaw. When the disease has progressed to the involvement of the floor of the mouth before the surgeon is consulted, it may be doubtful whether operation is justifiable. In such a case ligation of both lingual arteries may possibly retard the development of the growth, and excision of a portion of the lingual nerve on the side affected may relieve pain. This nerve can be felt in the mouth, lying underneath the mucous membrane at the angle of the lower jaw, vertically below the second lower molar tooth. An incision through the mucous membrane will enable the operator to take up the nerve by means of a hook and to excise a portion of it. This neurectomy lessens pain and diminishes the uncomfortable flow of saliva. The pain which makes lingual movements distressing may also be mitigated by painting the diseased tissue with cocaine, about forty grains to the ounce. The patient may require feeding by enemas or by having a tube passed through the nostril into the pharynx. Œsophagotomy may be available for feeding in cases where the fauces are obstructed by the growth.

FIG. 349.



Extirpation of carcinoma of the tongue. 1. Division of the external soft parts after Jäger, Rose and others. 2. Kocher's method. (TILLMANNS.)

It has been proposed to perform tracheotomy in order to prevent inhalation of the foul discharges which give rise to septic pneumonia. This seems scarcely necessary, since the free use of antiseptics with occasional powdering of the diseased tissues with iodoform will preserve a fairly clean condition of the ulcer.

The tongue can be entirely removed by dragging it forward while the mouth is held open by a gag, or by variously shaped incisions under the lower border of the jaw or from the margins of the mouth. A strong string passed through the organ at its tip will give the operator control of it and enable him to pull it well out of the mouth. By successive manipulations with the scissors the organ can be cut away without difficulty, and the spurting vessels tied as they are divided. It is well to have a ligature of silk passed through the stump and brought out of the mouth after the removal of the organ, in order that the patient may not be suffocated by the base of the tongue falling backward into the pharynx. This danger does not exist after twenty four hours have elapsed.

It is often advantageous to split the tongue in the middle line antero-posteriorly before attempting its complete removal with the scissors. The mouth should be well packed, after drying the stump, with iodoform gauze, which should be pushed into every irregularity of the mouth and retained several days until cicatrization of all the surfaces has been accomplished. The patient should not be allowed to talk or take food by the mouth for a week. Alimentation can be kept up by the rectum. If this radical operation is done early in the course of the disease, a considerable prolongation of life is usually secured. It is, however, bad surgery to attempt partial removal of the organ in cases of malignant disease.

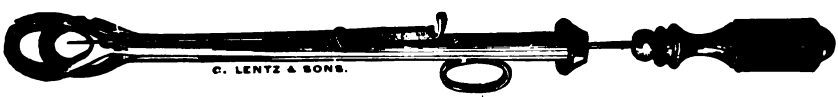
Subsequent to the removal of the tongue, the speech is not so imperfect as would be expected.

Diseases of the Tonsils.

Tonsillitis, or quinsy, may go on to suppuration and require incision for the evacuation of pus. A sharp pointed bistoury should be carried through the swollen gland and the surrounding tissue until the pus collection is entered. Usually the abscess is localized at the upper point of the tonsil, where it joins the soft palate. The point of the knife must never be carried outward, since the internal carotid artery lies just external to the gland. Detergent washes should be used after the operation. Relief is immediate. A solution of sodium bicarbonate has been highly lauded as an application in quinsy prior to the stage of suppuration. Syphilitic lesions and malignant tumors are at times found in the tonsil glands.

Hypertrophy of the tonsils is a chronic condition, probably inflammatory in its character, which is often seen in children. These enlarged tonsils are frequently associated with recurrent attacks of inflammation of the throat, and it is possible that they may have some relation to local tubercular infection. The increase in size may be so great that the enlarged glands extend to or beyond the middle line of the fauces, so that the opposite growths come in contact and result in mutual pressure. Ulceration of the masses may be thus induced. The disease causes obstruction to breathing and swallowing, and compels the child to keep its mouth open almost constantly and to snore during sleep. When the enlarged glands are attacked with acute inflammation, the difficulty in breathing may approach suffocation.

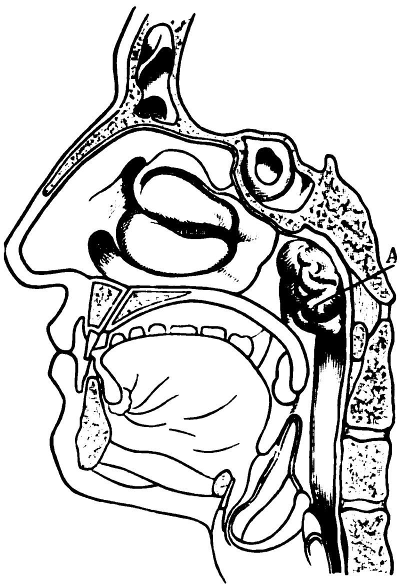
FIG. 350.



Tonsillotome.

The medical treatment of enlarged tonsils consists in the use of astringent gargles, the application of nitrate of silver, improved hygienic surroundings and the internal administration of good food, cod liver oil, iodide of iron and other tonics. Surgical treatment is often demanded because of the inefficiency of these measures. It consists in excision of a portion of the enlarged gland by means of a guillotine or tonsillotome. The operation is not a dangerous or a painful one, and may be done to very young children without an anæsthetic. A solution of cocaine may be painted upon the surface of the enlarged tonsils, if the child is very sensitive. The portion of the growth which projects into the ring of the tonsillotome, when it is laid over the organ, is removed. By pressure on the outside of the throat with the finger, the surgeon may thrust a larger portion of the tonsil into the ring of the tonsillotome and thus be enabled to remove more of the hypertrophied gland. Even when only a comparatively small portion is cut away the operation is successful, since atrophy of the hypertrophied mass is very apt to occur afterward. The hemorrhage usually is only very slight, although cases have been reported in which it has been profuse. In such cases it is proper to seize the bleeding point with a hemostatic forceps, which should be left in position for a few hours. Detergent gargles should be used after the operation.

FIG. 351.



Position of adenoid vegetations as commonly located in the upper pharynx. (PARK.)

When the circular knife, to which the name guillotine or tonsillotome is applied, is not at hand, the hypertrophic tissue may be cut away with a probe pointed bistoury, after the apex of the mass has been seized with a pair of toothed forceps. This method is less rapid, and more apt to frighten the child, than the other. Hypertrophy of the pharyngeal tonsil, the so-called adenoid growths in the pharynx, is apt to be associated with enlarged faucial tonsils. The condition also causes obstruction to nasal respiration and should be treated by operative removal of the adenoid growths as has been previously stated.

Salivary Fistule.

Fistules of the salivary ducts may be upon the inside or upon the outside of the mouth. If the abnormal opening is in the oral cavity itself, it requires no treatment. If, however, the opening is so placed that the saliva escapes upon the external surface of the face, it is necessary to operate in order to turn the current into the mouth. Salivary fistules are due to wounds, to abscesses, to calculi impacted in the ducts or to obstruction from inflammation of the ducts. The amount of saliva that escapes from a salivary fistule during mastication may be as much as a drachm within a few minutes. The fluid can be recognized as salivary by the characteristic test with potassium sulpho-cyanide and with ferric chloride.

The treatment of salivary fistule must begin with the removal of the calculi or other causative influence. A new opening must then be made from the mouth into the duct behind the site of the external opening. This may be done by inserting a probe into the external orifice, passing it along the duct upward toward the gland and making its point push up the mucous membrane in the mouth. An incision can then be made upon the point of the probe and a comparatively large opening made from the duct into the mouth so that the saliva will flow into the buccal cavity. This new orifice must be kept open by means of daily insertions of a probe from within the mouth. When the internal opening has been permanently established the external fistule will soon heal; if it does not, the orifice may be closed by the application of caustics or by a plastic operation.

Retro-pharyngeal Abscess.

Retro-pharyngeal abscess is a collection of pus between the posterior wall of the pharynx and the anterior surface of the vertebral bodies in the cervical region. It occurs especially in children of unhealthy constitution. It may result from caries of the cervical vertebræ, from suppuration of the lymphatic nodes behind the pharynx or from suppuration in some neighboring region burrowing behind the constrictor muscles of the pharynx. Acute abscess is necessarily more dangerous and more rapid in its course than a chronic tuberculous collection of puriform matter in this locality. The difficulty in breathing and swallowing associated with a soft, fluctuating swelling at the back of the pharynx makes the diagnosis evident. The abscess is not always in the middle line and may give rise to some stiffness of the neck due to an attempt on the part of the muscles to fix the vertebral articulation and prevent pain. In the event of spontaneous evacuation of the abscess there is danger of the quantity of pus being large enough to suffocate the patient from its entrance into the larynx. In rare cases the pus burrows into the posterior mediastinum or along the muscle sheaths and fascial spaces of the neck. Early and free evacuation of the pus is the essential treatment. It is accomplished by making a vertical incision through the posterior pharyngeal wall while the patient's mouth is kept wide open. It may be wise to evacuate the major portion of the pus by means of a trocar and canula in order that the gush of fluid may not asphyxiate the patient by getting into the larynx. Subsequently the cavity must be freely opened with a knife. Astringent and disinfectant washes should thereafter be used. Occasionally the pus may make its way laterally, and the abscess be readily opened and drained from the outside of the neck.

DISEASES OF THE ŒSOPHAGUS.

Wounds of the Œsophagus.

Wounds of the œsophagus, if external, are usually indicated by the escape of food from the opening. Deglutition is accompanied by pain, and emphysema of the cellular tissues of the neck may occur as a secondary symptom.

Rupture of the œsophagus may occur, though rarely, as a result of violent vomiting, and more frequently as a sequence of stricture or malignant disease which has caused softening and thinning of the coats. Feeding with liquids introduced by means of a tube passed through the injured gullet is necessary in these cases, if nutrition is not kept up by means of rectal injections. External wounds should be sutured by means of stitches passed through the œsophageal wall, and provision for drainage externally should be made because of the dangers of pus collection in the deep tissues of the neck. Such retained pus might very readily be the cause of mediastinal abscess or pleural inflammation.

Foreign Bodies in the Œsophagus.

Pathology.—Foreign substances swallowed may be caught in the pharynx or œsophagus instead of passing into the stomach. Dental plates and artificial teeth are not infrequently thus swallowed, and food sometimes becomes impacted in the œsophagus and gives rise to trouble. Very rarely fruit stones and substances which have previously entered the stomach have become impacted in the œsophagus during vomiting. Bullets and other missiles may enter the œsophagus through external wounds in the neck and throat. Persons of hysterical temperament sometimes imagine that foreign bodies are lodged in the gullet when no such condition exists.

Sharp pieces of bone may, during their passage through the gullet, scrape the mucous membrane and cause irritation, thus giving the patient the sensation of a foreign substance impacted in the canal after the vulnerating body has actually passed into the stomach.

Symptoms.—A comparatively large foreign body, lodged in the upper end of the œsophagus or in the lower portion of the pharynx, causes a feeling of suffocation, violent paroxysms of dyspnœa on attempting to swallow, repeated and vigorous efforts at deglutition, retching, spitting of saliva possibly mixed with blood, bulging of the eyes and great anxiety on the part of the patient, accompanied with sweating and prostration. Pressure on the larynx by, or a spasmodic condition of the glottis produced by irritation from, a foreign body may cause asphyxia and death. Loss of voice, dysphagia and pain are also symptoms. The combination of symptoms seen varies with the size and character of the impacted body. Small and sharp foreign substances will give rise perhaps to difficulty of respiration without much actual interference with swallowing, but are apt to be accompanied with bloody expectoration. The position of the body also causes change in the combination of symptoms. It is possible in some cases to feel the obstructing substance by thrusting the finger into the back part of the fauces and down the pharynx or by palpation of the throat externally. Auscultation of the œsophagus by means of the stethoscope, placed upon the exterior of the neck, sometimes gives aid in diagnosis, because fluids or other food swallowed are arrested or diverted in their course by the impacted substance and therefore produce sounds which can be distinctly heard through the stethoscope.

Inflammation of the œsophagus followed by ulceration, perforation, or abscess may result from prolonged retention of a foreign body; and cicatricial contraction due to such inflammatory processes may cause stricture of the œsophagus. Secondary to this stricture, dilatation above the point of stricture and contraction of the normal tube below may supervene. Perforation from a sharp foreign body or from abscess may involve the pericardium, the heart, the trachea, the pleura, the mediastinum or the aorta. Such secondary lesions are more apt to occur and prove fatal when the foreign substance is lodged low down in the œsophagus. The presence of a foreign body in the gullet may often be proved by carefully passing into the œsophagus a bougie or probang, which consists of an olive shaped tip attached to a long, flexible stem. It may, however, slip by a small bone or similar object without dislodging it and without giving the sensation of having passed an obstruction. Skiagraphy will reveal the position of bodies which cause a shadow when subjected to the X-ray. Foreign bodies in the trachea may cause difficulty in the diagnosis by this means of investigation.

FIG. 352.

Skiagraph of Dr. T. S. K. Morton's case of whistle in the œsophagus.

Treatment.—Masses of food and foreign bodies of moderate size may be carefully pushed into the stomach by the œsophageal bougie. This operation should be very carefully attempted lest the œsophagus be ruptured or the mucous membrane scraped loose. Substances lodged in the upper portion of the gullet may be extracted through the mouth by the finger of the surgeon or by curved forceps. Several forms of instruments to draw out coins and similar substances from the lower part of the œsophagus have been constructed. A very good method is to fasten a dry piece of a sponge to the end of a rod of whalebone and pass this beyond the obstruction. The sponge, after becoming swollen by the fluids of the œsophagus, fills the caliber of the tube and on being withdrawn brings up the obstructing substance. A somewhat similar instrument is made of horse hair, which after its introduction and passage beneath the obstruction is distended until it fills the tube. Its withdrawal carries the offending substances upward into the mouth. A special instrument is made for extracting coins from the œsophagus.

Vomiting may be induced by hypodermic injections of apomorphia (gr. $\frac{1}{12}$ to gr. $\frac{1}{10}$) or by the administration of emetics by the stomach, to cause ejection of the body in the œsophagus. Inversion of the patient's body has sometimes been successful in causing expulsion of the offending substance. There is, however, in this procedure some danger of causing asphyxia from the foreign substance becoming lodged in the upper portion of the œsophagus or at the opening of the glottis. Where the symptoms of dyspnœa are marked, either before the attempt at removal or during such effort, tracheotomy should be performed as a preliminary precaution.

If the methods described are ineffectual in relieving the patient's condition, it then becomes necessary to open the œsophagus. This operation is called œsophagotomy. If the operation is done high up in the throat the name pharyngotomy is applied. External œsophagotomy or pharyngotomy is usually performed on the left side of the neck, because the œsophagus is located a little to the left of the median line. If, however, the body to be extracted is more prominent on the right side, there is no objection to making the incision on that aspect.

During the operation the head should be turned a little to the right. An incision parallel to the anterior border of the sterno-cleido-mastoid muscle should be made, beginning on a level with the upper border of the thyroid cartilage and extending downward toward the sternum for four or five inches. This incision should be carried through the tissue between the sheath of the carotid artery and the sterno-hyoid and the sterno-thyroid muscles. The thyroid body and trachea should be pushed toward the middle line and the sheath of the carotid vessels drawn outward. In this space will be seen the omo-hyoid muscle which may be drawn aside and divided. Care should be taken to avoid the inferior thyroid artery, and also the recurrent laryngeal nerve. The latter structure lies in the groove between the trachea and the œsophagus. When the gullet has been exposed at the bottom of the wound, it is well, if the foreign body does not make a projection, to pass a bougie with a large tip through the mouth, in order that the gullet wall may be pushed up toward the surface and be made easily accessible for incision. A silk ligature may be passed through the œsophageal tissues by means of a curved needle, in order to give the surgeon control and to enable him to lift the wall toward the external wound. A small incision is next made into the œsophagus and an exploratory finger passed into the opening, which is subsequently enlarged in a longitudinal direction if necessary. The foreign body is then extracted with forceps, the œsophageal wound is closed with sutures and provision made for drainage of the external wound, the edges of which may be united by buried and superficial sutures.

Tumors of the Œsophagus.

Pathology.—Growths of benign character are quite rare in the œsophagus, but primary malignant disease in this locality is not infrequent. Of the forms of tumor epithelioma is the most common, and it usually attacks the œsophageal tube either at the upper or lower extremity. The affection is one occurring late in life, and more frequently, it would seem, in man than in woman. Involvement of the surrounding lymph nodes and tissues is quite common and ulceration of the growth usual. The disease has a rather rapid course toward death, its average duration being from four to sixteen months. The fatal issue occurs from hemorrhage; from starvation, the result of the contraction caused by the growth preventing the administration of food; from asphyxia, due to pressure on the trachea and the primary bronchi, and from secondary lung conditions.

Symptoms.—The symptoms are like those of non-malignant stricture hereafter to be described, and consist of pain, difficulty in swallowing, regurgitation of food, offensive breath, delayed digestion, constipation, inanition and great debility. The gullet is apt to be dilated above the site of the epitheliomatous stricture and may become perforated by ulcers in the neighborhood of the malignant growth. Symptoms arising from pressure upon the neighboring viscera may be prominent, and in some cases there is external evidence of tumor.

Diagnosis.—The early stages of malignant disease of the œsophagus may resemble hysterical stricture. A tumor outside of the œsophagus pressing the wall inward will give similar symptoms and at times render diagnosis of the true condition difficult. Exploration of the œsophagus with a flexible bougie, such as was described in the discussion of foreign bodies lodged in the œsophagus, will prove the existence of a growth of some sort, if the contraction made by it is at all conspicuous. It may be possible to differentiate the histological elements and to characterize the nature of the growth by microscopical examination of the tissue scraped off by the bougie.

Fibroid growths of the œsophagus give the impression of a smooth surface when touched with the bougie, are much more resistant than a malignant tumor and do not bleed. Hemorrhage occurring after careful manipulation suggests malignant tumor, as does, of course, the existence of a purulent, bloody discharge.

Treatment.—If the disease is situated in the upper portion of the tube, œsophagotomy may permit the removal of the tumor if small, or œsophagostomy, which is the formation of a permanent opening in the œsophagus, will establish an opening by which food can be administered. Removal of such growths by opening the gullet is only justifiable when the disease is limited. In other cases a small bougie may be passed every two or three days in the effort to keep the tube open and to allow the food to be administered by the normal channel. If the operations suggested are not deemed advisable, the performance of gastrostomy will permit feeding by the fistule made in the stomach. Gastrostomy is often delayed so long that the patient is too weak to enjoy long the benefit of the operation.

Stricture of the Œsophagus.

Pathology.—Diminution in the caliber of the œsophagus may be due to organic changes and contractions, resulting from malignant disease and the other conditions which have been mentioned, and to cicatricial contraction following inflammation of the œsophageal coats. Swallowing hot liquids or strong acids and alkalies with suicidal intent, or by accident, are frequent causes of such coarctations. Syphilis, tuberculosis of the mucous and submucous tissues of the gullet and wounds due to foreign bodies may, in a similar manner, lead to obstruction in the œsophagus. So also, aneurism, foreign bodies in the trachea and abscesses or tumors outside the œsophagus may, by pressure upon its walls, cause diminution of its caliber. The condition called œsophagismus, or spasm of the muscular coat of the œsophagus, which occurs at times in hysteria, gives rise to symptoms of stricture. A bougie can, however, be readily passed through the contracted portion and meets in its passage with no perceptible resistance. Indeed, the successful introduction of such a bougie will often convince the patient that no danger from obstruction exists and be thus the means of curing the symptoms. Auscultation with a stethoscope, placed over the œsophagus on the left side of the neck, is said to give information that the stricture is spasmodic and not an organic one. In the former case food which has been swallowed is regurgitated immediately; but in the case of true stricture regurgitation of ingested materials is more slow. Œsophagismus, moreover, is intermittent and not constant. The medical treatment of this hysterical affection consists in curing the coincident nervous symptoms. Fibroid or cicatricial strictures usually take place in the upper part of the œsophagus or in the pharynx. The contraction may be due to a puckering of the inner coats of the tube at the site of the scar, it may consist of a crescentic ridge extending partly around the tube on its internal surface or it may be a cicatricial ring involving the entire circumference of the gullet. Abscess about the injured portion may be present.

Symptoms.—Difficulty in swallowing solid food is one of the early symptoms of œsophageal stricture. If the contraction increases, deglutition of liquid foods soon becomes difficult. Regurgitation of food may take place after it has reached this stage, and may be slight or amount to actual œsophageal vomiting. The time at which regurgitation or vomiting takes place, after the attempt at swallowing food, gives an approximate idea of the position of the disease. The food when ejected may be more or less putrid and mixed with blood or smeared with mucus. A discharge from the œsophagus, having a coffee color, is symptomatic of malignant disease. The pain is usually slight at first, unless there is acute inflammation accompanying the stricture; severe pain may then be experienced. It may radiate to the shoulder and to the epigastrium. The location of the most severe and constant pain may indicate the seat of stricture, which may be more or less certainly ascertained by the sense of stoppage in the food tract when the patient endeavors to swallow nutriment. The use of the stethoscope may give the surgeon an idea of the position of the disease, because he may thereby learn the point at which food stops in swallowing or the point through which the food passes with difficulty. Palpation of the throat may at times reveal the mass which has caused the obstruction. The lodgment of the food which takes place above the contracted portion causes dilatation and hypertrophy of the wall of the gullet. Great debility and emaciation are later symptoms of the disease and are particularly slow in their progress when the stricture is a cicatricial one rather than a malignant one.

The passage of an œsophageal bougie will give the surgeon information as to the distance from the front teeth and the length, number and caliber of the contracted portions.

Treatment.—The treatment of œsophageal stricture consists in giving rest to the diseased organ, in nourishing the patient and in dilating the contracted tube. Rest is obtained by keeping up the patient's nutrition through rectal injections of milk, broth and other nutritious articles. This procedure is of special value if there is great sensitiveness of the œsophagus, since efforts at alimentation through the œsophagus then cause great distress and depression of the patient.

Dilatation of the contracted and contracting œsophagus is accomplished by the introduction of bougies with conical tips, the size of which is gradually increased. The bougie should not be passed oftener, as a rule, than once in three days, but at one sitting two or three increasing sizes may be successively introduced, each of which may be left in position about ten minutes. Such intermittent dilatation should be made in a gradual manner, since attempts to pass a large bougie after the passage of a much smaller one, is liable to cause laceration of the tissues. Rapid dilatation is not safe. Continuous dilatation can be accomplished by the introduction and leaving in position of tubes large enough to stretch the strictured portion slightly. Through this tube, which may be allowed to remain for three or four days, food may be introduced. At the end of this time the tube should be taken out to be cleaned, and should then be reinserted or succeeded by a tube slightly larger.

Internal œsophagotomy, or division of the stricture, by a sharp blade concealed in a sheath during its introduction through the mouth and pharynx is dangerous because of the liability of dividing the wall of the gullet as well as the stricture. It is good practice in certain cases to perform external œsophagotomy just above or just below the stricture, and then to make an internal œsophagotomy.

External œsophagotomy, or opening of the œsophageal tube from the exterior of the throat, may be useful, as has just been stated, to gain access to the stricture in order that it may be dilated or incised and also for the purpose of obtaining an opening through which food may be passed into the stomach. In the latter case the operation is called œsophagostomy. Such operations, it is evident, can only be done when the disease is situated high in the neck and gives room for an external incision above the clavicle. When the disease is situated in the lower portion of the gullet the stomach should be opened through the abdominal wall and a gastric fistule established for the introduction of food. This operation is called gastrostomy or "stomach-mouth" in contra-distinction to gastrotomy, in which the stomach is opened for the removal of a foreign body and immediately closed.

The œsophageal stricture may sometimes be divided by performing gastrotomy, passing a small filiform bougie upward from the stomach, and thus conducting a strong thread of silk through the œsophagus and out of the patient's mouth. The string may then be used as a string-saw to cut the stricture by pulling alternately on the gastric and oral ends. Retrograde dilatation with bougies may be performed by means of a preliminary gastrotomy.

Introduction of the Œsophageal Bougie and Stomach Tube.

Tubes or bougies may have to be introduced into the œsophagus alone or into the cavity of the stomach for purposes of diagnosis, for the treatment of stricture, for the evacuation of poisons which may have entered the stomach, for washing out the stomach and for feeding. It is important, therefore, that the surgeon should be familiar with the method of using these diagnostic and therapeutic instruments. The patient should be seated with his head thrown well back, in order to bring the mouth and the long axis of the gullet in the same line. The mouth, which should be wide open, may or may not be prevented from closing by means of a gag between the teeth. This is seldom needed, except in obstreperous patients. The surgeon, standing in front of the patient, should then pass the instrument, which has previously been well oiled and warmed, through the mouth backward toward the posterior wall of the pharynx. This portion of the operation should be done without touching the patient's tongue with the instrument. With his left forefinger on the tongue the operator next guides the instrument above the epiglottis and downward into the upper portion of the œsophagus. Pressure slowly applied then pushes the instrument downward toward the stomach. If any obstruction is felt the instrument should be slightly withdrawn and again gently pushed forward. The patient will soon discover that he can breathe notwithstanding the presence of a foreign body in the food tract, and he will suffer little or no inconvenience. Care must be taken, however, not to push the instrument into the trachea, which is likely to occur if the tube be a small one. If the surgeon prefer, he may stand behind the patient and, steadying the latter's head against his chest, introduce the bougie or tube from this position. In this method, however, the surgeon's forefinger cannot be used to insure the slipping of the instrument over the epiglottis. It therefore requires a little more dexterity on the part of the surgeon.

When the tube of the stomach pump is thus introduced for washing out the stomach, about two pints of warm water should be allowed to flow through the tube. This may be done by pouring water into a funnel attached to the outer end of the tube or by attaching to this extremity some form of a pump. When the fluid is withdrawn from the stomach it is wise not to permit all to come out, as the mucous membrane lining of the stomach may be sucked into the opening at the gastric extremity of the tube.

CHAPTER XXII.

DISEASES OF THE ABDOMEN AND PELVIS.

Patent Urachus.

THE fœtal canal extending from the bladder to the umbilicus may remain patulous after birth. This tubular canal may then permit the discharge of small quantities of urine at the umbilicus. In rare instances such an unobliterated urachus has been laid open in performing abdominal section for the treatment of abdominal disease. Cystic tumor, abscess and other pathological processes may occur here. Urinary calculi have been found in a patulous urachus.

Wounds of the Abdomen.

Wounds of the abdomen, when fatal, have probably caused injury to the solar plexus or to some one of the glandular or hollow viscera; which injury will be revealed by an autopsy. Death occurring without discoverable lesion is very infrequent. Contusions or wounds of the abdominal wall have no special importance except when associated with rupture of the viscera or some other internal lesion. They are treated, when uncomplicated, as are wounds in other regions. When there is a probability of visceral lesion as a complication, the necessity for abdominal section and exploration is often imperative. Gunshot or stab wounds of the belly are so liable to be complicated with intestinal lesions that abdominal section is very often required, in order to secure the patient from death by reason of internal hemorrhage or fecal extravasation into the peritoneal cavity. It is often doubtful whether a bullet or a cutting instrument has actually penetrated the intestines, because at times the vulnerating instrument does not travel the entire thickness of the wall, or is deflected by the muscular fascias. If a doubt exists as to the propriety of opening the abdomen for the purpose of discovering and repairing visceral damage, it is usually wise to give the patient the benefit of the doubt and to operate. Carefully done, aseptic abdominal section is almost free from danger, whereas intestinal wounds have a large death rate from peritonitis. The exploratory incision should be made in the median line, after which the whole length of the intestinal tract should be carefully examined, unless the wound in the wall has shown that the wounding of the stomach or intestine has been impossible.

Method of Operating within the Abdomen and Pelvis.

Fluids occurring and accumulating in the abdominal cavity as a result of irritation are very liable to septic changes. Therefore, the most absolute asepsis is important, since the large absorbent surface furnished by the peritoneal membrane makes the occurrence of septic processes in this cavity extremely dangerous. Twisted silk is usually preferred for ligatures by abdominal surgeons, while plaited silk or silkworm-gut is ordinarily deemed most satisfactory for suturing purposes. Catgut, however, is available for ligatures and sutures. These and all instruments and sponges should be rendered absolutely sterile. Experience has proved that water sterilized by boiling or sterile normal salt solution is better than antiseptic solutions for irrigation of the abdominal cavity. The frequency with which the external wound has been sutured though instruments and sponges have been left in the abdomen is sufficient reason for demanding that all instruments and sponges be counted before and after operation.

The abdominal incision, which should usually be made in the median line, should be large enough to permit good work. In operations for appendicitis and other conditions about the cæcal region, an incision to the outer side of the right rectus muscle is often preferable to one in the middle line. Tumors within the abdomen sometimes become adherent to the anterior wall, and the incision will, therefore, reach them before the surgeon enters the abdominal cavity. Such adhesions of the growth may be suspected, if there is much bleeding from the muscular incision or unusual pinkness of the deep muscular fascias and the subperitoneal fat. In all cases, the surgeon should be careful to get within the abdominal cavity before working along the wall from the incision. If he is not careful in this regard he may separate a large sheet of peritoneum from the inner surface of the muscles, and think that he is detaching an ovarian cyst or other growth adherent to the internal surface of the abdominal wall.

During the operation the intestines should be kept out of the way as much as possible by packing flat and warm pads of aseptic gauze around the field of operation, so as practically to shut it out from the rest of the peritoneal cavity. These pads should be squeezed out or substituted by clean ones when they become saturated with blood, serous fluid or pus. If it is necessary to allow the intestines to escape from the cavity temporarily, they should be wrapped up in a warm, moist, aseptic towel, which will not allow particles of lint to be detached from it.

The adhesions and attachments of morbid growths and diseased structures to be removed should be separated by means of the finger. The attachments, if vascular, should be cut only after firm ligation or compression of the stump by hæmostatic forceps. Points likely to bleed must be ligated before the forceps are removed.

Marked elevation of the hips so as to throw the intestines upward into the hollow of the diaphragm and give a better exposure of the cavity of the pelvis and lower part of the abdomen is of great assistance to the operator. It is called the Trendelenburg position; and may be obtained by placing an inclined plane of wood under the hips and thighs, or by the use of a special form of operating table.

By the toilet of the peritoneum is meant the removal of all blood and other fluids by irrigation or by sponges pushed into the pelvic or lumbar fossæ. This may require them to be seized by long forceps, so as to give them a sort of handle. If the fluid is gelatinous or purulent, it will be necessary to wash out the cavity with sterilized water or salt solution of a temperature of 105°, poured into the cavity. By this means any unrecognized bleeding is discovered, because the water returns stained, and shreds of tissue or lymph are effectively removed. It is not necessary to insist upon the removal of all such sterilized water which has been used to flush the cavity, because it is harmless and is soon absorbed.

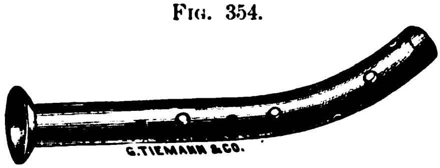
FIG. 353.

Patient in Trendelenburg position. (DAVENPORT,)

Whenever it is believed that a purulent cavity has not been perfectly cleansed and that purulent material remains, it becomes necessary to leave a drainage tube or gauze wick in the wound at the time of adjusting the sutures. Healthy peritoneum absorbs aseptic fluids rapidly, but a diseased peritoneum does so very slowly. In such cases, and where there is very great transudation of fluid subsequent to operation, Douglas's pouch and the fossæ in the renal regions are the receptacles in which such fluids accumulate; and disastrous inflammation is liable to occur because of the possibility of septic changes occurring there.

Hence drainage is often desirable in such cases. If the hemorrhage has not been entirely stopped or bleeding subsequent to the operation is feared, the insertion of a drainage tube is wise. The occurrence of secondary hemorrhage will be indicated by the escape of blood through the drainage tube, and will thus be susceptible of prompt treatment. These circumstances render it probable that in cases of doubt as to the necessity of drainage, the surgeon had better use a drainage tube, since, if the asepsis is perfect, it can scarcely do harm. In cases where the operation has been simple and uncomplicated, however, and when no pus has previously existed, complete closure of the wound without drainage is the proper procedure. A straight or curved glass tube, having a caliber of about a half inch, with an opening in its abdominal extremity and with a ridge or shoulder at its cutaneous end, is the proper sort of tube to be employed. A piece of rubber tubing will answer the purpose nearly as well. It is rather objectionable to have lateral openings in the tube near its outer end, because fluids entering the tube at its lower end may escape from these lateral openings and, becoming septic if the dressings are imperfect, infect the wound in the abdominal wall. The tube, as a rule, should be about six inches long and descend into the pelvis or one of the lumbar fossæ. Under rare circumstances it becomes necessary to introduce two or three tubes, in order to allow free drainage or irrigation in distinct regions of the abdomen.

FIG. 354.



Glass abdominal drainage tube.

Suction with a syringe will remove fluids which accumulate in the tube. The amount may be so great as to require this cleansing of the tube every few hours, or even oftener. The insertion of a small quantity of absorbent cotton, twisted into a rope and put into the tube, will increase the drainage and remove the fluid by capillarity. A sort of wick of absorbent gauze will be efficacious in the same way, and is often used without a tube. It is essential that the abdominal cavity be kept dry and free from fluid when oozing of blood is going on after closure of the wound, because moisture seems to encourage the flow of blood. It goes without saying that all recognizable bleeding points should be secured by ligatures or by the application of the cautery, before the abdomen is closed.

The abdominal wound is brought together by sutures of silk, catgut, wormgut or wire, carried through the entire thickness of the wall, including the peritoneum. Buried sutures for uniting the peritoneum and the muscles in separate layers are sometimes used in addition to the sutures carried all the way through the abdominal wall. The object of this method and of other similar methods is to ensure broad contact of the muscle edges so that the union of the wound may be firm. If this is not accomplished, the scar tissue is likely to stretch and permit the occurrence of hernia at the site of the incision. Any form of suturing which brings the cut surfaces of muscle close together and sutures the aponeurosis carefully is usually sufficient; especially if strain on the incision in the belly wall is prevented by a supporting dressing or bandage for three or more weeks after the sutures are removed. If a drainage tube is to be employed, the suture at the point where the tube comes out should not be tied, so that when, at the end of the second or third day, the tube is removed, the wound may be brought together by this suture and the pain of using a needle avoided. An ordinary gauze dressing, either aseptic or antiseptic, is then applied and a many tailed flannel bandage carried around the loins and secured in such a way as to make equable pressure upon the abdominal wall. If a drainage tube is used, its external end should be thrust through a small opening made in the center of a piece of strong rubber tissue about eight inches square. A ligature should then be thrown around the tube in such a way as to tie the rubber material close to the tube. This is to prevent the possibility of fluid escaping from the tube and running down its outside and coming in contact with the wound. By placing a mass of absorbent cotton or a sponge over the orifice of the tube and folding the edges of the rubber dam around it, a little bag is formed in which the escaping fluid is retained and thus prevented from coming in contact with the wound, which, therefore, heals by first intention. This rubber bag, as it practically is, can be opened several times a day, if necessary, to suck out the tube with a syringe and to remove the saturated cotton or sponge. This can all be done without disturbing the main dressing.

The after-treatment of cases of abdominal operation is very simple, unless some complication arises. Beef juice, thin arrowroot or oatmeal gruel, given in small quantities about every two hours, is probably the best food. Milk is believed to be improper food, because of its supposed tendency to induce flatulency. As a rule, it is well to give no food for the first twenty four hours. Most foods are perhaps more easily digested if peptonized. Water in moderate quantities should not be denied the patient. Very frequently the catheter will not be demanded; occasionally, however, it is required. Morphia should not be given unless absolutely required, and then in small amounts. Codeine, hyoscine, assafœtida, valerian and similar remedies should be tried before resorting to morphia. Opiates tend to constipate the patient, to disturb digestion and to mask symptoms of danger. Vomiting is liable to occur within the first twenty four hours as a result of the anæsthesia. If it persists or begins on the third or fourth day, it is probable that it is caused by incipient inflammation of the peritoneum.

The danger to be feared in abdominal cases is peritonitis. Vomiting and tympanites are often associated with, and are usually indicative of, incipient peritonitis. Vomiting is sometimes an effort to get rid of flatus and is then to be looked upon as salutary. Copious vomiting induced by the administration of warm water as an emetic will often aid in the eructation of a large amount of wind and be of service.

If the distention of the abdomen from flatus is great, it should be relieved by allowing the patient to lie upon his side or by the introduction of a tube in the rectum which may be left in the rectum for many hours at a time.

Incipient peritonitis, as has been suggested, is liable to cause vomiting and distention of the abdomen. It is probable, therefore, that the early removal of these symptoms is of the greatest importance. The administration of a saline cathartic, such as Epsom salt, Rochelle salt or sodium phosphate, so as to produce free evacuation of the bowels, will often give this desirable result. The administration of opium in such cases of peritonitis is decidedly harmful and should not be adopted. Turpentine injected into the rectum, about half an ounce of turpentine to the quart of soap-suds, with or without glycerin, will be of service in similar manner by promoting the discharge of gas and the evacuation of the intestinal contents. Enemas of assafœtida are valuable in this respect.

The purgative treatment of incipient peritonitis probably owes its value to the prevention of distention and to the draining of the abdominal organs of their serum. Carminatives, such as ether and peppermint, can be administered by the stomach as adjuvants, but will not very often be required. When vomiting is marked, nutrition should be kept up by rectal feeding, which is best done by the use of peptonized foods in a diluted state.

Peritonitis.

Peritonitis, occurring after operations done in the manner just described is rare. If the early symptoms of peritonitis are met by the administration of saline purgatives and if abstinence from the use of opium is enforced, it is probable that active peritoneal inflammation will not often occur. Should it take place it demands active treatment, such as opening the abdomen, in order to wash out and drain from the pelvis the accumulated fluid which has become septic. The continued use of salines in laxative doses and the avoidance of tympany are the essentials in the medical management of this disease. Traumatic peritonitis commonly follows wounds which have not been at once submitted to aseptic or antiseptic treatment. The vulnerating instrument is often a dirty one, and the clothing of the patient and his surroundings may cause septic inflammation before he reaches the surgeon's hands.

A circumscribed peritonitis occurs, however, in some cases, both in operative and accidental wounds. If there is absence of septic infection, the lymph exuded seals the wound and healing rapidly occurs. By such an exudation of lymph even a septic peritonitis is sometimes circumscribed and then may not do much harm, because the septic focus has been shut off from the rest of the abdomen by the plastic exudate. It is the diffused septic inflammation of the peritoneum, which gives rise to a large quantity of turbid serum or pus within the peritoneal cavity, which is so fatal. Peritonitis, except the local form due to aseptic mechanical or chemical injuries, is due to infection. The colon bacillus and the pyogenic streptococcus are the most frequent causes; but staphylococci and other micro-organisms of varying virulence are at times responsible for its occurrence.

The symptoms of peritonitis are vomiting, pain, tenderness, rigidity of the muscles of the abdominal wall, tympanitis, constipation, fever and systemic depression. It must be recollected that pain may be almost absent, however, and that high temperature is often not present. The cause of the peritonitis should always be sought, and this search will usually demand opening the abdomen. Intussusception of the intestines, rupture or inflammation about the vermiform appendix or the pouring out of pus into the pelvic cavity from a ruptured suppurating Fallopian tube will often be found to be causes of what was supposed to be traumatic peritonitis following a slight injury. Pus in the abdomen, from whatever cause, demands incision of the abdominal wall and free drainage.

The treatment of traumatic peritonitis will be better understood when the methods of dealing with visceral lesions have been discussed. Tubercular peritonitis and distention of the abdominal cavity with large quantities of serous fluid have been treated effectually by abdominal section, evacuation of the peritoneal fluid and drainage.

Tapping the Abdomen.

Withdrawing fluid from the peritoneal cavity with a trocar and canula or with an aspirating needle is called paracentesis abdominis. An incision through the abdominal wall for the purpose of exploring the abdominal contents, or to gain access to the organs in order to perform operations upon them is called abdominal section, laparotomy or cœliotomy.

Paracentesis of the abdomen is seldom employed at the present time, except for the evacuation of serous fluid in the peritoneal cavity, due to cirrhosis of the liver or to disease of the heart or kidneys. Unless the ascitic fluid which distends the abdomen is known to be due to disease of these organs it is better for the surgeon to make a small incision through the abdominal wall and introduce his finger. By this means not only is the fluid which is causing the distention evacuated, but definite information as to the cause of the accumulation of the fluid is obtained. One or two fingers introduced through a median incision an inch long, midway between the navel and the pubes, will be able to explore the pelvis and the abdomen almost as high as the liver. It is readily seen that tumors and other obscure conditions can be examined in this way, and information obtained which will be a valuable guide to operative procedure or other methods of treatment to be subsequently adopted.

The old practice of tapping the abdomen whenever it is distended with fluid without reference to the location and cause of the distention is now looked upon with disfavor. Ovarian cysts should not be tapped, but removed by laparotomy. Many other conditions of a similar character which were formerly tapped are now treated by radical means. Paracentesis, therefore, is reserved for cases in which a diagnosis of ascites from disease of the liver, kidney or heart of a medical kind has been made.

Before tapping the abdomen the bladder should be emptied and the possibility of pregnancy considered. The patient during the operation sits upon the edge of the bed or is propped up in a semi-recumbent position by means of pillows. A trocar and canula, not more than an eighth or a quarter of an inch in diameter, is then thrust through the belly wall in the middle line about two inches below the umbilicus. The forefinger of the surgeon should be placed about an inch from the point of the trocar as a guard, in order that the instrument may not be thrust too deeply into the abdomen. The instrument should be thrust through the tissue with a quick motion and with a little rotation. This causes less pain than a slow puncture and insures the entrance of the instrument into the peritoneal cavity. The trocar and canula should, of course, be aseptic. It is wise to percuss previously the point at which the perforation is to be made, in order to see that no portion of the bowel lies against the inner surface of the abdominal wall. An adhesion between the intestine and the parietal peritoneum at this point may have occurred and an injury to the bowel from the point of the instrument will occur, unless by percussion giving a resonant note the surgeon suspect such adhesion and select a point dull on percussion. The possibility of such an adhesion makes it wise to adopt a different point of puncture if paracentesis is repeated at a subsequent date because of the recurrence of the fluid.

A broad, four tailed bandage, placed around the waist in such a way as to permit the escape of the fluid from the canula, may be employed to compress the abdomen as the fluid escapes. If the bandage is applied before the tapping is performed, a hole may be cut in it to expose the skin at the point where the perforation is to be made. The four tails being crossed at the back enable the assistant or surgeon to draw the bandage more and more tightly as the belly collapses. If the canula becomes plugged by a portion of omentum or lymph being washed into it or lying against its end, an aseptic grooved director pushed in will cause the fluid to flow anew. After the withdrawal of the canula the wound needs no other treatment than the application of a piece of aseptic gauze. If oozing of serum continues from the wound a suture may be employed; this, however, is not often required.

Abdominal and Pelvic Abscesses.

There are many different positions in the abdomen and pelvis in which focuses of suppuration may occur. Abscess within the layers of the abdominal wall is not very unusual. The spaces, or loculi, formed by circumscribed peritonitis, causing adhesions between the abdomen and the other viscera or between the viscera and belly wall, may contain pus.

Diffused purulent peritonitis is not uncommon. This is not strictly an abscess, but is discussed at this point because its treatment and symptoms are those of abscess. It is strictly a purulent effusion into the peritoneal cavity. Abscesses may exist in the parenchyma of one of the solid viscera, such as the liver and spleen. The Fallopian tube may become distended with pus and give rise to the condition called pyosalpinx. Again, suppurative processes may occur behind the peritoneum, in the space occupied by the kidneys and other retro-peritoneal organs. Abscess is also possible between the layers of the mesentery; while suppuration around the vermiform appendix and cæcum is quite common.

Parietal abscess presents symptoms similar to abscess in other locations and is to be treated in a similar manner by evacuation of the pus. It derives its importance from the fact that it, and especially cheesy or tubercular deposits, may simulate an abdominal tumor.

Localized suppurative peritonitis, with the adherent viscera, may resemble tumor within the abdomen. The proper treatment is cœliotomy, with evacuation of the purulent collection and the insertion of drainage tubes. The escape of pus into the peritoneal cavity should if possible be prevented during the operation. Thorough cleansing, by irrigation or wiping, of the general peritoneal cavity is demanded if any pus accidentally flows into it. Thorough drainage is essential in all cases of visceral abscesses, whether of liver, spleen, kidney or ovary. Abscess behind the peritoneum, or within the layers of the mesentery, should be subjected to the same operative treatment.

Pus in the Fallopian tubes should be treated by removal of the tubes without rupture of them during the operation, since in this manner contact of pus with the peritoneal surfaces is obviated. If the tube becomes ruptured during its forcible separation from the adjacent structures to which it has become adherent, the pelvis and abdomen should be well irrigated and a drainage tube left in the wound. The pus of these conditions may be sterile, because the germs have lost their vitality.

Abscess in and around the vermiform appendix should be treated in the same way as pelvic abscess associated with tubal suppuration. Removal of the appendix and thorough drainage of the pus cavity are indicated. The pus varies in virulence in accordance with the activity of the mycotic cause. Peritonitis does not always develop when pus comes in contact with the peritoneum, because the micro-organism may be of slight pathogenic power or the tissues very resistant.

DISEASES AND INJURIES OF THE STOMACH.

Examination of the Stomach.

Physical exploration of the stomach is accomplished by inspection, palpation, percussion and auscultation of the epigastric region.

The contents of the stomach removed by a stomach tube will, at times, afford valuable information as to the condition of the disease. The stomach is usually distended in obstruction of the pylorus, while depression of the epigastric region occurs when the ingress of food is prevented by obstruction at the cardiac orifice. The movements of the stomach may be seen at times when it is dilated. Abnormal growths may often be seen and felt, while these and other conditions often give rise to local pain or tenderness on pressure.

Tumors of the wall of the stomach are examined with difficulty, especially if situated on the left side of the organ. There is a tendency for gastric tumors to be displaced downward by gravity; hence they are seen and felt at a lower level than would be thought possible if this fact were not remembered. Percussion of the stomach gives a tympanitic note. This may, however, be identical with the note elicited by percussion over the colon. A diagnosis may at times be made by causing the patient to drink a little water, when the stomach loses its tympanitic note, which, however, the colon retains. The lower border of the stomach is situated about midway between the sternum and the umbilicus.

Some information of the gastric condition is obtainable by stethoscopic examination, by which various splashing and gurgling sounds are heard during swallowing and digestion. Transillumination of the stomach by an electric light at the end of a flexible bougie introduced through the œsophagus may afford information as to irregularities in the thickness of the anterior wall. Chemical examinations of the gastric contents after the ingestion of a test meal will give opportunity to determine the absence or presence of hydrochloric acid. For this purpose the stomach tube is employed to remove the partially digested food. Digital exploration of the stomach by means of an abdominal incision followed by gastrotomy may be justifiable in obscure diseases.

Foreign Bodies in the Stomach.

Coins, artificial teeth and other indigestible substances are liable to be swallowed and become lodged in the stomach or bowels. It is not wise to give a purgative in such cases, but it is proper to delay the passage of the foreign body through the digestive tract by feeding the patient on a diet which is bulky and which will surround the foreign body with a mass of fecal matter. An exclusive diet of potatoes has been recommended with this object in view. If the foreign body is too large to pass with safety through the intestine it is necessary to remove it by operation, provided there is certain evidence by palpation or X-rays or by the history that the foreign body is actually lodged in the stomach or intestines. Opening the stomach after laparotomy is called gastrotomy, and is to be distinguished from gastrostomy, in which a permanent orifice is made.

Wounds of the Stomach.

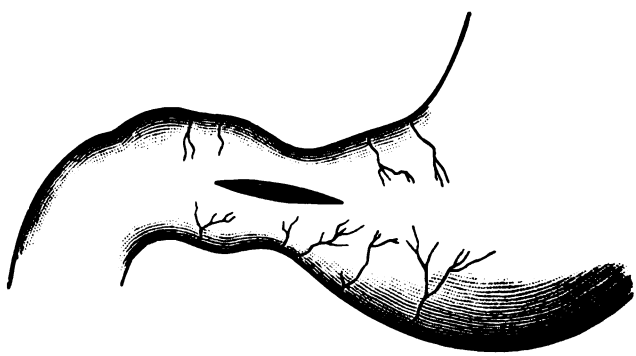
Rupture of the stomach, incised or gunshot wounds of the stomach and perforating ulcer of the stomach present symptoms similar to the same lesions of the intestines, with the addition of hæmatemesis or vomiting of blood. The treatment is practically the same as that for the corresponding lesions of the intestines, namely: abdominal section with suturing of the gastric wall (gastrorrhaphy). Before such operations are undertaken it is usually wise to wash out the stomach with sterilized water by means of a stomach tube. If a portion of the stomach has been injured sufficiently to lead probably to local gangrene, it is often best treated by pushing the injured portion toward the interior of the stomach and drawing the neighboring healthy tissue over it by sutures. This is done in order to prevent extravasation of the gastric contents into the peritoneal cavity when the sloughing occurs. Lembert's suture, which will be described under Intestinal Wounds, effectually accomplishes this object, and is the proper method of suturing to be used in closing wounds of the gastric wall.

Operations upon the Stomach.

Gastrostomy is the formation of a permanent opening from the exterior of the epigastrium into the stomach, by means of which food may be introduced. It is performed in cases of œsophageal stricture and of malignant disease of the cardiac orifice of the stomach.

Gastrotomy is an incision into the stomach; and is performed for the removal of foreign bodies, for the purpose of dilating a strictured

FIG. 355.



Pyloroplasty: incision. (RICHARDSON.)

condition of the pyloric or cardiac orifices, for examining the interior of the organ and for the removal of tumor involving the walls of the organ.

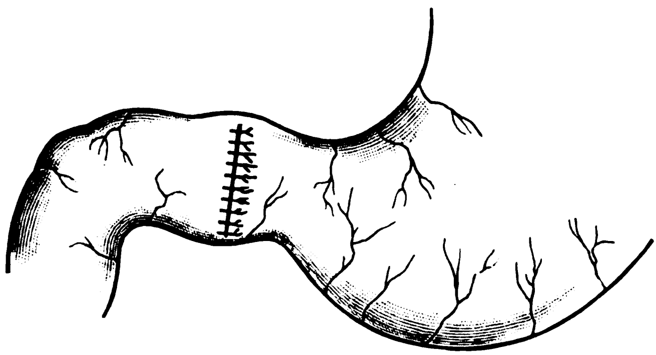
Gastrorrhaphy is suturing of the stomach wall, and is demanded in wounds or rupture of the stomach and in the treatment of perforating ulcers of the stomach.

Pylorectomy is a term used to express excision of the pyloric end of the stomach for malignant disease, just as gastrectomy is applied to operations for the removal of any portion of the stomach.

Pyloroplasty is an operation employed to enlarge the caliber of a constricted pyloric orifice. It consists in making a longitudinal incision through the anterior wall of the pyloric end of the stomach and suturing the wound so that the line of union will be vertical. This enlarges the lumen of the tube. It is employed in cicatricial stricture of the pylorus, and in malignant disease where pylorectomy is considered inadvisable.

Gastro-enterostomy is the operation in which an opening or fistule is made between the stomach and a neighboring portion of the intestine. It is employed when the contents of the stomach cannot be passed into the duodenum because of the obstruction of the pyloric orifice or of the duodenum.

FIG. 356.



Pyloroplasty, showing gain in caliber by method of suturing. (RICHARDSON.)

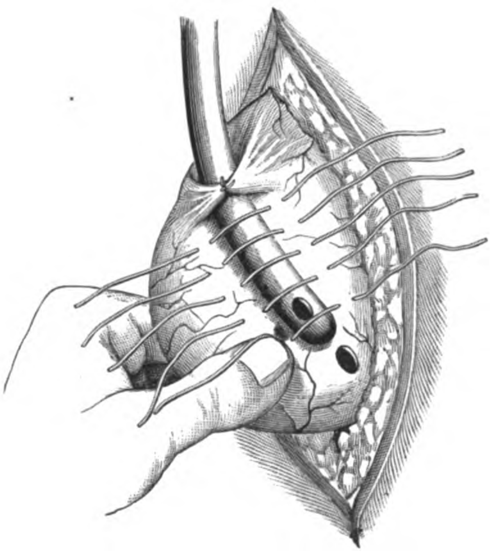
When operations are to be performed on the stomach it should, if possible, be emptied and washed out with the stomach tube. Boric acid solution or warm sterile salt solution may be used.

Gastrostomy.

Gastrostomy, as is seen from its derivation, signifies a mouth in the stomach. It is performed by attaching the stomach to the anterior belly wall and making a permanent opening by which food can be introduced into the stomach. The operation is performed in order to prolong life in malignant disease of the œsophagus, and to effect what may practically be a cure in cicatricial stricture of the œsophagus due to injury. The object of the operation, of course, is to prevent starvation, which is the only cause of death in cicatricial stricture.

The incision should be made parallel to the costal border of the lower ribs on the left side, and should be about an inch from that border and from an inch and a half to two inches long. The fistula, which is to be made to serve as an artificial mouth, should be in the angle between the lower edge of the liver and the costal cartilages, about one inch from the ribs and one inch from the lower border of the liver.

FIG. 357.



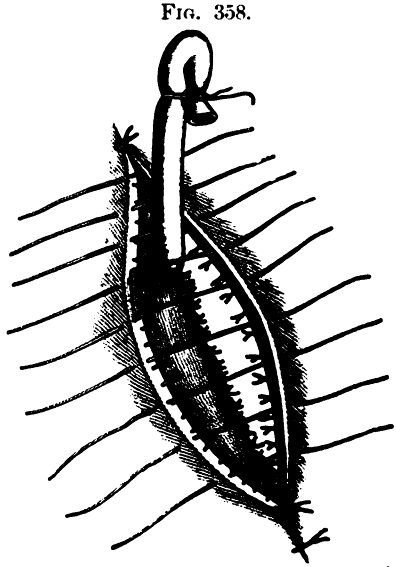
Gastrostomy: Witzel's method. Tube in position: sutures ready to tie. (RICHARDSON.)

It is not necessary in the modern methods of gastrostomy to divide the operation into two stages; first sewing the stomach to the abdominal wall and opening it only after adhesion to the peritoneum has occurred. The danger of leakage into the peritoneal cavity at the time of operation and of escape of food after operation is avoided by the method of Witzel by which an oblique fistulous track is made in the gastric wall; and by that of Frank, who draws a portion of the stomach upwards under a bridge of muscle and skin and makes the external opening in this diverticulum which is at a higher level than the cavity of the stomach.

In the former method the stomach is drawn through the wound, a rubber catheter or tube inserted through the opening made in the stomach, and the wall of the stomach stitched over the tube so as to make an oblique canal. The stomach is then sutured to the abdominal wall and the external wound closed.

In the other method a small portion of the stomach is drawn out of the wound and the base of this small finger-like process stitched to the parietal peritoneum. The rectus muscle is then split and the skin undermined with the knife or by blunt dissection. The diverticle of the stomach is then pulled through the opening in the rectus muscle

FIG. 358.

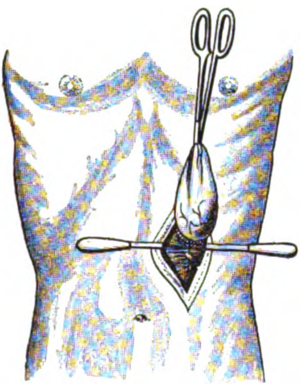


Gastrostomy: Witzel's method. Tube in position; sutures ready to close abdominal wall. (RICHARDSON.)

and under the bridge of the skin, to make its exit near the costal border, where the skin is incised. Here the process of stomach is stitched and then opened to make the orifice for introduction of food.

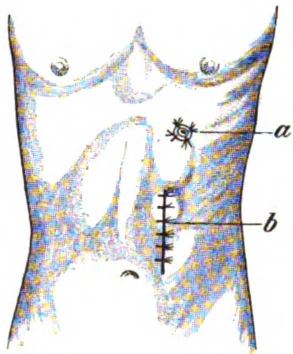
At first small quantities of peptonized liquid food are administered. Later solid food may be masticated by the patient and then introduced through the fistule.

FIG. 359.



Gastrostomy after Albert, Frank and Kocher. (TILLMANNS.)

FIG. 360.



Gastrostomy after Albert, Frank and Kocher. *a*, opening in the stomach; *b*, the sutured abdominal wound. (TILLMANNS.)

Gastrotomy.

This word was formerly used to denote what is now more properly called abdominal section, laparotomy or cœliotomy.

It properly signifies incision into the stomach which is subsequently to be closed, and differs, therefore, from gastrostomy, in which the opening made into the stomach is permanently maintained. Gastrotomy is performed for the removal of foreign bodies that are of such shape that they cannot pass through the intestinal tract; for the purpose of dilating the cardiac orifices which have become contracted by reason of malignant growths or cicatrices of wounds or ulcers; and also for the removal or curetting of malignant tumors involving the inner surface of the stomach.

The external incision should be about two or three inches long, and is made parallel to the costal cartilages on the left side or over the situation of the foreign body in the stomach, if there be any external prominence or skiagraphic evidence of its location. The fingers of the surgeon are then carefully introduced into the abdomen to feel for the stomach. The area of operation is surrounded with aseptic sponges, and two sutures may be introduced into the stomach wall so as to draw it up. These sutures should be parallel to the proposed gastric incision, which should be in the same direction as the external wound. A round needle passed so as not to perforate the mucous coat, should be used here as in the operation for gastrostomy. An incision is then made into the cavity of the stomach; and the foreign body is removed by the fingers or forceps, dilatation of the pylorus or cardiac orifice effected, or any other contemplated operation performed. The gastric wound is then closed with twisted silk sutures after the manner of Lembert. A sponge attached to a ligature may be pushed inside the stomach, so as to draw up the edges of the gastric wound. None of the sutures should be tied until all have been properly placed, when the sponge is withdrawn and the sutures tied securely. A second row of sutures may be placed between the Lembert sutures. These should be introduced through the peritoneum only, and taken as ordinary interrupted sutures.

The patient must be supported for three or four days by nutrient enemas.

Suturing gastric wounds, whether accidental or operative, is called gastrorrhaphy.

Tumors of the Stomach.

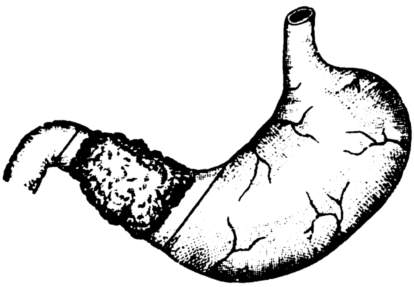
The tumors found involving the stomach walls are usually, though not necessarily, malignant. Malignant conditions of the stomach occur usually at the pyloric or cardiac orifices, but other portions of the stomach may be the seat of such conditions. The diagnosis of gastric tumors belongs to medicine rather than to surgery. The existence of a tumor may be discovered by palpation of the abdomen; but its relation to the stomach must be determined by the digestive and other symptoms accompanying it.

Malignant disease involving the pylorus and diseases of a similar nature occurring primarily in organs adjacent to the pyloric portion of the stomach give rise in many instances to stricture of the pylorus. When the growth does not actually involve the pylorus it may lessen its caliber by external compression. Non-malignant stricture of this orifice may also occur. It is stated that there is more anorexia in malignant than in non-malignant stricture of the pylorus. Disappearance of hydrochloric acid from the gastric juice is believed by some writers to occur in gastric carcinoma. Examination of blood may aid in diagnosis.

Excision of the pylorus, or pylorectomy, is at times undertaken for the removal of the pylorus for malignant disease. The term partial gastrectomy may be employed to denote this, or, indeed, any operation which removes a portion of the stomach. Total gastrectomy has been successfully performed in a few instances of malignant disease of the greater part of the stomach. The lower end of the œsophagus is then united with the duodenum.

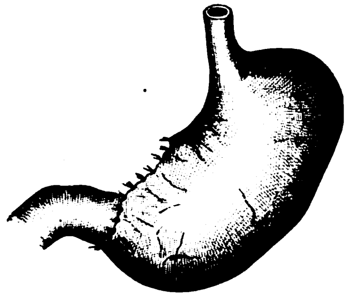
Before excision of the pylorus is attempted the stomach should be washed out. The incision should correspond with the long axis of the stomach and should be about two inches long. The pyloric end is then to be separated from the surrounding structures by means of the finger. It is possible that some adhesions may require to be cut by the scissors, after ligatures have been applied to prevent hemorrhage. The diseased portions of the stomach and of the neighboring duodenum are then removed with the scissors, and the remaining portion of the stomach sutured to the duodenum in much the same man-

FIG. 361.



Pylorectomy for carcinoma of the pylorus. (TILLMANNS.)

FIG. 362.



Suture of the duodenum into the greater curvature of the stomach after section of the pylorus. (TILLMANNS.)

ner as is done after excision or resection of the intestines. On account of the stomach at the point of excision having greater caliber than the duodenum, it becomes necessary to diminish the lumen of the former in order that it may join the duodenum without causing leakage. This may be done by cutting out a V-shaped portion of the muscular and peritoneal coats of the stomach, thus narrowing the orifice.

In pyloric disease it will sometimes be better for the surgeon to make a permanent opening between the stomach above the pylorus and the intestine below the duodenum by gastro-enterostomy. This may be done by suturing or by Murphy's buttons or similar mechanical devices.

Stricture of Gastric Orifices.

A strictured condition of the pyloric or cardiac orifices may be due to malignant disease, to cicatricial contraction after ulceration in these regions and perhaps to simple fibrous hypertrophy, similar to that causing fibrous stricture of the rectum. In these cases the symptoms may be ameliorated or cured by opening the stomach, as in gastrotomy, and stretching the contracted opening by means of the fingers or some form of dilating instrument.

The incision should be in the median line of the abdomen. In pyloric stricture the stomach should be opened about an inch from the pylorus and about midway between the greater and lesser curvatures. After one finger has been inserted through the contracted pylorus a second finger may be introduced and sufficient stretching applied to bring the fingers an inch and a half to two inches apart. The distance, of course, depends upon the character of the contraction and the peculiarities of the individual case. Pyloroplasty is often a better operation for this condition.

In operating upon a contracted cardiac opening the gastric incision should be near the cardiac end of the organ. If there is difficulty in reaching the cardiac orifice with the fingers, a pair of dilating forceps, similar to those used for dilating the rectum, may be employed.

In malignant strictures dilatation may add greatly to the patient's comfort and is far less dangerous than gastrectomy.

DISEASES AND INJURIES OF THE INTESTINES.

Foreign Bodies.

Foreign bodies in the intestines may require the operation of enterotomy, or incision into the bowel, for their removal. The abdominal opening should be made in the median line, and the bowel opened opposite its mesenteric attachments. After the removal of the foreign body the intestinal wound is closed by Lembert sutures. The intestinal incision is less likely to cause subsequent stricture if made transversely to the long axis of the gut; but this precaution is not of much moment.

Rupture, Wounds and Perforating Ulcers of the Intestines.

Pathology.—Rupture of the intestines occurs from blows and is particularly liable to take place when the gut is greatly distended with gas at the time of injury. The symptoms are collapse in varying degree, according to the extent of the injury, burning pain, feeble and irregular pulse and vomiting. After the contents of the stomach have been ejected, blood and bile may be vomited. Tympany usually but not necessarily occurs later, after which more marked symptoms of traumatic peritonitis supervene and are followed by death. If the hemorrhage, extravasation of feces or shock is very great, death may be immediate.

Typhoid fever ulceration, giving rise to perforation of the intestine, causes a similar set of symptoms, but these are developed, of course, during or after the existence of typhoid fever. In "walking" typhoid fever, collapse from perforation may be the first serious symptom noticed.

In all wounds of the abdominal wall, which have penetrated into the abdominal cavity, there is danger of death occurring from septic peritonitis, due to infection from the instrument at the time of the injury or to extravasation of feces.

Treatment.—Rupture and perforating ulcer of the intestines are uniformly fatal. There is but one rational treatment:—immediate laparotomy followed by suturing at the point where the solution of continuity has occurred. The chances of saving life are far greater in traumatic rupture than when perforation has occurred in typhoid fever. Small perforations or tears in soft and almost gangrenous gut, made during abdominal operations, may not be amenable to suture because of the friable condition of the intestinal coats. Here life may at times be saved by simply making the intestinal tube straight, and preventing, by mild laxatives, the accumulation of feces in the diseased gut. Thus strain is removed from the region of the perforation and fecal extravasation may not occur. A drainage tube should be placed in the external wound. This sort of surgery may be safer than resection, which is a prolonged operation. It is only admissible perhaps in small perforations.

Gunshot wounds and stab wounds made with a long knife almost always wound the hollow or solid viscera. It is probably best, therefore, to always open the abdomen, for the purpose of rendering aseptic any wound which is not accompanied with visceral injury and to repair the damage to the intestines or other organs in cases where such dangerous traumatisms have been produced. Hydrogen introduced, by means of a rubber bag and tube, into the rectum may be used as a diagnostic test of perforation. It escapes from the intestinal wound, enters the peritoneal cavity and then leaks out of the wound in the abdominal wall. Here its presence is made evident by igniting it with a candle. The test is not entirely reliable; as it does not always escape from the perforation.

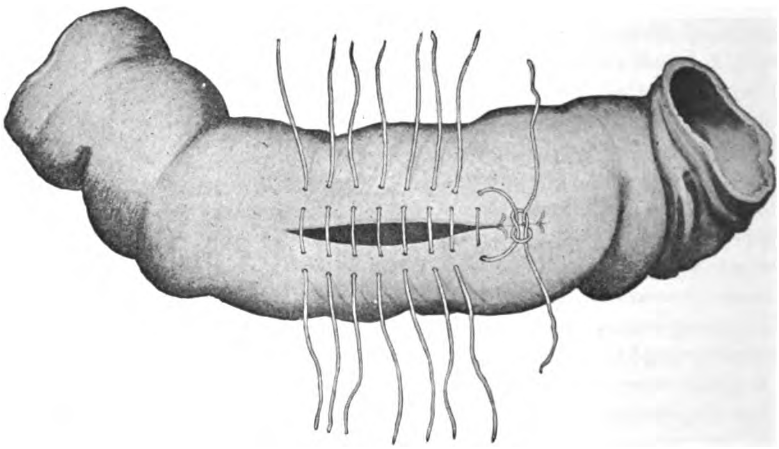
Intestinal wounds are dangerous because of the fecal extravasation which occurs always, unless the wound is quite small, and because the warmth of the abdominal cavity encourages bleeding from injured vessels. In all cases of presumable intestinal wound, abdominal section with examination of the entire length of the intestine is the wisest procedure. If done in a perfectly aseptic manner, according to the principles laid down in the paragraph on abdominal surgery, it is accompanied with no very great risk.

The cardinal rules are to make the abdominal cavity aseptic, stop hemorrhage and close the perforated intestine with sutures. All of these procedures demand as a rule immediate laparotomy, which in no instance should be delayed beyond a very few hours. Promptness here is more important than in almost any other field of surgery.

Enterorrhaphy, or suturing of the intestine, is the proper treatment for wounds, whether caused by gunshot or other injury. Lembert's method of placing the sutures is uncomplicated and most effective, and is the one now usually employed. The peritoneal and muscular coats at the two sides of the wound are punctured and drawn together by the suture, while the edges of the wound are turned into the interior of the intestine. By this means rapid occlusion of the wound is obtained because the peritoneal surfaces rapidly adhere by plastic exudation. Round needles are better for this purpose than bayonet pointed needles, because there is less bleeding from the punctures. The mucous membrane should not be included in the stitch. Either catgut or fine twisted silk may be used. All feces, blood and serum should be washed out of the abdominal cavity according to the rules adopted for abdominal operations.

If the bowel is divided across its caliber, the ends must be united by circular suturing or fastened to the belly wound so as to form an artificial anus. If the bowel or mesentery is so riddled with wounds as to render its preservation improper, resection of intestine (enterectomy) may become necessary. The cut ends may be united by immediate circular suture of the intestine or, if the patient's grave condition contra-indicates this long operation, the two ends of the divided intestine may be attached at the point of incision, so as to form an artificial anus. This may be closed some months afterward, when the patient has recovered from the dangers incident upon the original injury. Such a procedure, although not an ideal operation, will often be the means of saving the patient's life, since there is less danger of fecal extravasation occurring into the peritoneal cavity, and the patient's strength is not exhausted by the prolonged manipulation rendered necessary by circular enterorrhaphy, as would be the case if the resected ends were at once sutured. Circular enterorrhaphy may be performed very quickly by the use of mechanical appliances such as Murphy's buttons, Mayo's bobbins and collapsible rubber tubes or bags. These adjuncts are however unnecessary, though sometimes useful. Portions of the intestines which have been subject to contu-

FIG. 363.



Application of the interrupted Lembert suture closing a longitudinal wound. (PARK.)

sion or laceration occasionally slough and from the perforation so produced extravasation of feces occurs secondarily. Death may occur from such pathological perforation after other portions of the intestines which have been subjected to suturing for wounds have satisfactorily healed. Areas of gut which are very likely to slough had better, therefore, be turned into the lumen of the gut by Lembert sutures, passed beyond the slough margins in a manner identical with that which would be necessary if the contained area of tissue were actually a perforating wound. Fecal extravasation occurring in an abdomen which is left opened so as to permit free drainage and washing is not at all necessarily fatal.

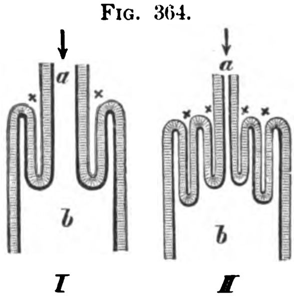
Intestinal Obstruction.

Definition.—By intestinal obstruction is meant such a condition of the intestinal caliber as prevents the passage of fecal matter through it. The term is not applied, however, when the obstruction is due to strangulation of a hernia, although the conditions are practically the same. Obstruction of the intestine is acute or chronic; the acute form may assume chronic characteristics and the chronic form may become acute.

Causes.—The bowels may be obstructed by being filled with gall stones, intestinal calculi, or indigestible materials which have been swallowed; by the process of invagination or intussusception, where one portion of the intestine is pushed into the other, as the finger of a glove may be thrust backward into itself; by stricture of the intestinal coats; by adhesions between the intestinal coils; by puckering of the mesentery; by inflammation or malignant disease involving the bowel walls; by twisting and bending of the intestinal tube (volvulus); by bands of inflammatory tissue or persistent embryonic structures, such as Meckel's diverticle, strangulating the intestine; by pressure from tumors or abscesses; and by the intestines being pushed through congenital or abnormal holes, in the mesentery or omentum or elsewhere, or through orifices made by inflammatory deposits.

Symptoms.—The symptoms of obstruction vary as it is acute or chronic in character. In acute obstruction the pain is commonly marked and is often localized in a particular region of the abdomen, but this locality does not necessarily correspond with the seat of the obstruction. Pain from strangulation of the intestine by a band or other similar stricture is usually sudden, intense, localized and continuous, though it may be somewhat relieved by external pressure. In stricture of the intestines pain is said to be more intermittent in character; while in volvulus it is more diffused than localized. Collapse and actual syncope is marked in many cases of intestinal obstruction, while vomiting, first of the contents of the stomach and subsequently of bile, is usually present. Constipation, tenderness, swelling, and distention of the abdomen are marked symptoms. The rolling of the distended intestines over each other from interference with normal peristaltic action causes at times marked gurgling. If the abdomen is thin, the hands placed upon its surface may feel the motion of the intestines and at times even locate the seat of the obstruction. Exhaustion, peritonitis and gangrene are the usual causes of death. In acute intestinal obstruction death occurs in from one to seven days. In intussusception the portion of the gut which is pushed into the adjoining part of the intestine may slough off, because of the

FIG. 364.



Intussusception (diagrammatic): *I*, single intussusception; *II*, double intussusception: *a*, the upper invaginated portion; *b*, the lower portion of the bowel. (TILLMANNS.)

constriction made upon it by the sheath which grasps it, and be discharged from the anus. The continuity of the caliber of the intestine may be reëstablished in this way, because, during the stage preceding sloughing, the walls while in contact have become united by inflammatory adhesions.

In chronic obstruction of the bowels pain and vomiting are often not very marked, but obstinate constipation is a prominent sign. Tympanites does not occur early in such cases, but when it occurs it is marked. Spontaneous recovery sometimes takes place, while death, which is a common result, does not occur until after six or eight weeks.

Diagnosis.—In making a diagnosis of intestinal obstruction the possibility of impaction of feces in the rectum or of strangulated hernia must be excluded. The surgeon should remember also that constipation of an obstinate kind may occur in enteritis and peritonitis and also in inflammation of an undescended testicle. Lead colic may mislead the careless examiner. It is important to determine the cause of the obstruction and to learn whether the case is of an acute or chronic character.

A short consideration of the special symptoms of the various forms of intestinal obstruction will here be proper.

Intussusception, or prolapse of one portion of the bowel into the lumen of an adjoining portion, occurs most commonly in children and is the most frequent form of intestinal obstruction. The invaginated portion, or intussusceptum, is usually the higher portion of intestine, while the intussuscipiens, or sheath, into which it passes, is the lower. Occasionally, however, invagination takes place upward.

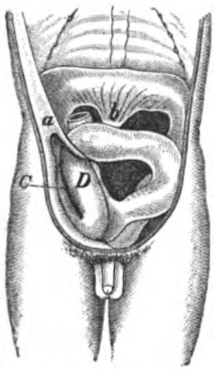
Polypus of the intestine, worms or undigested food may be a cause of intussusception. It is believed by some writers that many cases of colic in children are instances of intussusception, which correct themselves before inflammatory adhesion of the invaginated coats takes place.

The sheath, or intussuscipiens, having grasped the invaginated portion, forces it along by peristaltic action, gradually sucking in or swallowing more of the intestine, just as a mass of feces is pushed along the canal. Epithelioma is at times found involving the invaginated gut. It is a question in these cases whether the disease has occurred after the process of invagination or whether the malignant mass was the origin of the process of invagination.

The most prominent symptom of intussusception is a constant desire to go to stool. With this is associated a discharge of mucus and blood from the rectum. Fecal vomiting is not so often present as in some other forms of obstruction. A sausage shaped mass may at times be felt or seen through the abdominal wall. This is more frequently found on the left side of the belly. In children it is not uncommon to feel the invaginated portion by the finger introduced into the rectum. The accumulation of feces, which takes place above the seat of obstruction, is occasionally perceived by palpation. It is apt to be upon the right side of the abdomen and can be indented or pitted by the fingers pressed upon the exterior. This symptom is almost pathognomonic. Invagination may occur without obstruction to the passage of the feces. Usually the swelling of the mucous and other coats causes obliteration of the lumen, and obstinate constipation or complete obstruction supervenes. When these symptoms do not occur, a certain amount of patency to the canal is retained.

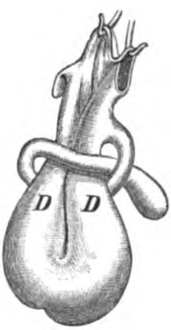
Internal strangulation by inflammatory bands, by orifices in the mesentery or omentum or by rings caused by fœtal structures which have remained within the abdomen is often called internal hernia. Its most marked symptom is intense prostration or syncope. It does not often occur in infants or in the aged. It presents, of course, the symptoms which have been described as indicative of obstruction.

FIG. 365.



Internal strangulation caused by a band (*a b*) passing from the omentum to the anterior abdominal wall. *CD*, the strangulated loop of bowel. (TILLMANNS.)

FIG. 366.



Internal strangulation caused by an intestinal diverticulum which had wound itself about a loop of small intestine (*DD*). (TILLMANNS.)

Twist of the bowel, or volvulus, occurs particularly in old people and usually at the sigmoid or ileo-cæcal region. Actual knotting of the bowel has been discovered. The prostration, however, is not so extreme as in internal strangulation. The abdomen is often unevenly distended, one side being rather flattened while the other is remarkably tympanitic. It is the right side which most frequently shows flattening, because the sigmoid portion of the colon is the most frequent seat of trouble. The accumulation of gas in the intestines is rapid and great.

Obstruction from stricture or tumor is usually chronic, and affects the large bowel more frequently than the small. A history of gradual constipation can at times be obtained and may aid in the differential diagnosis. Acute symptoms, however, may suddenly become engrafted upon such a condition of chronic obstruction and thus add to the difficulty of accurate diagnosis.

Obstruction in the small intestine is more apt to be rapid in course and accompanied with greater pain than is the same condition in the large intestine. Early vomiting is more conspicuous in obstruction of the small than of the large intestine. In other words, acute symptoms, except in the case of volvulus, are apt to be associated with obstruction of the small intestine, while chronic symptoms are usually due to obstruction of the colon. Less urine is secreted, it is said, as the stricture is tighter. Some writers, however, believe that the diminution of urine is connected with the position in the intestinal tube at which the obstruction occurs. The nearer the stomach the obstruction takes place, the less, it is stated, is the secretion of urine.

Treatment.—The treatment of obstruction should be prompt, but should never consist in the administration of purgatives. If the diagnosis has been made before inflammation of the peritoneum and distention of the abdomen have taken place and before the patient has been exhausted by the disease or his condition made more hazardous by the administration of purgatives, the possibility of relief is much increased. All cases are exceedingly dangerous, but the danger is often increased by injudicious attempts at purgation. The existence of hernia at any of the usual situations or the presence of impacted feces in the rectum must first of all be excluded. When this has been done and enteritis and peritonitis as a cause of the symptoms can be set aside, abdominal section should be performed as an exploratory measure within a few hours after the occurrence of obstruction; provided that attempts to relieve the obstruction by large enemas have failed.

Enemas of warm water or oil should first be given by means of a long tube, introduced preferably when the patient is in the knee-elbow position. This position will allow gravity to act and will aid in the introduction of very large quantities of liquid into the bowel. The hydrostatic pressure may be increased by raising the fountain syringe, or other reservoir, several feet above the patient. This can be done by the surgeon mounting a chair or step ladder. Such large enemas are of value in softening fecal accumulation and are capable of altering the abnormal positions or twists in the bowel which are causing the symptoms. Inflation of the intestine with air forced in by means of a long tube, connected with a stomach pump and introduced into the rectum, has its advantages.

If these means fail, a median incision into the abdominal cavity should be made and two fingers introduced to explore the peritoneal cavity and determine the cause of the obstruction. A short distance below the umbilicus is usually the most advantageous point for the section, unless palpation gives evidence of a higher point in the median line being preferable. The surgeon should immediately feel for the internal inguinal and femoral rings to see that no hernial protrusion, too small to be perceived externally, exists. Then he should examine the sigmoid or cæcal regions, as obstruction is quite common in these regions. Usually the distended intestine will be discovered forcing its way through the incision. The most dilated portion should be seized and the bowel followed along in the direction of the greatest distention and the greatest congestion. This will usually lead to the point of obstruction. Greig Smith states that this method is more satisfactory and more practicable than attempts to find the most constricted portion and to follow it to the seat of obstruction.

If a foreign body is found, the gut should be opened and the body removed. If it is a gall stone it will, perhaps, be possible to split it up into fragments by introducing a needle through the intestinal wall. A volvulus or internal strangulation may be relieved by untwisting the coils of gut or cutting through the constricting band. A stricture of the gut may be treated by opening the intestine and dilating the stricture by means of the fingers, as has been described in the treatment of strictures of the gastric orifices. If it is impossible to deal with the stricture in this way, the diseased portion may be excised, or the intestine may be opened above the obstruction and stitched to the external abdominal wound so as to form an artificial anus. It may be preferable in some cases to form a communication between the intestine above the seat of the disease and that below it, by means of intestinal anastomosis. In intussusception the invaginated portion may perhaps be withdrawn from the sheath or intussuscipiens. If this is impossible, the establishment of an artificial anus, the performance of lateral anastomosis or resection of the bowel will be proper.

This line of treatment is that which should be adopted in cases of acute intestinal obstruction.

In chronic cases the adoption of operative measures is not so vigorously demanded, but the case should be watched. No purgatives should be given and large enemas should be used. The patient should be kept upon concentrated food given in small quantities. In this manner the strength is retained without the formation of large quantities of fecal matter. After this treatment has been carried on unsuccessfully for about a week, abdominal section, with the performance of such intra-abdominal operations as may be suitable for the condition discovered, is proper.

In patients that have been allowed to suffer until their strength is exhausted and their general condition exceedingly bad, the administration of general anæsthesia may be ill advised. Greig Smith wisely suggests that in such cases an abdominal incision should be made under local anæsthesia by means of cocaine. A quick exploration of the abdomen should then be made and the bowel opened at any convenient point and stitched to the abdominal wound in order to establish an artificial anus. This rapid operation will cause but little shock and will relieve the immediate symptoms. Several weeks after, when the patient has attained a better general condition, the artificial anus should be dealt with and more radical measures adopted.

In all cases of intestinal obstruction it is important that the great distention of the intestines which exists should be relieved at the time of the operation for the treatment of the obstruction. This is best done by drawing out of the abdomen a coil of the distended gut, receiving it upon a warm aseptic towel and making an incision into it through which the gas and fecal matter may be forced out by manipulation of the adjoining coils. The incision, which should not be more than three fourths of an inch in length, should be transverse to the axis of the bowel and upon the side opposite to the mesentery. After the large quantities of gas and all fecal matter in the vicinity have escaped, the intestinal wound is closed by Lembert sutures and the intestine replaced.

Tumors of the Intestines and Omentum.

Tumors of various kinds occur in the intestinal walls. Malignant growths are more frequent than other solid tumors in this site, and are more common in the large than in the small bowel. The omentum may also be the seat of solid growths, as, indeed, may be the mesentery. In certain portions of the world hydatid tumors are not very infrequent in the abdominal organs.

The symptoms of tumor connected with the bowel or the adjacent tissues are pain, ascites, intestinal obstruction and subacute peritonitis. The symptoms, however, vary with the character of the tumor and its location. The abnormal mass is often detectable by palpation of the abdomen, especially if the examination is made previous to the occurrence of abdominal dropsy, which often occurs from obstruction of the venous current due to pressure on the portal vein and its branches.

The treatment of such growths consists in cæliotomy, followed by drainage or excision in the case of cystic tumors and by such operations as will effect the radical removal of solid tumors or overcome the conditions induced by them. Resection of the intestine or the establishment of a new route for the intestinal contents by means of intestinal anastomosis or the creation of an artificial anus will be the proper procedure in selected cases.

Operations on the Intestines.

Opening the small intestine for the removal of a foreign body or for any other cause is called enterotomy. Resection of the small intestine is enterectomy; while suturing of a wound of the small intestine is enterorrhaphy.

Colotomy should, in the strict sense of the term, mean opening the colon, but it is frequently employed to designate the formation of a permanent opening between this intestine and the external air. This should really be called colostomy. Colectomy is the excision or resection of a portion of the colon.

Enterotomy, enterectomy and enterorrhaphy are often used to designate operations on either the large or small intestine.

Artificial Anus.

Pathology.—An artificial anus is a permanent opening in the abdominal wall, between the bowel and the air, through which the fæces are extruded. The opening may lead into either the small or large intestine. When only a small portion of the feces escapes through such an orifice, and the remainder is evacuated at the normal anus, the communication between the external air and the intestinal canal is more accurately called a fecal fistule. Such openings are made intentionally, in order to save life during the performance of some abdominal operation, or they are the result of sloughing of the intestine after it has become adherent by inflammation to the parietes of the abdomen. Sloughing of the knuckle of the gut in strangulated hernia is at times a cause of artificial anus.

The bowel around the seat of the opening is adherent to the parietal peritoneum at the margin of the opening. In accidental cases the orifice or fistule is usually distorted and depressed, while the surrounding skin is the seat of eczematous inflammation. There may be two parallel intestinal tubes, with their adjoining walls adherent at the seat of the artificial anus, or there may be but a small opening in the bowel which is attached to the belly wall without any bending of the intestine. In the former case the artificial anus is due to the sloughing away of the bent portion or knuckle of intestine which formerly connected the two tubes, now lying parallel to each other. The upper portion of the gut, that is the portion nearest the stomach, is usually dilated and from it the feces escape; while the lower portion of the gut is collapsed. This lower portion of the gut may, rarely, be situated at the upper portion of the abdominal opening. By rotation it had become uppermost and then adhered to the upper part of the belly wall before the sloughing occurred. The term upper is employed in a technical sense to mean the portion of the intestine which is furthest from the rectum.

Usually, there is a spur or partition between the two tubes, which is the remains of the adjoining walls of the normal intestine at the point of flexion. It is this spur which tends to cause extrusion of the entire fecal contents through the abnormal anus. If this is absent, the contents of the bowel may continue down the tube and escape in the normal manner, with very little leakage occurring through the abdominal orifice. The condition is then a fecal fistule rather than an artificial anus.

Operation may be demanded to repair such an artificial anus or fecal fistule. It is important that it be undertaken before the lower portion of the gut has become so shrivelled or atrophied as to be quite different in caliber from the upper tube. If the artificial anus has occurred high up in the ileum or jejunum, the chyle escapes from the intestinal tract and causes the patient to suffer from partial or complete starvation. The condition then demands operative interference because of the difficulty in nourishing the patient, as well as on account of the disagreeable nature of the disease.

The introduction of hydrogen gas into the rectum from a rubber bag is a means of proving the relative locality of the opening. If the artificial anus is in the large intestine, the gas will escape from the abnormal orifice very soon after being introduced into the rectum and there will be no gurgling heard, such as is produced when the gas passes the ileo-cæcal valve. The time elapsing before the gas escapes from an abnormal opening in the small intestine will indicate the relative situation of the opening in the small gut. The presence of gas may be demonstrated by lighting it with a match as it escapes. The injection of milk or other fluid with a characteristic color may aid in a similar manner.

Treatment.—Simple means of closing an artificial opening should be tried before the more complicated and dangerous procedures are adopted. When there is no spur or when only a very small orifice exists, it is possible to cure the condition by the application of the cautery ; by paring the edges of the fistule and suturing them together; or by covering the opening by a flap of skin dissected from the surrounding surface after the edges of the opening have been freshened and stitched together.

When a spur directing the fecal matter through the opening exists, it is necessary to remove this partition by pushing it downward or dividing it, so as to restore the continuity of the intestinal caliber. Mere removal of this obstruction may cause spontaneous closure of the artificial anus. A simple method of depressing the spur is to push into the opening a piece of stiff rubber tubing, which is bent into a horseshoe shape. The two ends are thrust into the opening of the tube and, by their tendency to separate, the spur is pressed downward. The bent tube can be removed at any time by means of a string which has been attached to it. When the spur is large and thickened it becomes necessary to divide it. This is best done by an enterotome, which, in brief, is a long, two bladed clamp, by which the spur is grasped and held for several days, until the pressure causes sloughing of the portion of the spur between the jaws. The best form of enterotome is that in which the blades have ring-like extremities. This instrument causes sloughing in a circle and, therefore, removes a disk from the spur, instead of making a simple incision through it.

The opening upon the surface of the abdominal wall is to be closed by a suitable plastic operation, unless spontaneous closure occurs soon after restoration of the lumen of the bowel by the removal of the obstructive spur.

In many cases of artificial anus the best method of treatment is to make an anterior abdominal incision, put the patient in the Trendelenburg position and detach the intestine from the abdominal wall. The bowel is then excised at the point of perforation aud circular enterorraphy performed. If the opening in the gut is small, suture without excision may be sufficient. The abdominal opening, at the point where the artificial anus existed, is then curetted or made raw by cutting away the cicatricial tissue, and closed.

Appendicitis.

Pathology.—Appendicitis means an inflammation of the vermiform appendix. Typhlitis is the term used to designate inflammation of the cæcum, while perityphlitis signifies the same process in the

PLATE VIII.

Illustrating various degrees of involvement of Appendix Vermiformis. (Richardson.)

A. Chronic, recurring.
B. Ditto, much thickened.
C. Acute, with necrosis and rupture.
D. Showing local necrosis.
E. Gangrene and perforation permitting fæcal extravasation.
F. Total gangrene without perforation.

tissues outside of the cæcum. The great majority of inflammations in this region begin in the appendix.

Appendicitis is a very common and exceedingly important abdominal disease. It and inflammations of the uterine appendages constitute a very large proportion of all abdominal infections. It occurs at all ages and in males more frequently than in females. It is the cause of nearly all cases of peritonitis in men; and of most cases in women, outside of those due to conditions of the sexual organs. It is an infective disease and is perhaps associated with imperfect drainage of the contents of the appendicular canal into the cæcum. The colon bacillus seems to be the common pathogenic cause; but other organisms are at times the apparent mycotic irritant. Occasionally foreign bodies or fecal concretions in the appendix seem to have been a possible source of lowered resistance by causing damage to the mucous membrane.

Ulceration of the mucous membrane, thickening of the walls, gangrene, perforation, obliteration of the cavity and distention with mucous or muco-purulent fluids are conditions found. Adhesion of the inflamed appendix to the intestines, abdominal wall, uterus or bladder is a common result of the peritonitis, which occurs secondarily when the infective process spreads to the outer coat of the appendix. Retro-peritoneal abscess burrowing downwards into the groin or pelvis or upwards to the kidney and diaphragm may occur, if the appendix lie behind the cæcum. If it hangs more freely in the abdomen, a localized peritonitis may cause a wall of intestines and lymph to shut off the purulent focus, due to the perforative appendicitis, from the general peritoneal cavity; at other times the peritonitis becomes general, because no limiting wall has been formed. These pathological variations are apparently due to differences in degree of the infective process.

Death is a common sequence of appendicitis. The fatal issue is due to peritonitis or to chronic sepsis from long continued burrowing suppuration. Perforations at the tip of the organ are said to be less dangerous than at the base, because fecal entravasation is slower and the peritonitis more apt to be localized. In acute appendicitis death may occur in a few hours from virulent septic peritonitis. In chronic cases the symptoms may be of slight severity. After the patient has been free from all symptoms for several months or years, the disease may recur.

Symptoms.—Pain and vomiting, with rigidity of the abdominal wall over the appendix are early and important symptoms. To these are subsequently added the symptoms of peritonitis, local or general, and of suppuration and abscess. The pain is usually felt at first near the navel or in the epigastrium, but soon it becomes localized in intensity at a point midway between the navel and anterior superior spine of the right ilium. Occasionally the appendix is situated in the left side of the abdomen. Then the pain is felt there. The pain, being at first paroxysmal, may be considered due to intestinal colic; but it soon becomes constant. Local tenderness is present. The temperature may rise a little and the pulse become increased in frequency. Chill is not common. The bowels may be constipated or unusually loose. If no perforation occurs these symptoms subside in a few days. Frequency of pulse is more important as a danger signal than rise in temperature.

When perforation takes place, fecal escape occurs and peritonitis arises. If the peritonitis is localized, dulness on percussion and tumor, or swelling, may be noticeable. Subsequently signs of intra-abdominal abscess present themselves. The cases of general infection of the peritoneum are characterized by great general pain and tympanitic distention of the abdomen. In the former case the inflammation may subside and the patient be restored to perfect or a moderate degree of health. Perhaps slight tenderness may remain at the seat of the adherent appendix. In the event of general peritoneal infection death is very probable.

In chronic appendicitis the chief symptom is pain in the region of the appendix with some local tenderness. There may be exacerbations of pain from time to time with evidences of an active inflammation. In the intervals of this relapsing appendicitis, the patient may be well, or have slight pain and tenderness with digestive symptoms. These digestive disturbances, such as diarrhœa, colic, nausea and vomiting, may be erroneously ascribed to indiscretions in diet. Febrile movement and constipation may be present or absent.

Diagnosis.—Acute appendicitis must be diagnosticated from inflammation of the Fallopian tube, renal calculus, internal strangulation of bowel, ruptured extra-uterine, pregnancy and ovarian neuralgia. The diagnosis is usually easy, especially in male patients; because of the localized pain, tenderness and abdominal rigidity, and the infrequency of other abdominal inflammations. Chronic appendicitis is rather more difficult to recognize with certainty, especially in women with chronic iliac pain and evidences of probable pelvic disease. Quite often the swollen and painful appendix can be felt by palpation through the belly wall, if the muscles are relaxed while the patient lies on the back with the hips flexed. The pressure of the palpating fingers must be moderate, lest rupture of a distended appendix be caused. The appendix if long may hang down into the pelvis and if inflamed simulate inflammation of the uterine appendages. Digital examination by the vagina or rectum may sometimes furnish valuable information.

Treatment.—Appendicitis is a surgical disease, though a considerable number of cases may be successfully treated by medicinal means. The physician who essays to treat it unaided by a surgical colleague should have a considerable knowledge of surgical diagnosis, so as to recognize the moment when operative treatment is required. The first requisite in the successful management of the disease is its recognition. All doubtful cases should be regarded as probable appendicitis and given careful supervision.

In cases of mild onset the patient should be put to bed, the bowels opened by an enema and a mild laxative, and an ice bag or cold water clothes applied to the iliac region. Cold applications are probably better than hot fomentations. Leeching may be serviceable. Morphia and opium should be avoided. Active purging and very large rectal injections are probably dangerous, as they may cause perforation of an ulcerated appendix or cæcum. If the symptoms show little increase in severity during the first twelve hours, it is probable that the case will do well and that operation will not be required. If the pain becomes severe in this time and there is local rigidity of the abdominal wall over the region of the appendix, with continued vomiting and frequent pulse, cœliotomy and removal of the inflamed organ are indicated. The temperature of the patient may not be much above normal, though operation is demanded. If these mild cases show no tendency to become severe, but remain at a standstill or improve in the first forty eight or seventy two hours, immediate operation may, as a rule, be safely discarded. It may, however, be necessary to operate later for the evacuation of a localized abscess or for the removal of an adherent and painful appendix, which gives rise to recurrent attacks of inflammation.

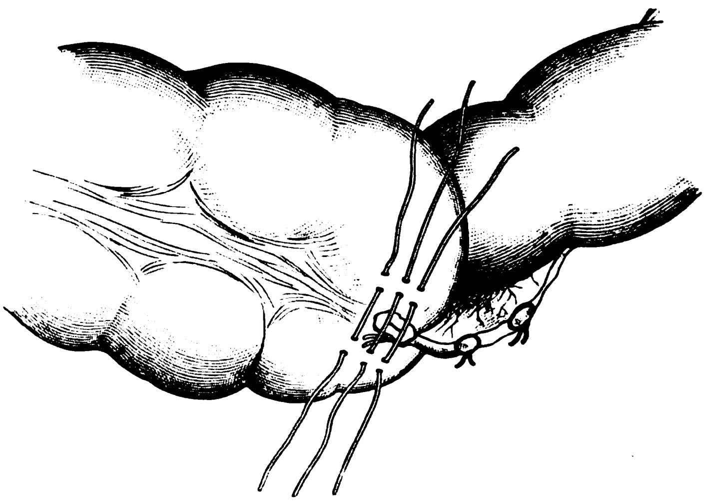
If the attack is accompanied by severe local or severe general symptoms at the onset, operative treatment is demanded. If in a mild case, severe symptoms suddenly arise, immediate operation is imperatively demanded. It is these cases, in which urgent symptoms suddenly arise from perforation and infection of the peritoneum, that have led some surgeons to advise operation in all cases of appendicitis as soon as the diagnosis is made. Such advice is not judicious. Death may sometimes occur because operation was not done soon enough, but death may also occur from an operation done unnecessarily. It is probably a good rule to operate not only in all cases where the indications for operation are clear, but also in those where there is doubt. This rule excepts from operation only those cases in which it is clear that operation need not be done or can at least be delayed until the case develops.

The danger of operating on cases of moderate or diminishing severity on the third or fourth day consists in the liability of breaking down the wall of lymph which separates the local suppurative process from the rest of the peritoneal cavity. A general peritonitis may be thus caused. If this occurs, the chances of recovery may be less than if the walled-in appendicitis is let alone until a thicker wall has formed. This will permit operative evacuation of the abscess, with or without the removal of the appendix, with comparative safety.

The incision should be made over the swelling or over the point of tenderness and should be about three inches long. It may be placed over a point midway between the navel and the anterior superior spinous process, if swelling and tenderness furnish no special indication. The cut may extend vertically, parallel to the outer border of the rectus muscle, or be oblique, following the direction of the fibers of the external oblique muscle. The deeper muscles are divided in the same direction. It is, however, better when practicable, as it usually is, to separate the fibers of the muscular layers by blunt dissection, so that the openings through the muscles will not all be in the same direction. Then, when the wound is closed by buried sutures the integrity of the wall will be restored and hernia at the cicatrix will be unlikely to occur.

When the cæcum is uncovered and brought out of the incision, the surgeon follows one of its longitudinal bands downwards and thus comes to the base of the appendix. The meso-appendix is tied, the appendix cut loose from it, and the base of the appendix encircled with a catgut or silk ligature. The appendix is then cut off, the stump invaginated into the cæcum, and the serous coat of the cæcum stitched over the invaginated stump. The end of the stump may previously be touched with a drop of undiluted carbolic acid to sterilize the exposed mucous membrane. Instead of treating the appendix by ligation, a portion of the wall of the cæcum and the attached appendix may be cut out with scissors and the wound be closed by Lembert sutures, as in other wounds of the bowel.

FIG. 367.



Excision of the appendix: the meso-appendix has been tied, the appendix removed, and the stitches are in position to bury the stump. (RICHARDSON.)

If the appendix is bound down by adhesions, it may be difficult to find. Careful dissection with the finger will often disclose and isolate an appendix that at first was completely hidden. The surgeon may, in suppurative cases, do harm, by a too prolonged or too energetic search, by rupturing the wall of lymph that separates the area of suppurative inflammation from the general peritoneal cavity. In chronic cases operated upon in the interval between attacks of active inflammation, this risk is not present. Hence it may be better in some cases to be satisfied with draining the abscess, and not to insist upon removing the appendix at the first operation.

When attacks of appendicitis recur in cases in which the organ has not been removed, it is usually wise to excise the appendix after the second or third attack, even if the inflammation be of a mild grade in each instance.

Colotomy and Colostomy.

When an artificial opening into the colon is established for the purpose of giving exit to the feces, the operation is often termed colotomy, though, as previously stated, colostomy would be the more strictly accurate term. A new anus may be made upon either side, and in either the lumbar region or the groin; the former is called lumbar colostomy, the latter inguinal colostomy. The term laparo-colostomy would be better for the last named, since at times the artificial anus is made in the median line or between it and the groin. The transverse colon is not often opened; but the operation is usually done upon the sigmoid flexure or cæcum, as would be supposed from the fact that the loin or the inguinal region is usually the place elected for operation.

Colostomy is performed for the relief of imperforate anus, for stricture of the rectum to afford an exit for the feces, in ulceration of the rectum in order to put the rectum at rest and in recto-vesical fistule.

Lumbar colostomy, often called colostomy by Amussat's method, is accomplished by making an incision in the loin. The colon is then opened at the place where it is not covered with peritoneum, but attached to the posterior abdominal wall by loose cellular tissue. The patient is placed in the prone position with the side to be operated upon elevated by means of a firm pillow placed under the belly. This makes the loin prominent. The anatomical position of the colon is half an inch behind a vertical line drawn upward from the middle of the crest of the ilium. The incision is from two to four inches long and is made midway between the lower rib and the crest of the ilium with its center over the colon, the position of which has previously been marked on the skin. The incision is made obliquely downward and forward, which makes it nearly parallel to the ribs. The dissection is carried toward the abdomen until the lumbar fascia and the edge of the quadrate muscle is reached. The former is divided and the edge of the latter may be incised if necessary to get room. By tearing through the transversalis muscle and fascia the colon is found in the line previously marked on the skin, a little in front of the border of the quadrate muscle. It is recognized by the feces, which can be felt in it, or by the longitudinal bands of fibrous tissue which characterize the great intestine. If there is not an impassable stricture of the rectum present, the intestine may be distended with air by means of an ordinary syringe, the nozzle of which has been passed through a plug fitting the anus. The nozzle of the syringe may be passed through the center of a roller bandage made conical. This makes an exceedingly good plug to prevent escape of the air pumped into the rectum by the syringe. This distention may be a great aid in the recognition of the colon. It is often seen distinctly, however, without such assistance.

Care must be taken that the peritoneum bulging into the wound be not mistaken for the colon. If the peritoneum should be unwittingly punctured, the edges of this serous membrane should be held together by means of one or two hemostatic forceps and ligatures of catgut or silk tied around the opening. The operation is performed on the right side if the obstruction is above the sigmoid flexure. A curved needle should be passed into the wall of the colon and a suture carried through, in order to have the ends of the suture for drawing the gut up to the surface of the wound. The colon is then carefully stitched fast to the edges of the wound and opened at once or after the lapse of two or three days when it has become adherent. The latter method is safer, since the possibility of feces escaping into the tissues around the colon is avoided. The opening may be made without anæsthesia, since the intestinal tissue is not very sensitive. In either event the deep portion of the wound should be carefully sutured and drainage tubes put in both the upper and lower extremities of the deep wound.

Absorbent dressings to catch the discharging feces should be applied and frequently changed. This is especially necessary if the intestinal opening has been made at the time of the original operation. Some prolapse of the mucous membrane often occurs in the cases of colostomy, but it does not usually become very marked. Indeed, an artificial anus often shows a tendency to contract, and dilatation may be required to keep it sufficiently patulous.

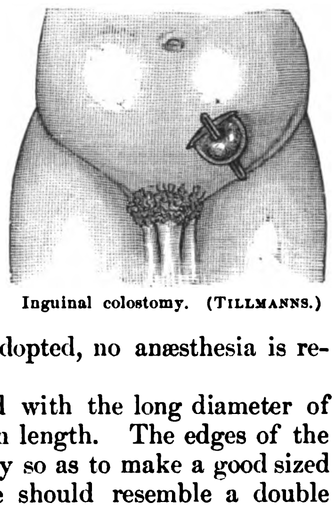
The patient usually has no great inconvenience from an artificial anus and soon learns to dress it so as to catch any fecal matter which may escape at inconvenient times. Absorbent pads are often more comfortable than any form of plug or receptacle made by instrument makers. A portion of the feces may in certain cases pass beyond the opening and get into the bowel below. This is due to the fact that when the intestine was brought to the surface it was not sufficiently bent upon itself to make a spur or partition. Various operations have been devised to prevent or remedy this occurrence. In making the artificial anus the surgeon should endeavor to secure a good spur between the upper and lower portions of the tube.

Laparo-colostomy.

When an artificial anus is established in the inguinal region (often called Littré's method), and when the incision for the artificial opening is made in the middle line, the operation is called laparo-colostomy. This operation has some advantages over lumbar colostomy. The bowel is more easily found and a more accurate exploration of the condition for which the operation was done is possible. These advantages are particularly marked, if the median instead of the inguinal incision is made. If it is found that an opening in the descending portion of the colon would not be serviceable in relieving the obstruction, it is possible to make at once an opening in the ascending colon. This is a distinct advantage over the lumbar incision, in which, of course, the large bowel can only be opened upon the side corresponding with the external wound. The anterior operation, moreover, is less serious and troublesome in its performance than the lumbar method, and puts the artificial anus at a place where it can be easily attended to by the patient.

Laparo-colostomy, if done in the inguinal region, requires a two inch incision, which should be parallel to Poupart's ligament, beginning an inch inside of the anterior superior spinous process of the ilium. It should be situated a short distance above Poupart's ligament. After the parietal peritoneum has been sutured to the skin, the sigmoid flexure is found, and a portion with a rather long mesocolon drawn through the incision, until the mesocolon is sufficiently outside of the abdomen to permit a glass rod, a piece of drainage tube or a strip of gauze to be passed through a slit made in it. This procedure is adopted so as to insure a marked spur at the seat of the artificial anus, which will prevent feces descending beyond the opening into the lower section of bowel. The protruding portion of gut is then sutured with care to the skin and parietal peritoneum. This closes the general peritoneal cavity. The opening into the intestine may be made at once or delayed a day or two until adhesion has occurred between the intestine and abdominal wall. The latter method is unnecessary. If it is adopted, no anæsthesia is required when the bowel is opened.

FIG. 368.



Inguinal colostomy. (TILLMANNS.)

The intestinal wound should correspond with the long diameter of the bowel and should be about an inch in length. The edges of the wound may subsequently be trimmed away so as to make a good sized opening. The two portions of intestine should resemble a double barrel shot gun. The glass rod or other mechanical contrivance to insure the production of a spur is removed at the end of three or four days. Instead of this method, sutures can be so adjusted as to hold the two inches of bowel outside of the wound and make a spur. The operation in the median line is conducted on the same principles.

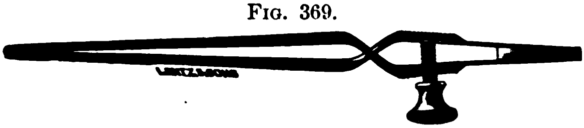
Resection of the Intestine.

Resection or excision of intestine is the removal of a portion of the bowel; and is often followed by immediate suturing together of the ends of the tube. The word enterectomy is often used to include operations of this sort upon the large as well as upon the small intestine. Strictly, it should be employed only for resection of the small intestine, while colectomy should be used when a portion of the large bowel is cut away. Resection of the intestine is adopted in gunshot and in stab wounds, when the bowel is too much injured to admit of simple suturing; in malignant and other strictures of the bowel; in gangrene of the intestine; and in some cases of incurable artificial anus. After gangrenous hernia resection may be necessary at the inguinal canal. At other times it is done after making a preliminary abdominal section, which is usually made in the median line.

The operation is divided into three stages: Separation of the bowel, excision of the intestinal tube and suturing together of the cut ends. Adhesions between the portion about to be excised and other intestinal loops or between it and the solid viscera are a contra-indication to operation. The portion to be operated upon must be movable enough to be brought to the surface of the abdominal wound in order to permit the necessary manipulation.

In resection of the bowel the removal must include sufficient of the intestinal tube to reach healthy tissue above and below the seat of the disease. The intestinal contents, whether feces or gas, should be pressed backwards out of the portion of the tube to be operated upon, and strips of gauze should be used to compress the intestinal tube above and below the site of operation, to prevent escape from the cut ends. These are applied by making a hole in the mesentery near the bowel and passing the narrow piece of gauze or a tape through. The bowel is then constricted by tying these flat ligatures firmly enough to just close the lumen. Special intestinal clamps are no better than these ligatures.

FIG. 369.



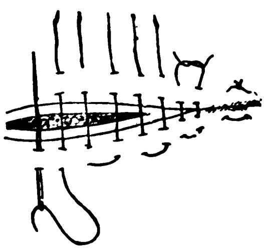
Clamp for resection of bowel.

The bowel is then divided and cut loose from the mesentery and the clamps or ligatures successively released in order that the feces and gas retained beyond the ligature may be allowed to escape. In cases of obstruction the amount of material which will thus flow out is, of course, great. Much care should be taken that this substance does not come in contact with the general peritoneal cavity, which may be separated from the field of operation by packing large gauze pads into the abdominal wound. The portion of gut which the surgeon is about to cut off may, after it is detached at the lower end, be used to conduct away this accumulation of fecal matter into a vessel held alongside the patient. After the portion to be excised has been separated from the mesentery some surgeons prefer to cut out of the mesentery a V-shaped piece in order to get rid of the redundant mesenteric tissue. If this is done it is necessary to unite carefully the edges of the mesentery by overlapping them and applying sutures. It is not necessary, however, to make this V-shaped excision, since the redundant mesenteric tissue can be folded up by means of sutures and attached behind the junction of the two ends of the intestine after they have been sewed together. This adds somewhat to the strength of the union.

Bleeding from the small vessels of the intestinal wall will follow excision of the diseased portion and should be stopped by means of fine ligatures. Care must be taken not to devitalize the intestinal coats by compression of these vessels with large hæmostatic forceps, which grasp a great deal of tissue. Small pointed arterial forceps should be used, and only the vessels should be enclosed in their grasp.

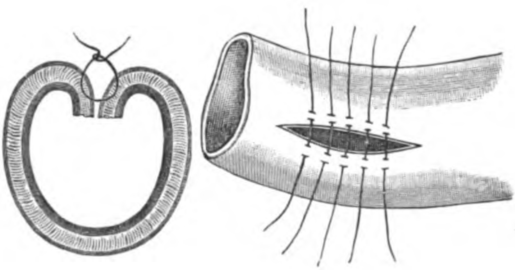
The most important and tedious step in enterectomy is stitching together the cut tube, which must be well done in order to prevent extravasation of feces into the general peritoneal cavity after the abdominal wound has been closed. Fine twisted silk makes the best sutures. They should be carried through the peritoneal and muscular coats, but should never perforate the mucous membrane so as to enter the lumen of the bowel. If any sutures are inserted for the purpose of uniting the mucous membrane, they must be tied on the inside of the gut and not come through to the peritoneal surface. The Lembert suture is probably the best form to use after resection of the in-

FIG. 370.



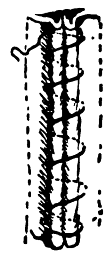
Quilt suture.

FIG. 371.



Lembert suture. (TILLMANNS.)

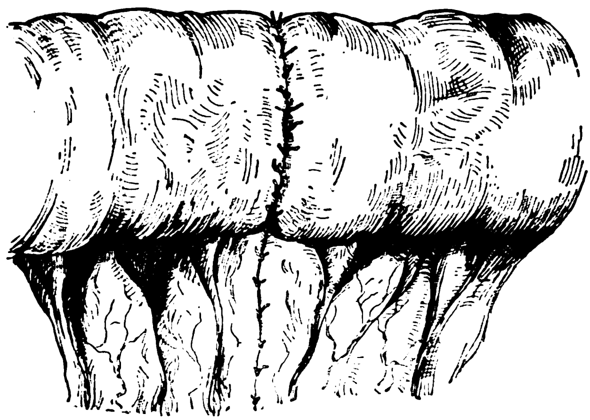
FIG. 372.



Continuous Lembert suture applied to intestine.

testinal tube. After the insertion of these sutures the continued suture may be used as an additional means of support at any dangerously weak spot in the bond of union. The quilt suture is another satisfactory method.

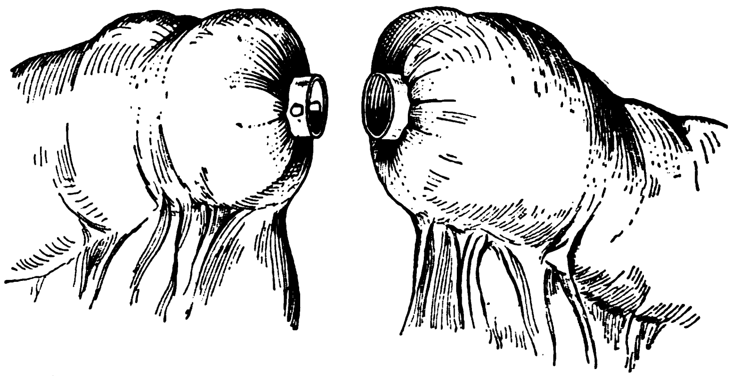
FIG. 373.



End-to-end suture after the application of interrupted Lembert stitches. (RICHARDSON.)

The sutures may be inserted while the clamps are upon the intestines, or some liquefiable cylinder, such as a long plug of cocoa butter, may be inserted into the cut ends of the tube and the sutures placed while the bowel is thus distended. A rubber bag, which can be distended with air, will answer the same purpose. Such devices are,

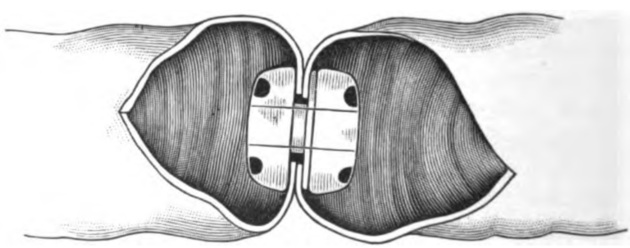
FIG. 374.



End-to-end union of intestine by means of the Murphy button: the two portions of the Murphy button, held in position by purse-string sutures, are ready to be pressed together. (RICHARDSON.)

however, not necessary. The Murphy anastomosis button or Mayo's bobbin may be used to lessen the time of operation in cases of circular enterorraphy, but they are seldom necessary. The gut should be stitched together first at the mesenteric attachment and then opposite to that point. This gives a certain amount of steadiness while the remaining suturing is being done.

FIG. 375.



End-to-end union with the Murphy button. (RICHARDSON.)

The least point of leakage at the place where the enterorrhaphy is made will destroy the success of the operation, and will probably give rise to fatal peritonitis. In order to make the point of union still more perfect, Senn has proposed to take grafts of omentum and apply them along the suture line. He cuts out a small strip of omentum about two inches in width and long enough to go around the gut. He keeps this in a warm antiseptic solution (sublimate 1 to 2000), until he is ready to apply it around the junction as a sort of collar. The ends of the graft are stitched to the mesentery; and as the graft is aseptic it becomes united to the gut at the seat of operation. To make the graft more readily adhere, the peritoneal surface of the bowel may be slightly scratched with a needle point to cause rapid exudation of lymph.

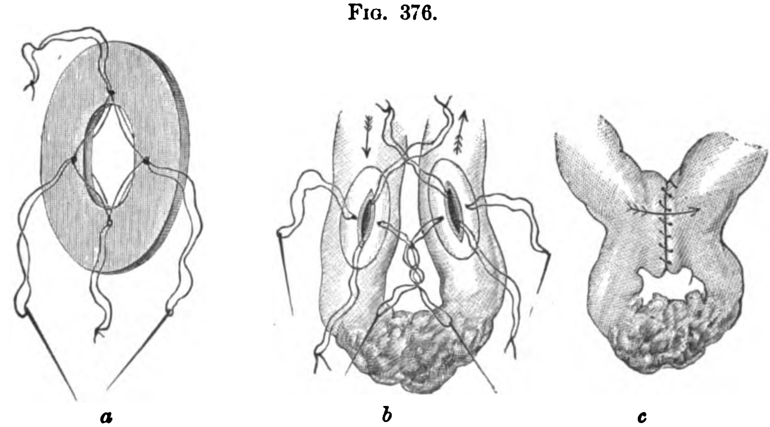
The bowel thus prepared and sutured is returned into the abdominal cavity, for these manipulations have been done outside the abdomen, and the wound closed in the ordinary manner. If there is any doubt about the perfection of the enterorrhaphy, it is well to stitch the repaired gut to the edge of the wound. Then, if one of the sutures becomes untied or a leak occurs, it will be at once discovered; when opening of the abdomen, irrigation and drainage may be promptly instituted.

If it is impossible to complete the resection in a case where this has been attempted, an artificial anus must be made by attaching the wounded intestine to the abdominal wall. If colectomy is anticipated when the operation is begun, it may be better to make a lateral rather than a median laparatomy. After such lateral opening has been made, which may be small for exploratory purposes, it is not improper to do the operation through another incision, made in the median line, if the lateral one is found disadvantageous.

Intestinal Anastomosis.

This term signifies the construction of a permanent orifice between two portions of gut, so as to exclude the intervening portion from conducting the feces. When intestinal anastomosis is established between the jejunum and the ileum, the term jejuno-ileostomy is used. Ileocolostomy is the construction of an orifice between the ileum and the

FIG. 376.



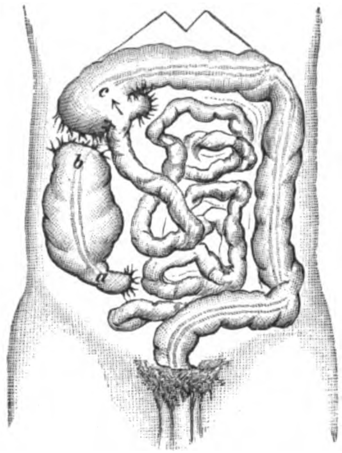
a *b* *c*

Senn's method of performing lateral anastomosis: *a*, plate of decalcified bone; *b*, plates in position within the intestine; *c*, after completion of the operation. (TILLMANNS.)

colon, while gastro-enterostomy is applied to the creation of an opening between the stomach and a portion of the small intestine.

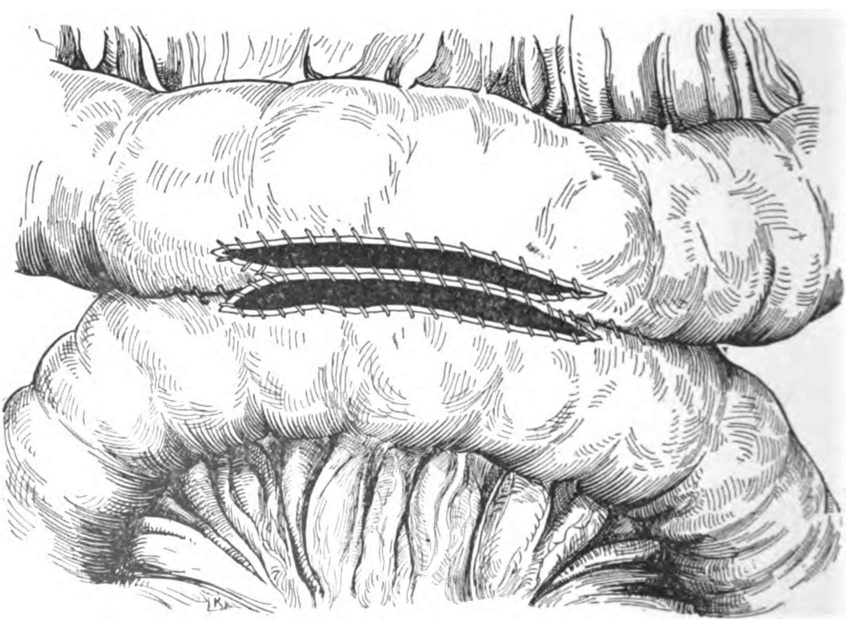
Intestinal anastomosis is indicated in obstruction of the intestines and in such malignant strictures as cannot be overcome or removed with safety. Apposition of the tubes between which the orifice is to be made is maintained by decalcified bone plates with central openings, by elliptical rings of catgut or rubber, or by anastomosis buttons. After these have served their purpose in keeping the serous surfaces in contact, they are either dissolved in the intestinal fluids or, as in the case of rubber rings and buttons, pass through the bowels and escape from the anus undigested. In using the rubber rings it is customary to cut them at one or more points and unite the cut ends with catgut, which becomes dissolved and allows the rings to pass through the bowel straightened out or in pieces and not as a circle. The use of plates or rings adds possibly to the safety of the operation of intestinal anastomosis. In suturing the apposed tubes a preliminary scratching of the peritoneum with a needle point will add to the certainty of the results.

FIG. 377.



Intestinal anastomosis in which a portion of the bowel (*a b*) is completely separated from the rest and closed at both ends; the small intestine is sutured into the side of the transverse colon at *c* so as to make a lateral anastomosis. (TILLMANNS.)

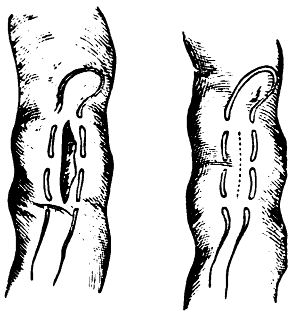
FIG. 378.



Lateral anastomosis without the use of plates or buttons: first stage of the operation. (RICHARDSON.)

Ligatures of gauze are put upon the intestines above and below the seat of operation after the intestinal contents have been squeezed out, as in resection. A point must be selected which will not cause dragging upon the mesentery or the bowel when the surfaces are put together. An incision from two to two and a half inches long is made in each portion of the gut, corresponding with its long diameter, and on the side opposite to the mesentery. Through these are passed into the lumen of the bowel the catgut or rubber rings, to each of which four sutures are attached or fastened. The lateral threads are carried through all the coats of the intestinal wall, while the threads at the end of the elliptical rings come through the wound. The ends of the corresponding threads are then tied upon the peritoneal surfaces of the apposed coils of gut. The opening in the center of the ring prevents obstruction of the intestinal flow from one coil to another.

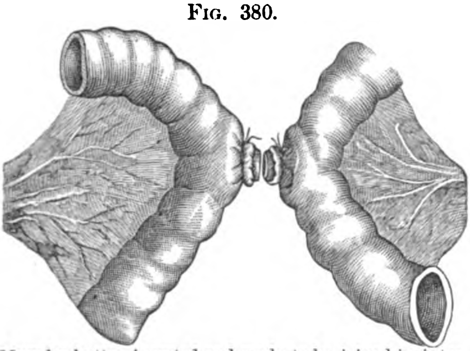
FIG. 379.



Application of sutures for the use of the Murphy button in lateral anastomosis. (DUNN.)

Instead of bone plates or rings, the Murphy button may be used. It consists of two portions which, when pressed together, lock and hold the two cylinders of bowel in close apposition. The bowel has a slit made in it at a point around which an encircling suture has been placed; the half button is inserted into the lumen of the bowel, with the neck of the button protruding through the slit and the ligature tied. The same steps are taken with the other portion of bowel and then the two halves of the button are pressed together. Pressure necrosis takes place after a few days and the button drops into the gut, to be voided at the anus. Before the button cuts its way through the intestinal wall plastic adhesion has occurred; and hence no escape of intestinal contents takes place because of the opening between the intestinal tubes.

FIG. 380.



Murphy button inserted and ready to be joined in intestinal anastomosis. (VON FREY.)

Instead of using these mechanical devices the surgeon may make a long incision in each portion of intestine, stitch the mucous and peritoneal layers together along the edge of each wound, and then sew the two tubes together. The anastomosis opening should always be large for it is likely to contract.

Lateral anastomosis may be employed instead of circular suturing after resection. In this case the two cylinders are laid side by side, and the walls at the cut ends are turned in and sutured in a straight line across the extremity. After this a new opening is made and the apposition rings adjusted.

FIG. 381.

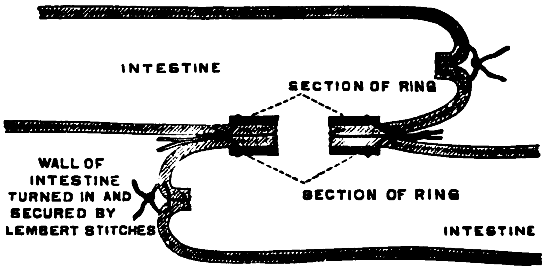


Diagram showing position of decalcified bone plates in intestinal anastomosis after resection of bowel.

The mere slit, made for the insertion of the rings and for the new orifice between the intestinal tubes, seems at times to give too small an orifice for the ready passage of feces. It probably contracts during cicatrization. It is possible that trimming away the edges of the intestinal incision, so as to make an elliptical hole in each cylinder of gut, may obviate this condition.

DISEASES AND INJURIES OF THE LIVER.

Laceration and other wounds of the liver may be indicated by local pain, jaundice, clay colored stools, bilious vomiting and sugar in the urine. The symptoms vary with the locality and extent of the injury. The treatment is immediate abdominal section with suturing of the liver, and ligation or the use of the actual cautery to stop bleeding.

Abscess of the liver is especially frequent in tropical countries, but is also met with elsewhere. The suppurative process not infrequently gives rise to multiple abscesses. The pus, which may originally be formed at some distance from the surface of the liver, may be evacuated spontaneously into the chest, abdomen or bowel or upon the exterior of the body. The symptoms are rather negative, but increased hepatic dullness associated with pain and tenderness is suggestive of the possibility of abscess. The amœba coli causes hepatic abscess and is usually preceded by amœbic dysentery. This is the usual etiology of tropical abscess of the liver. Pyæmic abscesses of the liver, secondary to appendicitis and other abdominal infections, may occur by the route of the portal vein.

Hydatid cysts give rise to symptoms similar to abscess. The peculiar fremitus, which is so characteristic of the presence of this form of cyst, is often absent in hepatic hydatid cysts. Suppuration of the cysts is not uncommon. Then the symptoms are identical with abscess from other causes. Fluctuation is only perceptible in abscess and hydatid disease when the collection is large and near the surface.

The best treatment of hepatic abscess is cœliotomy, followed by incision of the abscess (hepatotomy) and drainage by a tube left in the wound. It is unwise to wait for the occurrence of adhesions between the liver and the belly wall with the idea of incising or aspirating the abscess through the parietes, because fatal rupture may take place before adhesion occurs. Moreover, there is often no means by which the surgeon can be sure of the existence of adhesion between the liver and abdominal wall. An abdominal incision should be made over the swelling, if there be any. If adhesions of the liver to the belly wall are found to exist after this incision has been made, it is wise to close the exploratory wound and to open the abscess by a new cutaneous cut carried through the adherent area. In other cases the abscess is punctured, a finger inserted and the liver drawn up to the abdominal wound in order that the abscess cavity may be evacuated without pus escaping into the peritoneal cavity. When this abscess has been emptied the finger should explore its interior and rupture any neighboring abscesses, so that all will empty themselves through the original opening in the liver. A weak antiseptic solution is used to wash out the suppurating cavity, after which the edges of the abscess wound are stitched to the skin and a large drainage tube of rubber inserted. The peritoneal cavity should be thoroughly washed out with warm sterilized water if it has been soiled, and the usual dressings applied. Pus should be sucked out of the abscess cavity every day, by means of a syringe and daily irrigation with a weak antiseptic fluid will probably be wise. Hydatid cysts should be treated by incision and suturing to the belly wall in the same manner as abscesses.

Malignant Diseases of the Liver.

A malignant tumor of the liver, if single, may be removed by cœliotomy. The red hot knife of the Paquelin cautery will be of aid in excising the growth without hemorrhage. It is unusual, however, to find a single malignant nodule, since the symptoms are scarcely prominent enough to suggest exploratory laparotomy until the disease has advanced far enough to cause multiple tumors or large and irremovable growths.

DISEASES AND INJURIES OF THE GALL BLADDER.

Wounds of the Gall Bladder.

Rupture and wounds of the gall bladder are, because of the inflammation caused thereby, nearly always fatal unless treated by surgical means. The exudation of plastic lymph, as a concomitant of a localized peritonitis, may occasionally circumscribe the inflammation and thereby prolong life or even prevent the fatal issue.

The treatment, however, is clear. It consists in opening the abdomen and stitching the edges of the wound in the gall bladder to the skin, as in the ordinary operation of cholecystotomy.

Cholecystotomy.

Cholecystotomy, or incision of the gall bladder, is performed for the extraction of gall stones, for the treatment of dropsy and empyema of the gall bladder, for obstruction of the bile ducts; and in cases of rupture or wounds of the gall bladder. Gall stones give rise to attacks of hepatic colic, the pain of which is often agonizing. Inflammation, suppuration and gangrene of the gall bladder may occur as a result of the presence of stones in the bladder, while their passage into and arrest in the biliary passages may cause obstruction of the cystic, hepatic or common bile duct. Such obstruction, if involving only the cystic duct, gives rise to local symptoms, such as distention of the gall bladder, followed, perhaps, by inflammation, gangrene and the occurrence of biliary fistule. By sloughing of the wall of the gall bladder and surrounding tissues, gall stones may pass into the lungs, bowels or peritoneal cavity. Fatal peritonitis is a complication which may be thus excited. If gall stones become impacted in the common bile duct, jaundice and cholæmia result in addition to local pain and inflammation.

Stones lying in the gall bladder and not becoming entangled in the duct, may give rise to no special symptoms and remain unnoticed for years. Dropsy, or empyema, of the gall bladder is usually due to stones, but may be caused by hydatids or intestinal worms plugging the duct, to inflammation or to pressure from some tumor connected with the neighboring viscera. The distention may be so great as to cause the bladder to fill nearly the entire abdomen. In such cases the walls are apt to be thinned. Stricture from inflammation of the mucous membrane of the duct may give rise to purulent distention of the gall bladder. Thickening, ulceration and perforation of the walls may occur as a result of suppurative inflammation within the gall bladder. Acute suppurative cholecystitis occasionally occurs.

The diagnosis of these pathological changes in the gall bladder is made by the existence of a tumor in the right hypochondriac region. It may be fluctuating or so tensely distended as to be hard. It may be pear shaped or globular, but usually increases in size in an oblique direction from the hypochondrium toward the umbilicus. Jaundice is frequently absent, because the common bile-duct is not obstructed.

The diagnosis between distention of the gall bladder, cystic tumor of the kidney, movable kidney and inflammation about the pylorus or head of the pancreas is difficult.

The operation of cholecystotomy is demanded in wounds, dropsy and empyema of the gall bladder. It is often required in cases of gall stones, but in this condition should not be performed until the frequency of hepatic colic, the persistence of cholæmia or the evident existence of a bladder filled with stones indicates its necessity.

The operation is more successful in cases in which jaundice is not present, because bile in the blood (cholæmia) depresses the patient's forces and renders the bleeding more profuse. The operation, however, must often be done in cases where jaundice exists. Opening the gall bladder and simply stitching its wall to the abdominal parietes is the operation called cholecystotomy. Removal of gall stones after such an incision is cholelithotomy; while, if it is necessary to crush the stones before removing them, the procedure is termed cholelithotrity.

The incision should be made over the fundus of the gall bladder, which corresponds with the tip of the cartilage of the tenth rib on the right side, or it may be made over the tumor, if one exists. The incision should be vertical. If the bladder is greatly distended, some of the fluid may be drained away by an aspirator before an incision large enough to permit insertion of a finger is made. Care should be taken, by packing gauze around the seat of the operation, to prevent the bile flowing into the peritoneal cavity. It is true, however, that bile, if healthy, is aseptic. The gall stones should be removed with a scoop or forceps or crushed with appropriate forceps. The surgeon must recollect that the walls are thin and easily torn. If laceration occurs it may be necessary to remove the entire bladder (cholecystectomy).

If the stone is immovably fixed in the cystic duct, it may be nibbled away with Tait's forceps. Possibly it may be broken up by thrusting a needle into it or crushing it with padded forceps applied outside of the wall of the duct. Stones impacted in the common bile duct may be removed through an incision in the duct, which is afterwards closed. Sometimes it is wise to open the duodenum and pass a probe upward from the intestine, in order to push the stone back into the dilated portion of the duct behind the obstruction. Removal may be then possible through a cut in the duct. After the stones have been removed or the dropsical fluid or other contents evacuated, the edges of the wound in the gall bladder are usually sutured to the edges of the belly wound. The stitching should be by a continuous suture of silk and pass through the skin, peritoneum and bladder wall. If the bladder wall is healthy and no pus was contained in the bladder, the wound may be sutured by Lembert sutures and the bladder dropped back into the abdomen.

A drainage tube, preferably of rubber, should always be inserted into the open gall bladder, if its walls are fastened to the edges of the wound. The bile which flows from the tube may be conducted into a bottle lying alongside of the patient. A piece of rubber dam may be fixed around the orifice of the tube, so as to prevent the bile coming into contact with the wound, and a mass of absorbent material placed over the orifice.

If all stones have been removed so that the bile flows through into the intestine, the fistule made by the operation will finally close. If such is not the case, it may become necessary to make a permanent opening between the intestine and bladder by subsequent operation. Such an operation is entero-cholecystostomy; and is probably best done by a small Murphy's button, though this instrument is not an essential. Biliary fistules from spontaneous evacuation of the bladder contents will seldom close unless the bile is conducted into the intestine by this same operation, after which plastic operations upon the external openings may be made if closure does not take place.

DISEASES AND INJURIES OF THE SPLEEN.

Rupture or wounds of the spleen should be treated by abdominal section and suturing. When the damage done is very great, removal of the spleen may be demanded. Cyst of the spleen is to be treated by laparotomy and incision, followed by drainage. The operation of incision into the spleen is termed splenotomy. Excision of the spleen, or splenectomy, may be required in some cases of movable spleen, in hypertrophy of the spleen, when it is not leukemic, and in tumors.

Splenectomy is performed by an incision through the left semilunar line. The attachments of the organ are ligated and divided, clamps in some instances being required before the adhesions are cut. Hemorrhage is the great danger, hence it is necessary that the stump be well ligated. It may be wise to tie the vessels separately as they show on the end of the pedicle.

DISEASES AND INJURIES OF THE PANCREAS.

Abscesses and cysts of the pancreas should be treated by laparotomy, incision of the abscess or cyst and the establishment of a fistule by attaching the edge of the sac to the abdominal incision. This is done because of the necessity of providing for the escape of the pancreatic fluid, which would otherwise flow into the peritoneal cavity. The incision should be made over the tumor.

DISEASES AND INJURIES OF THE UTERUS AND ITS APPENDAGES.

Injuries of the abdomen seldom involve the uterus, unless it be pregnant, except in cases where the injury is so extreme as to do damage to many of the abdominal and pelvic organs. A pregnant uterus has by error been tapped for abdominal dropsy. The wound in such cases is apt to cause abortion. If serious symptoms or peritonitis should arise from this or any other uterine injury, abdominal section should be performed, and the condition found treated on general principles, such as suturing the wound, irrigating the peritoneal cavity and drainage.

Fibro-myomatous tumors of the uterus are quite common growths, especially in the negro. They are often called fibroids, because they resemble fibromas. They are, as a rule, however, largely myomatous in their histological features; and are the most common of uterine tumors. If they develop beneath the peritoneum they are called subserous, or subperitoneal, fibro-myomas; if under the mucous membrane of the uterus, submucous fibro-myomas; while those developing within the substance of the uterus are called interstitial or intra-mural tumors.

These tumors are interesting surgically, particularly when they are developed under the peritoneum, as then they may be confounded with other growths until the abdomen is opened. A uterine fibro-myoma gives rise to pain, uterine hemorrhage and a hard irregular tumor, which can often be felt through the abdominal wall.

Ergot is given for the relief of the hemorrhage and to cause uterine contraction, by which it is hoped the growth may be gradually forced through the uterine cavity toward the vagina, where it is more accessible to removal. The submucous form sometimes has quite a long pedicle. If this is the case, the growth may be removed by the écraseur, introduced through the vagina. Sessile growths of this sort are treated by scraping away with a spoon having a saw like edge, after a preliminary dilatation or incision of the os has been performed, so as to facilitate the intra-uterine manipulation. The intra-mural fibromyomas may also, at times, be enucleated by scraping or incising the internal uterine wall after dilatation or incision of the os.

Subserous tumors are amenable to operative treatment by abdominal section. The growth may then, perhaps, be enucleated from the uterine tissue; or the uterus, if occupied by enormous or numerous growths, is extirpated (hysterectomy).

Apostoli and others have earnestly advocated the treatment of these uterine tumors by the application of galvanism. Removal of the ovaries to bring on the menopause, and thereby stop the monthly congestion of the uterus which aids in the growth of these tumors, is sometimes adopted. Excision of the tumor from the uterus after a cœliotomy, called myomectomy, or the operation of hysterectomy are the usual methods at the present time.

Fibro-cystic disease of the uterus is a rare condition, and need not be discussed.

Malignant disease of the womb is most frequently met in the cervix. For its treatment, amputation of the neck by the introduction of instruments into the vagina is often performed. The diseased portion may be eaten away by chloride of zinc or other caustics. The best treatment is removal of the entire uterus by the operation called vaginal hysterectomy. In this operation the uterus is pulled down by toothed forceps and an incision made through the vaginal mucous membrane in front and behind, so that the operator's fingers can be carried into the peritoneal cavity to drag down the entire organ. The broad ligaments are then ligated, or clamped with large hæmostatic forceps, and the uterus cut loose. The peritoneum and mucous tissue at the top of the vagina fall together as the uterus is withdrawn. If clamps are used to control the vessels of the broad ligament, they are taken out at the end of twenty four or thirty six hours. Instead of vaginal hysterectomy, abdominal hysterectomy may be adopted.

Tumors of the Ovary.

Pathology.—These growths are of importance to the surgeon, because a diagnosis is often required to be made between them and other abdominal conditions; and because the abdomen has often been opened for some other condition, and an ovarian cyst or tumor unexpectedly found to be the cause of the symptoms.

Ovarian tumors are most commonly cystic; the cyst may be unilocular or multilocular. What are called unilocular cysts are not infrequently multilocular cysts with one cyst greatly developed. Sometimes such cystic tumors are in part solid. Tumors which are dermoid cysts, wholly or in part, are not very rare in this locality. Tumors of the broad ligament, called parovarian tumors, may be cystic or solid. Solid tumors of the ovary are rare and when found are usually malignant.

Symptoms.—Ovarian cysts when small produce no symptoms. If they increase in size they displace the uterus forward, or backward or laterally, and probably depress it a little. This takes place when the tumor is small enough to be contained in the pelvis. When, from increase in size, it rises into the abdomen, such changes are not apt to be present.

The symptoms of ovarian tumors, which are now to be described, are not very reliable, for similar symptoms may occur in other diseases and ovarian cysts may be present without giving rise to them with sufficient distinctness to be of value in diagnosis. A small, rather globular mass, either firm or fluctuating and probably movable, is found sometimes on one or other side of the belly. As it increases in size a feeling of discomfort, frequent urination, constipation and œdema of the limbs from compression of the veins may arise. Pain from pressure on the sacral or lumbar plexus may occur and be reflected down the legs. Nausea, vomiting, colicky pains and, perhaps, diarrhœa are not improbable. Ascites from interference with circulation in the portal vein is quite usual, and hemorrhoids from a similar interference with the venous return are an annoying complication. Albuminuria also may be present and dyspnœa, from abdominal distention due to the bulk of the tumor and from the peritoneal dropsy just mentioned, may be very distressing.

When the cyst becomes large enough to distend the abdomen greatly, and particularly when the cyst is unilocular, it very much resembles peritoneal dropsy or ascites occurring from visceral disease. A differential diagnosis is then a matter of great importance. Multilocular cysts are not so liable to make a diagnosis difficult, because they usually have an irregular surface and because fluctuation is more marked in some places than in others. The fluctuation wave does not cross the whole abdomen, but is limited to various portions of it, unless one of the cysts in the multilocular growth is very much larger than the others. A unilocular cyst has a smooth outline, is elastic and gives a fluctuation wave over its whole extent. This last symptom is very like that given by ascites. Dullness on percussion exists over the tumor whether it is unilocular or multilocular. In ovarian dropsy, a term often used to signify an ovarian cyst, the area of dullness is circular, with the convexity of the circle directed upward near the middle line, with resonance extending downward upon each side. In ascites the dull area gives a crescentic line with the concavity upward, while resonance is notably situated between this line and the stomach. The dullness of ascites is changed by turning the patient on her side. This does not take place in ovarian dropsy, where the line is practically unchanged by such movement. It should be remembered that when an ovarian cyst is accompanied by ascites, due to pressure of the cyst upon the venous trunks, there may be dullness in the flank and fluctuation across the whole abdomen, because of the complicating ascites. This will destroy the outline of the resonant area indicative of ovarian cyst.

In ovarian cysts there is often a peculiar heaping up, as it were, in the middle line, which is due to the greater distention in the middle portion of the abdomen; but in ascites, gravity acting on the unconfined fluid causes distention at the sides of the abdomen and flattens the front of the belly. In ascites, moreover, there is apt to be evidence of disease of the heart, kidney, liver or some other abdominal organ, with perhaps œdema of the arms and face. Œdema of the legs does not aid much, because, though frequently occurring in cardiac, renal and liver diseases, it also exists in cystic tumor of the ovary, from pressure of the growth on the caval and iliac veins. When abdominal dropsy exists in addition to the ovarian cyst, the diagnosis of a tumor in addition to the ascites may sometimes be made by quick and forcible pressure of the finger upon the abdominal wall. The sudden pressure or tap causes the peritoneal fluid to be pushed aside and the fingers come abruptly upon the ovarian cyst or other growth. This would not occur if ascites alone existed, nor if a large ovarian cyst without accompanying ascites were present. The fluid of ascites is usually thin yellow serum. The fluid of ovarian cysts is frequently brownish in appearance.

Encysted dropsy of the peritoneum is difficult to diagnose from ovarian cyst. A differential diagnosis is often impossible. Cysts of the broad ligament resemble ovarian tumors in their symptoms and in their treatment, except that tapping is sometimes curative in the former. Ovarian cysts should seldom, if ever, be tapped and then tapping is not curative. As other growths, cysts of the ovary may become adherent to the intestines, solid viscera and abdominal wall. The presence of adhesions cannot with certainty be made out before the abdomen is opened.

Rupture of an ovarian cyst may occur, and the fluid, if it escapes through a small opening, may give rise to no special symptoms; but if it is suddenly evacuated into the peritoneal cavity in large quantities, collapse and death may occur at once. In any case, the escape of fluid may give rise to peritonitis; this it is sure to do if the contents be purulent. Twisting of the pedicle may occur from rotation of the tumor, and inflammation and gangrene of the growth take place as a result.

Treatment.—The only treatment for ovarian cyst is removal by cœliotomy, which, at the present day, is exceedingly safe if the operation be properly done. Tapping the cyst, so often employed formerly, is not justifiable as a general course of treatment. It may be employed to prolong life, when removal of the tumor is impossible; or it may be done in order to make the patient comfortable until the removal, then unadvisable, be proper. For example, the existence of an acute disease may render immediate ovariotomy impossible. Then temporary relief from tapping may be justifiable. There is no advantage in it in order to make an examination of the fluid as a means of diagnosis, since such examination is fallacious. Since the only proper treatment cannot be undertaken without opening the abdomen, exploratory incision, followed by immediate removal of the ovarian cyst, if one be found, is the correct surgical procedure.

Peritonitis, due to rupture of a cyst or to the occurrence of suppuration within the cyst, indicates immediate operation. Ovarian cysts have been successfully removed while the patient was pregnant.

The incision for removal of an ovarian cyst should be about three inches long, in the middle line and midway between the navel and the pubes. It is wise to go no nearer to the pubes than one inch, to make sure that the bladder be not injured. The incision can always be enlarged upward with safety at any stage of the operation. If the surgeon carries the abdominal incision above the navel it is best to carry it around the outside of the navel on one side rather than to go directly through it. All hemorrhage of the abdominal wound should be stopped before the peritoneum is opened. The cyst is then tapped with a trocar before the adhesions, if there be any, are broken down, and the contents of the cyst allowed to flow through the trocar. The wall of the sac should be drawn out of the wound to prevent extravasation of the cystic fluid into the peritoneal cavity.

The adhesions are then gradually torn through with the fingers, or, if very firm, are divided with a pair of scissors, perhaps after previous ligation. Every precaution to prevent hemorrhage is taken. The wound made by the trocar in the sac should be closed with a T-shaped hemostatic forceps, to prevent the escape of cystic fluid into the peritoneal cavity.

Injury to the bowels must be carefully avoided by detaching with caution the adhesions from the intestinal wall. Vascular adhesions must be ligated in a way similar to that adopted for tying a pedicle. The pedicle of the growth is found, after the sac has been separated from its adhesions and drawn through the wound, and must be ligated before the sac is cut away. This is best done by transfixing the pedicle with a blunt needle and thereby carrying a double silk ligature through it, or by thrusting a pair of closed hemostatic forceps through the pedicle, seizing the ligature in the middle and drawing it backward through the opening made with the forceps. An aneurism needle does very well for this purpose. The loop of the suture is then cut, leaving two portions of silk lodged in the pedicle. After a twist around each other has been given to the threads at the point where they perforate the stump, each half of the stump is tied separately. One of the ligatures is then carried around the whole pedicle, making the ligation more secure, and the ends, by means of needles threaded upon them, may be carried through the base of the pedicle on the side away from the tumor, and tied in such a way as to anchor the whole ligature. This prevents the possibility of its slipping from the stump when the tumor is removed.

Various forms of interlocking ligatures have been devised for use upon the pedicle. One of the best is the Staffordshire knot. It is made by carrying a double ligature through the middle of the pedicle, bringing the loop, which is on one side of the pedicle, over the tumor, so as to be on the same side as the two free ends and then passing one end through the loop. One end is thus placed over, the other under, the loop. The two ends are then pulled until the loop is tightened and finally tied with a flat knot. The cyst is then cut off outside the ligature and the ligated stump dropped into the belly. The toilet of the peritoneum must be carefully performed. Drainage should be instituted, if there is necessity for it by reason of pus escaping from the sac into the cavity or because of oozing of blood from many small points which cannot be ligated.

Solid tumors of the ovary should be removed by laparotomy and excision. The handled screw of Tait may be inserted into the mass in order to render its manipulation convenient.

Diseases of the Fallopian Tubes.

Pathology.—Tubal disease may arise as a consequence of uterine and pelvic inflammations and of gonorrhœa. Inflammation of the tubes is called salpingitis. Suppuration within the tubes is often a sequence of gonorrhœa and is called pyosalpinx. Injury of the Fallopian tube or obstruction to the escape of menstrual fluid from the vagina or uterus may give rise to distention of the tube by blood (hæmato-salpinx). A collection of serum in the tube causes the condition called hydro-salpinx.

Tubal disease is of importance to the surgeon because it is often the cause of pelvic and abdominal suppuration. Purulent peritonitis is sometimes on examination found to be due to rupture of the Fallopian tube, which has been the seat of suppurative inflammation, or to a ruptured abscess of the ovary.

Symptoms.—The symptoms of tubal disease are pain, especially severe upon exertion or coition, tenderness in the ovarian region, painful and irregular menstruation and other symptoms referred to the pelvis and uterus. Symptoms formerly attributed to pelvic cellulitis are probably in the majority of cases indicative of tubal disease. Pelvic cellulitis without disease of the uterine appendages is now believed to be rare. In disease of the tubes vaginal examination will probably reveal the presence of a fluctuating oblong tumor through the roof of the vagina. Such a tumor may exist upon one or both sides, and may be movable or adherent. The elongated shape of a distended tube differs from that of a small ovarian cyst or ovarian abscess. Pyosalpinx sometimes gives rise to rigors and febrile conditions.

Treatment.—The treatment of diseased oviducts is largely operative. Hæmatosalpinx may, perhaps, be excepted from the rule that diseased tubes should be removed. When the tube contains pus there is great danger of spontaneous or accidental rupture and of thus creating purulent peritonitis. Hence removal is demanded. The excision of tubes distended with serum is often judicious treatment.

The operation of salpingectomy, or removal of the tubes, is a simple one, and consists in making a two inch incision in the middle line of the abdomen, through which one or two fingers are introduced. The adhesions, which are often present, are carefully torn and the diseased oviduct drawn through the abdominal incision. The ovary should be brought out and removed along with the tube. Afterward the pedicle is secured and tied with silk. Great care must be exercised in operating for pyosalpinx to avoid rupture and escape of pus into abdomen or pelvis. If this accident happens, as it may, because of the firmness of the adhesions, the abdominal and pelvic cavities must be well irrigated and subsequently drained by a glass or rubber tube being left in the wound. An interlocking ligature about the broad ligament which forms the stump is probably the safest.

Oöphorectomy, or removal of the ovaries when not the seat of cystic disease or other gross lesion, has been employed in the treatment of ovarian neuralgia, insanity, epilepsy and menorrhagia accompanying fibro-myomatous tumors. The term ovariotomy is usually employed to indicate removal of ovaries which are the seat of cystic or solid tumors. It will be seen, however, that oöphorectomy, which etymologically means removal of the ovaries, has the same signification, though the terms are usually used with a distinction. Ovariectomy is occasionally employed to signify removal of the ovary.

Tubal pregnancy is a condition not as uncommon as was formerly supposed. It is a dangerous condition because of the likelihood of fatal hemorrhage from rupture of the ectopic sac and the possibility of sepsis. It is a condition that not infrequently comes first to the knowledge of surgeons, become the patient has suddenly become collapsed from a large intra-abdominal hemorrhage due to rupture of the sac. Immediate cœliotomy with removal of the gestation sac and fœtus is demanded.

If the pregnancy has reached the fifth month and the child is evidently living, it may do in some cases to await developments, with the hope that the child will be carried to term and be born alive by the natural route or by an abdominal section. In the earlier months operative removal is proper, and after five months, removal should be the treatment if the fœtus is dead. It is questionable whether any case should be permitted to remain without prompt operation for removal of the sac.

CHAPTER XXIII.

HERNIA.

Definition.—Hernia, or rupture, is a protrusion of any portion of the abdominal or pelvic contents through an abnormal opening in the wall of these cavities, which is not a recent penetrating wound. The tumor is usually covered with integument. Such is not the case, however, in hernia through the diaphragm nor in hernia into the vagina or rectum.

The term hernia is sometimes applied to a protrusion of other structures through an opening, such as hernia of the brain, which is a protrusion of cerebral and inflammatory tissue through an opening in the skull, and hernia of the iris, which is a protrusion of the iris through an opening in the cornea.

Causes.—Hernia is apt to occur where the wall of the abdomen or pelvis is weakened by the passage of some normal structure, such as the spermatic cord, the round ligament or the femoral vessels or by a cicatrix left after a wound. A protrusion through a recent wound is not called a hernia, but a protrusion occurring at the cicatrix of an old wound is a hernia.

The predisposing causes of hernia are a long mesentery, a patent funicular portion of the vaginal tunic or canal of Nuck, congenital defects in the wall of the belly, relaxed muscles from pregnancy or emaciation, and cicatrices.

The exciting causes are muscular exertion, such as occurs in lifting heavy weights, straining at stool and in the repreated compression of the viscera which occurs in stricture of the urethra, phimosis, stone in the bladder and chronic cough. These conditions give rise to hernia, because the muscular contraction involved causes a diminution of the cubical space in the abdomen and pelvis and tends to thrust the contents of these cavities through any weak portion of the wall.

Pathology.—The ordinary seats of hernia are the inguinal canal, the femoral canal, the umbilicus and cicatrices left after cœliotomy or accidental penetrating wounds of the abdomen. Hernia at the obturator foramen, at the great sciatic foramen, or through the diaphragm into the chest is rare. A diaphragmatic hernia may occur through any of the normal openings in that muscle or through a congenital defect. Hernia in the lumbar region, into the perineum or into the space between the vagina and the ramus of the ischium is rare, as is also hernia into the rectum and vagina.

A hernial tumor usually pushes before it the parietal peritoneum, which is stretched or undergoes interstitial growth in front of the descending tumor, and forms a sac. The contents of the sac are usually intestine or omentum, but almost any of the abdominal or pelvic organs may be contained in the hernial protrusion. Outside of the sac are found the fascias and muscular structures pertaining to the region in which the hernia occurs.

When hernia occurs into the vaginal tunic of the testicle, because the funicular portion in the inguinal canal has not become obliterated, the condition is called a congenital hernia. Here there is no true hernial sac or protrusion of the parietal peritoneum, since the canal of the peritoneum already existed as an unclosed fœtal structure.

The sac of a hernia has a body, a neck and a mouth or orifice, through which the hernia enters the sac. The sac is usually pear-shaped or globular, but may assume almost any form. It may be divided by partitions into separate chambers, and in one or more of these chambers there may be serous fluid. The sac walls of old hernias are often very much thickened; sometimes they are irregularly thinned in places. The neck of the sac in a recent hernia is more or less folded or plaited, but in old cases it usually has become smooth, indurated, and thickened by inflammatory deposits.

When the contents of a hernial sac consist entirely of intestine the hernia is called an enterocele. A hernia consisting of omentum is an epiplocele; while one in which the contents are both intestine and omentum is known as an entero-epiplocele. The ovaries and bladder and portions of the solid viscera are found in some large hernias, but usually it is the small intestine with or without a portion of the omentum which is found in the hernial sac. In rare cases, only a portion of the caliber of the knuckle of intestine enters the hernial sac, which in this case is small.

An untreated hernia may become exceedingly large, until several feet of gut lie outside of the abdominal cavity. The intestine, the mesentery and the omentum of an old hernia usually become hypertrophied and more or less adherent to one another and to the sac wall. A limited amount of serum is often found in the sac, and occasionally rice-like bodies composed of inflammatory lymph are present. If a hernia has been kept within the abdomen for a long time with a truss, the neck of the sac may become obliterated and the sac remain as a cyst filled with serous fluid.

When the protruded viscera can be pushed back into the cavity of the abdomen the hernia is said to be reducible. When such is not the case and the protruded viscera cannot be reduced by manipulation, the hernia is called irreducible. The word incarcerated is sometimes employed to indicate the condition of irreducibility; unfortunately it is also used occasionally as synonymous with obstructed hernia.

A strangulated hernia is one in which the protruded viscera are so tightly grasped that it is impossible to push the mass back into the abdominal or pelvic cavity, and in which the circulation of the part protruded is so impeded that inflammation or gangrene take place. If the hernia which is strangulated contains intestine, the passage of the feces is also prevented by the compression of the gut.

In an obstructed hernia the intestine is obstructed with a mass of undigested food or of feces. It is irreducible and occurs especially in old persons. The liability of such hernias to become strangulated or inflamed is very great.

An inflamed hernia is one in which the sac contents are in a condition of inflammation. This pathological condition is most common in small irreducible hernias and is due to wearing an ill-fitting truss, to violent exercise or to injury. An inflamed hernia is apt to become strangulated.

In reducible hernia the hernial contents often return into the belly spontaneously when the patient lies upon his back. The sac, in recent cases, sometimes goes back at the same time that the intestine and omentum do. In most cases, however, the sac remains adherent to the surrounding structures after its contents have spontaneously or by manipulation been returned to their normal site.

A hernia becomes irreducible because of changes in the vicinity of the ring, in the protruded tissues themselves or in the sac. The ring or opening may have become inflamed and thereby contracted; the neck of the sac may have become elongated and its walls thickened; the protruded structures may, from growth or inflammation, have increased in size below the neck after their extrusion; adhesions may have occurred between the contents of the sac and the sac wall or between various portions of the hernial mass; and, finally, bands of inflammatory tissue developed within the sac or the fluid contained in it may interfere with the reducibility of the hernia.

A recent hernia may be strangulated by suddenly being forced through a small opening which instantly exerts great constriction. An old hernia may become strangulated by a sudden protrusion of a new portion of the intestine or omentum in addition to the previous mass; by swelling from inflammation of the omentum or of the mucous membrane of the intestine; or by increased size of the gut from obstruction with gas or feces. The constriction causing strangulation may be at the outside of the sac at the hernial ring, in the neck of the sac itself or within the sac. In the last case the strangulation may be caused by inflammatory bands or by openings between two portions of the hernia within which another portion may have become constricted. Strangulation may be acute or chronic in its course, according to the mechanism which produces it.

The compression of veins by the strangulation gives rise to venous congestion, followed by inflammation and gangrene. The interference with circulation soon renders infection with the bacteria of the intestine probable, because of the lowered resistance of the tissues. The bacteria penetrate the wall of the bowel and soon infect the serum in the hernial sac. The paralysis of the muscular coat, which sometimes occurs, may interfere with peristaltic action and cause obstruction to the passage of the feces, although the lumen of the intestines is not entirely closed by the pressure. Strangulation may occur also in Littré's hernia, although the entire caliber of the intestine is not constricted in this form of hernia. It is easily understood that the greater the swelling the greater the constriction, and that, at the same time, the increase of constriction thus caused tends to produce a further increase of swelling. A strangulated knuckle of bowel usually at first becomes red, then of a dark color and finally black or gray. This last condition is often accompanied with ecchymotic spots. The swollen, sticky and œdematous coats of the intestine exhale a fecal odor and exude a dark fluid. Sloughing and perforation of the intestinal wall occurs as a later step and is followed by fecal extravasation into the sac, which, if the patient lives long enough, ends in fecal abscess and in the formation of a fistule between the gut and the external surface. Peritonitis occurs quite early after strangulation has taken place. The intestine soon becomes glued to the belly wall surrounding the hernial ring, and, therefore, in cases of fecal abscess, the extravasated feces are not apt to escape into the general peritoneal cavity. In the majority of cases, death takes place from exhaustion and peritonitis before fecal abscess and fistule have occurred.

Symptoms.—A feeling of local weakness is often experienced by the patient before the hernial protrusion takes place. If the disease is gradual in its development, a small tumor, not larger than a finger tip, may at length be noticed. When the patient lies down the tumor spontaneously disappears, because the protruded bowel or omentum slips back into its normal position. In other cases, sudden and painful protrusion occurs at one of the ordinary seats of hernia during straining at stool or violent exercise.

The hernial tumor is usually round or oval and rather smaller at its base, which represents the seat of the neck of the sac. It is enlarged when the patient stands or coughs, but disappears under gentle pressure or when he lies down. Coughing often causes in the tumor an impulse which is very perceptible to the hand when grasping it. If the hernia consists of intestine alone, the tumor is smooth, elastic, tympanitic on percussion and slightly gurgling when compressed. The impulse on coughing is marked. Rumbling from intestinal gases is present, and the patient has a dragging sensation at the seat of the tumor. Reduction is accompanied by a distinct gurgling, due to the escape of gases and liquid feces, and by a sudden peculiar croaking sound as the gut slips back into the belly.

If the hernia contains only omentum, the tumor is apt to be irregular and to have a doughy feeling; it shows less impulse on coughing, and when being reduced slips back gradually without any gurgling or croaking sound.

The symptoms of irreducible hernia are not unlike those already described, except in so far as these symptoms pertain to the possibility of the protrusion being pushed back into the abdomen. Colicky pains are rather characteristic of irreducible hernia. In some cases, where both intestine and omentum are contained in the sac, the gut is reducible, but the omentum is irreducible.

Strangulated hernia gives rise to very characteristic symptoms. The tumor becomes painful, tender and tense, and a tympanitic note is given if the intestine is contained in the sac. Impulse on coughing is lost. Pain is usually referred to the umbilical region, which is the reason that strangulated hernia has been so often mistaken for ordinary colic. If the constriction is not relieved, the skin overlying the gut which has become gangrenous, assumes a dark hue and gives rise to a fecal odor. The sensation of pain is apt to cease if gangrene occurs. To the uninitiated this appears to be a good omen. The surgeon, however, knows that it is a sign of grave pathological change. The intestinal obstruction due to strangulation causes obstinate constipation and vomiting. Constipation is complete except that the lower bowel may be emptied of its contents during the earlier hours of the disease. Constipation is not, as a rule, complete in Littré's hernia. Vomiting is violent and gushing without much retching. The vomited material is at first the contents of the stomach; then bile and the other fluids found in the upper part of the small intestine are ejected. Finally the ejection of a brownish yellow fluid with the odor of feces indicates that the contents of the lower portion of the small intestine are being thrown up. The fluid is indeed feces, and to such vomiting the name stercoraceous vomiting is given. There is no flatus discharged from the rectum, but the contents of the large bowel may be evacuated either voluntarily or after the administration of an enema. The face becomes pinched and anxious; the pulse is frequent and weak and perhaps irregular; the tongue is furred and brown. There is profound collapse and, later, exhaustion and death take place. Recovery after the formation of a fecal abscess and fistula due to gangrene of the gut does occur, but it is rare. In young persons and in recent hernia, strangulation usually gives rise to acute symptoms; but the strangulation symptoms occurring in the irreducible hernia of old people are apt to be more chronic in their course.

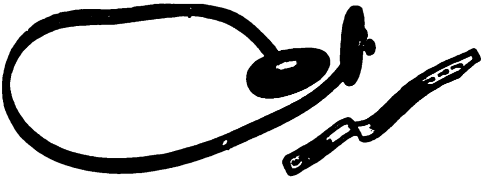
Treatment.—The palliative treatment of reducible hernia is the application of a compress of gauze or other material, to hold the intestine within the abdomen until a properly fitting truss can be obtained from the instrument maker. A hernial truss consists of a pad held in place over the hernial ring by a spring around the pelvis. The truss varies in shape and size in accordance with the seat and character of the hernia. It should be made to fit comfortably and to make only such pressure over the hernial opening as will retain the structures which are liable to protrude. If the patient can be seen by the instrument maker, a properly fitting truss is generally readily obtained. When, however, the patient lives at a distance from a large city the surgeon should send the instrument maker the girth of the pelvis midway between the crest of the ilium and the great trochanter,

FIG. 382.

Truss for inguinal hernia.

describe the kind of hernia, tell on which side it exists, give the sex and age of the patient and express his opinion as to the relative strength of the spring required. The truss should be adjusted while the patient is recumbent and the hernia reduced. It should always be worn when the patient is in the erect position and should never be taken off until he is recumbent. Many patients can go without their trusses at night because there is little tendency for the hernia to recur while they are lying down. Others need to wear a truss at night, but then it is not necessary for the spring to make as much pressure as during the daytime. Hence a weaker truss may be used. A truss at night is wise when the patient suffers from a cough. It usually takes some time for the patient to become accustomed to wearing the support, as is the case with those wearing an artificial limb or spectacles for the first time. The annoyance, however, is only temporary.

FIG. 383.



Truss for femoral hernia. This form is applied across the pelvis from the sound side.

FIG. 384.

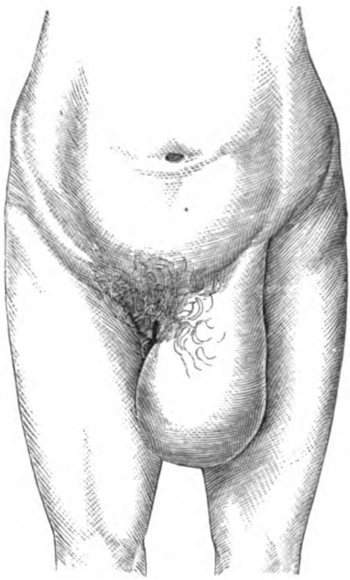
Truss for umbilical hernia.

A properly fitting truss should permit the patient to go up and down stairs and jump off a chair without permitting escape of the hernia. If the pad of the truss irritates the skin, as it often does, the cutaneous surface may be sprinkled with lycopodium powder and bathed frequently with whiskey and alum.

The radical treatment of hernia consists in reducing the protrusion, removing or obliterating the sac and closing the ring. In young persons with small hernias, wearing a truss may induce sufficient inflammation of the peritoneum forming the sac to cause the latter's obliteration. This is especially true of congenital hernia, in which the unobliterated portion of the vaginal tunic very readily becomes adherent from the irritation caused by pressure of the truss.

In other cases the radical cure is only possible by operative interference. The radical treatment is especially employed in inguinal hernia. An incision is made over the tumor, the sac separated from the surrounding tissues and opened and the protruding viscera returned to the abdomen. Various means are employed for dealing with the sac so emptied and separated. Some surgeons tie a ligature around the neck of the sac after having reduced the hernia, and then cut off the sac below the ligature, push the stump within the abdomen and sew the columns of the ring together. The sac, on the other hand, may be folded up into a plug and stitched behind the internal inguinal ring. In these operations the peritoneum lining the inner surface of the abdomen around the internal ring should be separated from the parietes for a short distance from the circular margin of the ring. This is done in order to insure solid closure of the ring by preventing the formation of a concavity at its former site, which tends to allow the pressure of the intestines to start the formation of a new hernial sac.

FIG. 385.



Large inguinal hernia in a woman.

In operations for the radical cure of inguinal hernia, it is usual to displace the spermatic cord outwards; so that the canal, through which the hernia descended, can be closed more securely. This is done by splitting the muscular wall upwards and outwards for about a half inch from the internal abdominal ring, pushing the cord into this split and then closing the canal with sutures underneath the cord. The aponeurosis of the external oblique muscle is sutured above the cord. Bassini's name is associated with the original form of this method. After dealing with the sac and cord the internal ring is closed by means of buried sutures carried through the abdominal aponeuroses and margins of the opening. Then the cutaneous wound is closed.

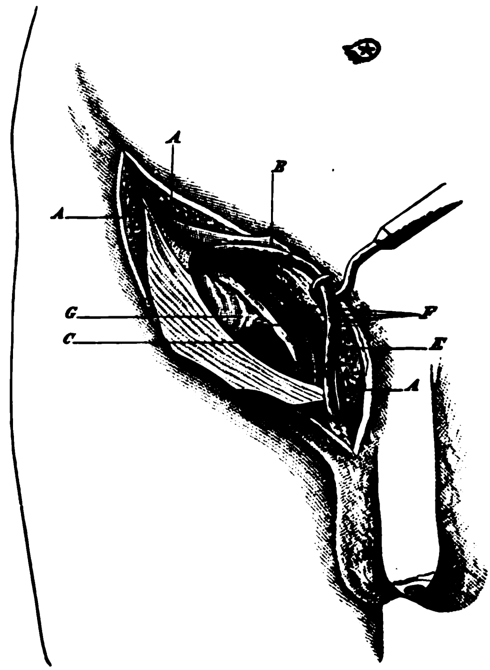
Operations for the radical cure of femoral, umbilical and ventral hernia are performed on similar principles; but are not complicated by the presence of the spermatic cord, which adds to the difficulty of making a strong closure of the inguinal canal. The borders of the internal femoral ring are not readily and satisfactorily sewed together; therefore some operators dissect a triangular flap of fascia from the surface of the pectineus muscle, with its apex downwards, turn this flap up and stitch it to the internal surface of Poupart's ligament.

Ventral hernia occurring after laparotomy is treated by a bandage, pad or truss; or by excision of the sac and stitching the borders of the opening together.

Radical operations for hernia, when done with antiseptic precautions, are attended with a very limited amount of risk. A return of the hernia may occur, but the recurrent hernia is smaller and more manageable by a truss than was the original. Radical operation is proper in reducible hernias which are large and in those which a truss will not control or which are painful. It is also proper in patients whose occupation requires violent exertions or who are often away from centers of population in which surgeons are readily obtained in case strangulation occurs.

Irreducible hernias frequently give great discomfort from their bulk or from the dyspeptic symptoms produced by their existence. In irreducible hernias the operation for radical cure is more troublesome than in reducible hernias. The intestinal adhesions have to be released and portions of omentum perhaps excised in order to accomplish a return of the protruded viscera. The congenital forms of hernia are more amenable to permanent cure by radical operation than other forms, but they are also more amenable to cure by truss. The sac should always be opened in operating for the radical cure of hernia, so that the surgeon may deal efficiently with adhesions.

FIG. 386.



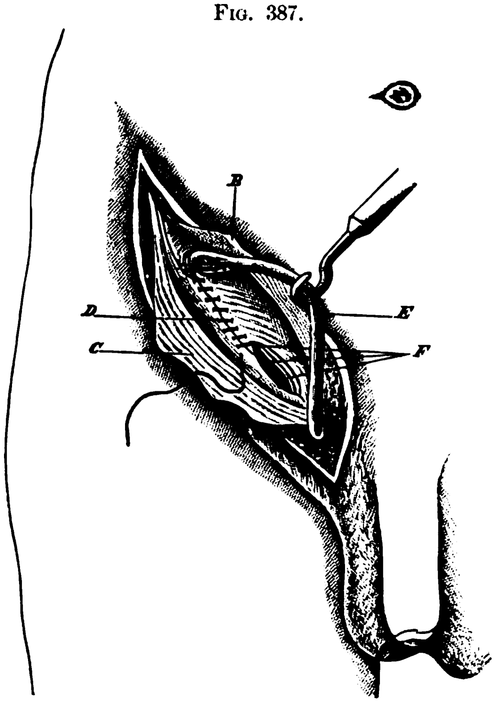
Bassini's method of operation for inguinal hernia: *A*, *A*, *A*, subcutaneous fatty tissue; *B*, upper portion of the divided aponeurosis of the internal oblique muscle dissected from underlying structures; *C*, under portion of aponeurosis of external oblique; *E*, cord; *F*, 1, internal oblique muscle; 2, transversalis; 3, fascia of Cooper; *G*, peritoneum. (BULL and COLEY.)

Irreducible hernias often become so large that they are a burden to the patient; and they are dangerous because they are liable to inflammation, strangulation or obstruction. An attempt should be made to protect them from injury and to prevent their increase in size by wearing a suitable bag shaped truss or supporter. If a hernia has recently become irreducible, it is proper to attempt to render it reducible. This may be accomplished by rest in bed, the administration of saline laxatives and the application of ice to the surface of the tumor. Such measures are of no avail unless resorted to shortly after the advent of irreducibility. Operation for the radical cure should be performed, when the conditions of asepsis and proper surgical attention are attainable.

Strangulated Hernia.

When a hernia becomes strangulated the reduction must be made at once, since every hour adds to the danger of the condition and increases the inflammatory changes in the gut or omentum which is subjected to pressure. Purgatives to relieve the constipation are useless and extremely harmful. Prolonged and forcible manipulation of the tumor in the hope of reducing the protruded mass is equally unjustifiable. The word taxis is employed to describe the series of manipulations used in reducing a strangulated hernia.

FIG. 387.



Bassini's method of operation for inguinal hernia: the end of the third step of the operation. The cord has been transplanted and the musculo-aponeurotic tissues on the inner side have been sutured to Poupart's ligament (*D*) on the outer side. (BULL and COLEY.)

When strangulation has occurred, taxis should at once be attempted, but the surgeon must remember that the manipulations must be gentle and continued for but a few minutes. If reduction by taxis is not accomplished in this manner, the use of enemas to empty the lower bowel and of ice locally to the tumor and the internal administration of moderate doses of morphia may be adopted. Ether has been recommended as a local application because of its refrigerant effect. In some kinds of hernia this line of treatment will cause the tumor to become reducible; and gentle taxis employed at the expiration of three or four hours will effect reduction of the strangulated gut. A hot bath is sometimes apparently efficacious, though in strangulation of

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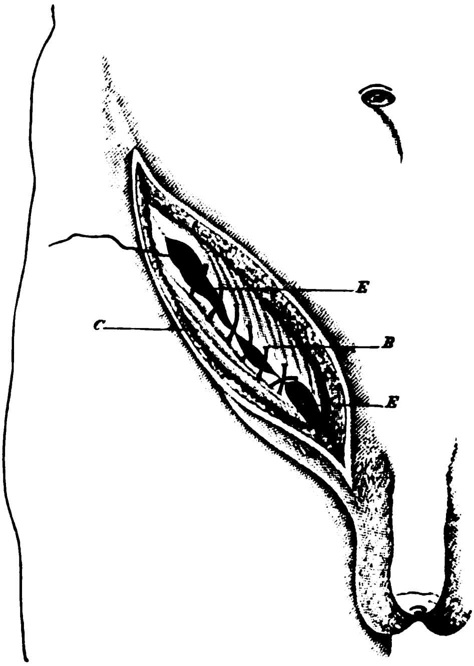
femoral hernia it appears to be valueless. If these measures fail, immediate resort to operation for the relief of the strangulation is proper.

In attempting to reduce a hernia by taxis the surgeon seizes the tumor with one hand and slightly lifts it, exerting at the same time a little pressure upon it with his fingers. The pressure on the constricted knuckle causes, if the caliber be not entirely closed by the

FIG. 388.



Bassini's method of operation for inguinal hernia: fourth step. Suture of the divided aponeurosis over the cord with a continuous suture. (BULL and COLEY.)

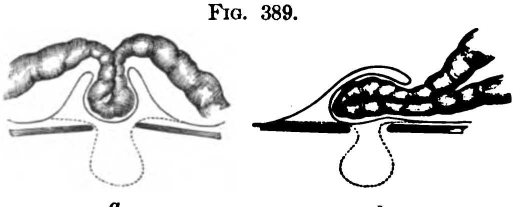
constriction, the expulsion of gas and feces and thereby reduces the bulk of the hernia. With the fingers of the other hand he slightly compresses the protrusion at the neck of the tumor, to prevent the contents from bulging over the ring when pressure is being made with the other hand. It is often well to draw down the tumor a little with the right hand, in order to pull out a little more intestine and thus disengage the protruded portion from the grasp of the ring through which it has escaped. It is clear that the portion of the hernia which has escaped from the abdomen last must be the first to be pushed back. Hence the part near the neck must be coaxed into the belly before the lower part can be reduced. During these manipulations the pelvis should be slightly raised. Inversion of the patient so that his shoulders are very much lower than the pelvis, as in the Trendelenburg position for abdominal operations, may cause the extruded intestine to be returned to the abdomen more readily. In femoral hernia the thigh should be flexed and rotated a little inward in order to relax the fascia lata which forms the external femoral or saphenous opening. The pressure exerted during taxis should be gentle and steady.

The site of the hernia causes a variation of the direction in which the pressure should be exerted, for it is easily understood that the gut must follow the same route in reduction as it took in protrusion, though in the opposite direction. Hence the line of pressure proper in an inguinal hernia is not suitable for the reduction of an umbilical or femoral hernia. In the discussion of Special Hernias the direction in which taxis should be employed in each variety will be given.

When strangulation is relieved and the hernia slips back into the abdomen, a peculiar croak is heard if there be gut in the tumor. If the reduction is not readily effected by such gentle taxis, the surgeon must desist, since force or too long employment of taxis may cause bruising of the intestine and sometimes actual rupture. Two minutes is probably long enough to continue the efforts in a small, tight femoral hernia and about five minutes in other hernias, whether femoral, inguinal or umbilical.

Taxis is more successful in relieving strangulation of recent hernias than of old hernias. It is also more effective in inguinal than in femoral hernias. Anæsthetics should always be resorted to after the first efforts at taxis have been ineffectual. It is usually best to gain the consent of the patient to operation before administering the anæsthetic, so that the surgeon may proceed at once to radical measures, if taxis under anæsthesia proves unavailing. If another surgeon has previously made protracted efforts to relieve the strangulation by taxis or the hernial tumor is tender and inflamed, it is unwise to make repeated efforts at reduction. When fecal vomiting has existed for some time and hiccough has occurred, and especially so in femoral hernia, it is not wise to make efforts at taxis. The danger in these cases lies in the fact that injurious pressure may be made upon an already inflamed and gangrenous intestine, which will be followed by rupture of the gut or fatal peritoneal inflammation. Operation is, in such cases, to be undertaken without running the risk of causing damage by taxis. It is possible to push the hernial sac into the abdomen or between the parietal peritoneum and anterior wall of the abdomen without relieving the strangulation. This is fortunately a rare occurrence, but it should be remembered.

FIG. 389.



Two forms of reduction *en masse* of a strangulated hernia (diagrammatic). (TILLMANNS.)

The operation for relief of strangulation of a hernia is called herniotomy or kelotomy.

Herniotomy or Kelotomy.

Herniotomy is undertaken for the purpose of liberating the constricted bowel or omentum, so that the protruded structures may be returned to the abdominal cavity. If the protruded structures are gangrenous, so that their return would be followed by serious consequences, their excision, the establishment of an artificial anus or the resection of intestine, with or without immediate suturing, is demanded.

FIG. 390. Levis's notched hernia director.

The incision in herniotomy is made in the long axis of the tumor, and the coverings of the hernia down to the sac are carefully divided in the same direction or are torn apart by means of the fingers, forceps or the handle of a scalpel. By this procedure the hernial sac is exposed. Care must be taken that the sac is identified, because, if it is opened unwittingly, the intestinal wall may be mistaken for the sac and incised.

Characteristics of the sac are its tense, smooth appearance, and the longitudinal direction in which its vessels run. The blood vessels of the intestines run around the gut in a direction transverse to its long axis. Often the sac may be picked up from the contents of the hernia in such a way that the bowel may be felt to slip away from between the fingers holding the sac. In some instances in which the sac is distended with fluid, the sac wall is so thin that the coils of intestine or omentum may be distinctly recognized within. The sac usually does not feel as thick as the intestine, when pinched between the fingers. The sac is picked up at one point with a forceps, and its wall punctured by means of a knife held horizontally. The small opening thus made is enlarged until the whole interior of the sac is exposed to examination. It is often possible to tear through the thin sac with the finger nail. This is safer than using a knife. Ordinarily, however, there is not much danger of injury to the gut, because in many cases there is fluid filling the space between the intestine and the sac wall. Occasionally, however, the gut lies in immediate contact with the sac wall; then great care is necessary to avoid injuring it.

If the fluid within the sac is simply yellow serum, the condition of the contents of the sac may be considered good. The escape of bloody or turbid fluid, however, and especially if it exhales a fecal odor, is indicative of inflammatory and gangrenous intestine or omentum. The stricture is next sought for with the finger, and at the same time any adhesions between the intestine and omentum or between these structures and the sac are broken down. The finger tip is then slipped under the strangulating band, and a blunt pointed bistoury or hernia knife carried along the pulp of the finger until it lies beneath the constriction. The knife lying flat upon the finger should be pushed under the band. After it has been put in proper position, the edge is turned against the tight band and used so as to make two or three shallow nicks, which are better than a single deep one. After division of the stricture, taxis is undertaken.

If sufficient division of the stricture has not been performed, as indicated by the impossibility of reduction, the strangulating band should be divided or torn a little more. In those cases in which the strangulation is too tight to permit the entrance of the tip of the finger, a hernia director should be carefully inserted under the tense band. One of the best forms is the Levis notched hernia director, which catches the strangulating band in a notch and holds aside the intestines, so that their injury with a knife is almost impossible.

If the intestine is found to be gangrenous, the constricting band should be notched and nothing more done; since breaking up the adhesions is to permit access to the general abdominal cavity of the fetid fluid contents of the hernial sac. After the constriction has thus been relieved an incision should be made into the caliber of the gangrenous intestine, to permit the escape of feces. An artificial anus or fecal fistula will then be established at the site of the operation. This may be treated by operation some weeks later, when the patient has recovered from the immediate results of the strangulation.

In some cases of omental hernia, a small knuckle of gut is wrapped up or covered by the omentum. This should be sought for before the omental hernia is returned, since the whole mass may be returned with the hidden intestine still strangulated.

In many cases of operation for strangulated hernia it is difficult to decide whether the intestine is in condition to be returned. The question is easy enough of determination in cases where actual gangrene has occurred and in instances where there is not a great deal of inflammation; but there are many border line cases which require serious consideration. If the fluid in the sac is serous and the intestine, though congested, still has a shiny surface, it is proper to return it. If its walls are ashy gray in color and show no evidence of elasticity, it is equally clear that gangrene has taken place, that the mass should not be returned and that an artificial anus should be established. If the intestine is extensively diseased, resection of the gangrenous portion should be performed. In such an event the open ends of the bowel should be stitched to the external wound, in order that the fecal contents may escape upon the surface of the body, or circular enterorrhaphy may be at once performed and the sutured bowel replaced in the abdomen. To do this usually requires an enlargement of the incision at the hernial opening in the belly wall. If the gut is purplish in color, shows ecchymotic spots and is covered with sticky lymph, it is not always clear whether it should be returned. If a large coil presents this condition, it may be left in the hernial sac after the strangulation has been relieved, so that in the event of sloughing the extravasated feces and the contaminating fluids from the diseased structures may be kept outside of the abdominal cavity. Where a very small knuckle presents these characteristics, the surgeon may sometimes, with wisdom, push the knuckle just inside the ring, where it will probably become adherent to the belly wall. If sloughing then occurs and gives rise to perforation, the feces will have an opportunity to escape into the sac, which has been left open, without invading the general peritoneal cavity.

If by accident the intestine has become opened during the division of the coverings, the wound should be brought together by Lembert's sutures, as described in Wounds of the Intestines. Subsequently it should be returned to the abdomen as if no such accident had occurred. If the protruded omentum is small in amount and not gangrenous, it should be returned. If, however, a large omental mass is present or if an omental hernia of any size is thickened or inflamed, a ligature should be cast around it near the neck of the sac, the part outside of the ligature cut off and the stump pushed back into the abdomen. Silk or catgut ligatures may be used. The stump or pedicle may be tied in sections by interlocked ligatures, if it is large. The effort to tie individual omental vessels is injudicious.

The last step in herniotomy is the treatment of the sac. If the patient is weak or if complications arise from the condition of the gut or from peritoneal inflammation, the sac should be let alone and the external wound closed with sutures or left open as previously described. If, however, these complications do not exist, the proper operation for radical cure should then be undertaken.

The after-treatment of cases of hernia is identical with that of other abdominal operations. Some pressure, however, should be made upon the wound by the dressing in order to prevent recurrence of the hernial protrusion. It was formerly the practice in certain cases to divide the constriction causing strangulation without opening the sac. This method of operation is now abandoned; since it is better to see the contents of the sac, and the former fear of exposing the peritoneum is unknown to an aseptic operator.

The symptoms of strangulation usually disappear immediately after the reduction of the gut, whether it has been accomplished with or without operation.

A persistence of vomiting due to the anæsthetic may seem to indicate that the hernia has not been relieved. This vomiting, however, soon stops; it has not the gushing character of vomiting from strangulation and is more apt to be accompanied with retching. Temporary paralysis of the muscular coat of the gut by interfering with peristalsis may simulate a condition of strangulation, while the presence of another unsuspected hernia which is strangulated may, of course, give rise to a continuation of the dangerous symptoms. Gangrene of the gut occurring after reduction may cause perforation and peritonitis. In rare instances the intestine may become strangulated within the abdomen as a result of inflammation in the neighborhood of the hernia. Acute enteritis and peritonitis, moreover, may give rise to alarming symptoms. In all such cases laparotomy in the median line should be performed if within a reasonable time the cause of the complication is not evident.

It is impossible to insist too strongly upon the necessity for early interference in cases of strangulated hernia. Nearly all cases will promptly recover if strangulation is quickly relieved, while nearly all will terminate fatally if this is not effected. It is the continuation of efforts at taxis and the postponement of operation that causes the fatality in patients the subjects of this dangerous surgical disorder.

SPECIAL HERNIAS.

The most common sites of hernia are the inguinal canal, the femoral canal and the umbilicus; hence, inguinal, femoral and umbilical hernias must receive special consideration.

Inguinal Hernia.

Anatomy and Pathology.—In inguinal hernia the intestine or omentum escapes through the inguinal or spermatic canal. In some cases the hernia traverses the entire length of the canal, whereas in other cases it comes through the abdominal wall directly behind the external opening, which is called anatomically the external inguinal or spermatic ring. In the former case the hernia is called an oblique inguinal hernia, in the latter case a direct inguinal hernia. In the first variety the neck of the hernial protrusion lies external to the deep epigastric artery, but in the second variety it is internal to that vessel. In oblique hernia, then, the intestine leaves the abdominal cavity at the internal inguinal spermatic or abdominal ring, follows the canal through the abdominal wall and escapes at its lower opening, called the external inguinal, spermatic or abdominal, ring. Here it appears as a tumor lying outside of the aponeurosis of the external oblique muscle, just above the body of the pubic bone. If

FIG. 391.

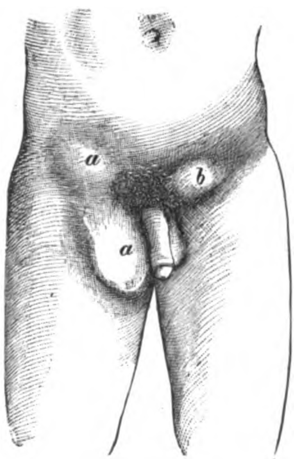
Large labial hernia. (Author's case.)

the protrusion is not large enough to follow the course of the entire canal and make its exit at the external ring, the hernia is called incomplete, because the viscera have not completely followed the canal, but lie within it. If the hernia escapes from the external ring it is a complete one. As the complete hernia increases in size, the intestine descends into the scrotum or vulva and it is then denominated a scrotal or labial hernia. An incomplete hernia is often termed a bubonocele.

The coverings of a complete oblique inguinal hernia are skin, superficial fascia, inter-columnar fascia, cremaster fascia, funnel-shaped process of the transversalis fascia (infundibuliform fascia), subperitoneal fat and peritoneum (sac). In the female there is no cremaster fascia, and hence this covering is wanting. In incomplete oblique inguinal hernia, there is instead of the inter-columnar fascia, a covering formed by the aponeurosis of the external oblique muscle and instead of the cremaster fascia the lower fibers of the internal oblique and transversalis muscles make a covering. In this instance there is no difference between the male and the female.

The stricture in strangulated oblique inguinal hernia occurs at either the internal or external ring, or in the canal.

FIG. 392.



Inguinal hernia: *aa*, oblique inguinal hernia (scrotal); *b*, direct inguinal hernia. (TILLMANNS.)

There are several varieties of oblique inguinal hernia. In the acquired form the peritoneal sac is pushed down through the inguinal canal and into the scrotum, so that the hernia usually lies above, or in front of and above, the testicle or cord.

In congenital inguinal hernia the intestine descends into the scrotum along the unobliterated funicular process of the peritoneum, which makes the fœtal canal between the vaginal tunic of the testicle and the abdomen. In these instances the protruded gut lies within the vaginal tunic and comes in direct contact with the testicle. There is no true hernial sac.

In another form the hernial sac may be pushed down behind the unobliterated funicular process and give rise to what has been termed infantile inguinal hernia. Varieties of inguinal hernia occur in which the relations of the sac and the funicular process vary from the most frequent varieties just given.

Direct inguinal hernia is a protrusion through the abdominal wall behind the external inguinal ring. In this variety the gut does not enter the inguinal canal but after piercing the wall escapes through the external ring. Sometimes, however, it bursts through the belly wall a little outside of the external ring, and then does enter the lower part of the canal before emerging at the ring. The neck of the sac in both varieties of direct hernia is internal to the deep epigastric artery. In indirect or oblique hernia the neck of the sac is external to the deep epigastric artery.

The protruding intestine in direct hernia may push the conjoined tendon in front of it, may go through an opening in the tendon or may pass under its lower border. The coverings of direct inguinal hernia are skin, superficial fascia, inter-columnar fascia, conjoined tendon, transversalis fascia, subperitoneal fat, and peritoneum (sac). It is evident that a covering from the conjoined tendon will not be present if the hernia, instead of stretching and pushing forward this tendon, perforates it or goes under its lower border. The strangulation of a direct inguinal hernia occurs at the external ring or at the opening in the conjoined tendon.

Diagnosis.—The differential diagnosis between oblique and direct hernia is often difficult, because when an oblique hernia attains considerable size or has existed for a long time, the internal ring is by the weight of the tumor dragged down until it is directly behind the external opening. The neck of the sac, therefore, lies immediately over the body of the pubes and seems to be at the external inguinal ring. A direct hernia may descend into the scrotum or labium exactly as does an oblique hernia.

Inguinal hernias present the general signs and symptoms of all hernial tumors. The neck of the sac in old oblique hernias, and in recent direct ones as has just been stated, is over the body of the pubes and internal to the spine of the pubes. In recent oblique hernias the inguinal canal is filled up with a protrusion, which can be seen and felt occupying an oblique position above Poupart's ligament. The tumor is reducible at first, if subjected to moderate pressure applied upward and outward.

An incomplete oblique hernia might be mistaken for a femoral hernia which has curled up over Poupart's ligament, but is differentiated by the fact that a femoral hernia has its neck below Poupart's ligament, and external to the spine of the pubes. The inguinal canal in femoral hernia is unoccupied by a mass, while in oblique inguinal hernia, even when incomplete, the mass seems to fill up or to occupy at least part of the canal.

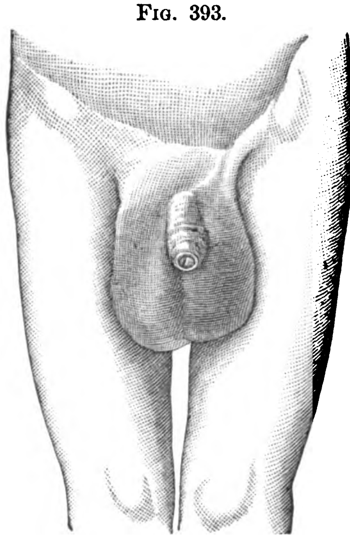
Chronically enlarged lymphatic glands may resemble inguinal hernia, but here the tumor is apt to show the characteristic signs of enlarged or inflamed glands and the inguinal canal is unoccupied by any swelling. The characteristic impulse of hernia is also absent.

An encysted hydrocele of the spermatic cord occupies a position similar to inguinal hernia. It is, however, tense, oval and well-defined in outline and without impulse. A cyst of the canal of Nuck in the female presents similar characteristics. An encysted hydrocele of the spermatic cord can sometimes be pushed up into the belly.

An undescended testicle may be distinguished from an inguinal hernia by absence of impulse on coughing, and by the facts that the tumor is not reducible, that pressure produces the peculiar sickening testicular pain and that the testicle on the corresponding side is absent from the scrotum. An inflamed, undescended testicle may give rise to vomiting which will suggest strangulated hernia. The vomiting, however, is not gushing, as is that which occurs as a symptom of strangulated hernia. In doubtful cases an exploratory incision is justifiable.

A scrotal hernia may be confounded with hydrocele, orchitis, solid tumor of the testicle and varicocele. Hydrocele of the vaginal tunic is often translucent and is a tense, semifluctuating tumor without impulse. Its rounded upper margin is generally very distinctly felt when the surgeon's fingers are placed upon the upper part of the cord and the tumor is pushed up against these fingers by pressure exerted with the other hand. This well defined upper limit is very different from the gradual extinction of the upper portion of a hernia as it blends with or is lost in the belly wall.

FIG. 393.



Right inguinal hernia and left hydrocele showing the difference in the neck of the tumors. (WHARTON and CURTIS.)

It must not be forgotten, however, that in hydrocele of infants the fluid can sometimes be pushed back into the abdomen so as to simulate hernia. There is, fortunately, no such croaking sound accompanying the disappearance of the tumor as is frequently heard in reducible hernia. Unfortunately for diagnostic purposes the hernia of children is sometimes translucent, and thus resembles hydrocele.

In orchitis the tumor is heavy, showing signs of inflammation, and is more or less ovoidal and hard. The swelling does not extend up into the inguinal canal.

Varicocele disappears when the patient lies down, is increased by pressure made upon the external inguinal ring, gives the sensation of a bag of worms under the skin and conveys to the finger, on coughing, a thrill rather than an impulse. Reducible hernia is, after reduction, prevented from recurring by pressure at the external abdominal ring, and therein differs from varicocele.

Treatment.—The treatment of inguinal hernia is identical with the treatment described for hernia in general. The incision of the constricting fascia or tendon at the ring, in operations for strangulation, should be made directly upward in order to avoid the epigastric artery, which will be upon the inner or outer side of the neck according as the hernia is oblique or direct. As it is often difficult to decide which variety of inguinal hernia exists, the position of the epigastric artery is uncertain, hence incision directly upward is safest. If an undescended testicle lies in the groin and is a complication of strangulated hernia, it may be necessary to excise the testicle at the time herniotomy is done. Indeed, such excision may be demanded in the treatment of reducible hernia accompanied by undescended testicle, in order to make it possible for the patient to endure the pressure of a truss in this region. The radical operation has been described under the Treatment of Hernia.

Femoral Hernia.

Anatomy and Pathology.—Femoral hernia is never congenital, and occurs in women more often than in men. The protruding viscera escape from the abdomen into the sheath of the femoral vessels. Usually the exit is made internally to the femoral vein through what is called the internal femoral ring. The descending intestine then follows the femoral canal and comes out upon the thigh at the saphenous opening, also called the external femoral ring. If the tumor increases, it turns up over the falciform process of the fascia lata and lies just below or may even overlap Poupart's ligament. In the latter case the tumor lies beneath the integument upon the aponeurosis of the external oblique muscle of the abdomen, but the neck of the sac is at the internal femoral ring. This ring or opening is situated below Poupart's ligament and above the horizontal ramus of the pubic bone, where this bone is covered by the pectineus muscle. Toward the middle line the ring is bounded by the sharp edge of Gimbernat's ligament, while on the outer side it is separated from the common femoral vein by a thin, fibrous partition within the sheath of the femoral vessels. Sometimes the hernia lies in the femoral canal and does not escape at the external femoral ring or saphenous opening. It is then an incomplete femoral hernia.

There are no structures of importance on the inner and upper sides of the neck of the hernial sac.

When the obturator artery takes its origin, as an anomaly, from the deep epigastric artery, it *occasionally* curves around the inner side of the neck of the sac. It is then in danger of being wounded in the operation of herniotomy, when the stricture at the neck of the sac is divided.

The coverings of a complete femoral hernia are skin, superficial fascia, cribriform fascia, anterior layer of the sheath of the femoral vessels, femoral septum, subperitoneal fat and peritoneum (sac). These coverings are often thinned so that the hernia seems to be almost directly under the skin. In other cases, however, the coverings are thickened. If the hernia is incomplete, the fascia lata becomes a covering in place of the cribriform fascia. When strangulation occurs in femoral hernia the stricture is either at the saphenous opening, at Gimbernat's ligament or at the neck of the sac.

Diagnosis.—Femoral hernia presents the ordinary symptoms of hernia. The tumor is usually small, tense, globular or ovoidal in shape, and situated below Poupart's ligament, with its long diameter transverse or oblique. The neck of the sac is felt to be external to the pubic spine; this distinguishes it from inguinal hernia, in which the neck of the sac is internal to the pubic spine. The essential point in the diagnosis of femoral hernias from inguinal hernias is the position of the neck of the hernia relative to the spine of the pubes. The neck is outside of the spine in femoral hernia. A femoral hernia never attains the immense size that is possible in inguinal hernia.

A group of enlarged lymphatic glands about the saphenous opening may resemble a femoral hernia. If a small femoral hernia is overlaid by enlarged glands, the hernia may escape notice even when symptoms of strangulation are present. Suspicious symptoms occurring in such a case should cause an exploratory operation to be instituted.

A psoas abscess pointing in the groin gives rise to a swelling near the site of the femoral hernia. In such cases the tumefaction is usually outside of the femoral vessels instead of inside, as in hernia; there is some fulness in the iliac fossa, the tumor shows some fluctuation and there is often evidence of tubercular disease in the spinal column.

Varicosity of the saphenous vein may give rise to a small tumor in the neighborhood of the saphenous opening. It presents the characteristic tortuosity of varicose veins, and will probably be found associated with a varicose condition down the inner side of the thigh.

Treatment.—Reducible femoral hernias should be reduced and the recurrence of protrusion prevented by wearing a truss. Operations for a radical cure have been described under the Treatment of Hernia. In strangulated femoral hernia taxis should be undertaken with the thigh slightly flexed upon the pelvis, adducted and rotated inward, in order to relax the falciform edge of the saphenous opening. If the tumor is large, pressure should be directed downward before the hernia is pushed upward and backward. As in all hernias, lifting up the tumor so as to draw a little more intestine out through the ring is often a good preliminary manipulation. In reducing the hernia it must be recollected that the portion of the gut which has protruded last must be pushed into the abdomen first.

Etherization, opium and hot baths are not very efficacious in aiding the reduction of strangulated femoral hernia; hence, early operation is demanded in cases that do not yield to moderate taxis. The incision should be a vertical one. The skin over the hernia is usually pinched up in a fold and laid open by transfixion, because the thinness of the coverings renders an incision made by puncture from the exterior a little dangerous. The point of strangulation is discovered by the tip of the finger, after opening the sac. The strangulating band should be divided by incision inward and upward. Several shallow notches are better than one deep one, since there is less possibility of injuring an abnormal obturator artery, which might be present, curving around the neck of the sac or along the edge of Gimbernat's ligament. The occasional abnormal course of this artery renders the use of a quite dull hernia knife judicious at this stage of the operation, since the arterial wall is less liable to be injured with a dull knife than with a sharp one. The dense fibrous tissue causing the stricture is readily sawed through with a dull edge. Sometimes the surgeon can feel the artery beating as he pushes the tip of his finger against the edge of Gimbernat's ligament. Under such circumstances, incision of or notching Gimbernat's ligament close to the pubic bone is less liable to do damage than the ordinary cut upward and inward. It is said that incision directly inward is not so satisfactory as one inward and upward, since it is apt to make a larger wound, and causes difficulty in restraining the hernia afterward by means of a truss.

Umbilical Hernia.

Anatomy and Pathology.—A hernia occurring at the navel is termed an umbilical hernia. It occurs in infants through the umbilical ring, and in adults either close to or at that opening. This form of hernia is most frequent in infants and in old, corpulent women. The hernial sac is thin and often full of holes. The contents of the sac are usually omentum with some coils of intestines wrapped up in it. The coverings of an umbilical hernia are skin, superficial fascia, transversalis fascia, and peritoneum (sac). Very often these coverings are so thin that there is scarcely anything outside of the hernia but the skin and the peritoneum. In adults this hernia may become very large and it is frequently more or less irreducible. Obstruction is not uncommon; strangulation is comparatively rare.

Fig. 394.

Large umbilical hernia. (Author's case.)

Treatment.—In infants the condition is often cured spontaneously. Nevertheless, it is wise to keep the hernia reduced by placing over the umbilicus a pad held in place by means of adhesive plaster or a bandage. A large coin or a piece of cork wrapped up in adhesive plaster with the adhesive side out may be applied with great satisfaction. The adhesive surface of the plaster keeps the coin from slipping, and a broad strip of adhesive plaster carried over the whole with the ends reaching the back makes a convenient dressing. It should be employed for several months, being renewed about once a week; at which time the skin should be washed. In adults an umbilical truss or an elastic bandage should be applied.

If strangulation occurs, an incision for the relief of the stricture is demanded. The external wound is usually made over the top of the tumor. It does not make very much difference in what direction the constricting band is divided, as there are no structures of importance around the umbilical aperture. An upward incision, however, is probably the most desirable. In opening the sac great care should be taken, because the coverings are so thin that the intestine may be suddenly and unexpectedly wounded. The protruding omentum should be ligated and excised, after which the stump should be returned. Any portion of intestine hidden from view by thickened omentum should be carefully searched for, since the strangulation of gut may be unrelieved unless the intestine is fully inspected. After the strangulation has been overcome and the sac excised, the edges of the ring should be freshened and sutured with silk or chromicized or formaldehyde catgut sutures.

In umbilical hernias giving trouble because of their irreducibility or tendency to become obstructed, radical operation is justifiable. This is probably judicious in all except small umbilical hernias, which are easily controlled by trusses.

Sometimes hernia occurs in the linea alba between the navel and the ensiform cartilage. They are usually small and should be treated by the radical operation.

CHAPTER XXIV.

DISEASES OF THE RECTUM.

EXAMINATION OF THE RECTUM.

THE outlet of the rectum is guarded by an external sphincter of voluntary muscle and an internal sphincter of involuntary muscle. The internal sphincter is situated above and partly within the external sphincter. A crescentic fold of mucous membrane at the right and anterior side of the rectal tube, two and a half or three inches above the anus is sometimes called the third sphincter. Its presence is to be remembered because the ends of bougies may become entangled in it. For examination of the rectum, the patient should be put in the knee-elbow position with the buttocks toward the light, after a thorough evacuation and cleansing of the rectum by means of warm water injections. The oiled forefinger of the surgeon is then introduced. Inspection of the interior is accomplished by specula of various forms. A long cylindrical speculum and a head mirror will permit examination of the sigmoid flexure in addition to the rectum.

Malformations of the Rectum.

Pathology.—Certain congenital malformations of the anus and rectum require operative treatment. These congenital deformities are ordinarily discovered soon after the birth of the child, by the absence of intestinal discharge and by the occurrence of vomiting. The anus may be entirely occluded or it may be represented by a minute orifice through which the meconium and feces are not effectually expelled. In other cases the anus may be entirely absent, and the skin between the buttocks not even dimpled in the anal region. The partition between the surface and the end of the rectal pouch varies in such cases from a quarter of an inch to an inch in thickness. If the occluding tissue is thin, it may bulge down when the child cries and transmit to the eye the dark color of the meconium on the other side; thereby indicating that it is of no considerable thickness. In some cases the anus is perfectly formed and it is only by the introduction of a probe or the finger that the nurse or the surgeon discovers that the exterior orifice has no connection with the rectum above. In still other instances, the whole rectum may be absent, and the large bowel terminate in a blind pouch at the top of the sacrum or at a still higher point. In these cases the anus is usually imperforate—that is, absent. Clinically, it may be impossible to tell a case of simple imperforate or absent anus from a case of imperforate anus complicated or associated with imperforate rectum. It is readily seen that if the anus is absent, the surgeon has no means of discovering whether the rectum is present or absent, unless examination of the external surface of the abdomen gives indications of a swelling due to retention of the intestinal contents in a colon which has no lower outlet.

Treatment.—The operative treatment in these cases consists in dissecting through the perineum toward the rectum, with a view of establishing an outlet for the meconium and feces. If only a thin diaphragm causes the obstruction, a crucial incision liberates the retained contents and converts the deformity into a normal condition. Operation under such circumstances is unattended with shock, and the functions are soon normally performed. If a deep dissection is required to find the lower end of the bowel, the operation is a serious one and may terminate fatally from shock. Under such circumstances, a straight incision is made from behind the scrotum to the point of the coccyx and gradually deepened backward and upward, following the line of the coccygeal curve. Caution is required to avoid injuring the bladder. Excision of the coccyx has been advocated in order to gain room for such operative manipulation, when the lower end of the rectum is situated at a high point.

Some authorities advise that when the bowel is found, an attempt should be made to draw it down and to stitch its wall to the skin. This can seldom be accomplished if the distance is great; and as it is a somewhat dangerous operative procedure under such circumstances, it is probably best not to attempt it. If a dissection extending from an inch to an inch and one half upward does not enable the operator to find the rectum, iliac colostomy on the left side of the abdomen is the proper operation. If it is uncertain whether the descending colon is properly developed, colostomy above the right groin is to be done.

The rectum or colon occasionally opens into the bladder, urethra or vagina, or upon the surface of the body at some distance from the anal region. In such congenital deformities an attempt should be made to open the normal route from the anal region to the intestines; when this has been done successfully the abnormal opening will close spontaneously or may be occluded by plastic operation. If it is impossible to construct a canal from the anus to the bowel when the rectum opens into the bladder, it is proper to make a perineal incision into the posterior urethra, in order to permit free escape of the intestinal contents. If the rectum opens into the vagina by a large orifice, operation may be deferred until the child is two or three years old.

After constructing new openings for the escape of feces, in cases of congenital malformation of the anus and rectum, the surgeon must use rectal bougies or have the mother insert her finger daily, in order to prevent cicatricial stricture.

Pruritus of the Anus.

Pathology and Symptoms.—Pruritus, or itching, of the anus is usually most troublesome at night. It may be due to lice, to the vegetable parasite causing eczema marginatum, to thread worms or to a papular eruption about the anus, or it may be secondary to uterine disease. In some cases the gouty diathesis is probably a predisposing cause. The symptoms are violent itching, making it often impossible for the patient to abstain from scratching, while locally there is little or no cause for the troublesome affection, except perhaps a little redness of the skin. In old cases there may be enlargement of the cutaneous folds at the anal opening, and the skin may be thickened and discolored by prolonged inflammation, due to scratching. Hemorrhoidal tumors may be associated with anal pruritus.

Treatment.—Anal pruritus is to be treated by removing the cause, and by keeping the bowels open and the parts well washed. It is important that after washing, the skin should be thoroughly dried by a soft towel or absorbent cotton without rubbing the skin, since the least rubbing may start an attack of itching, which will be followed by scratching. Carbolic acid is probably the best application to relieve the intense itching. It may be used in a lotion containing from fifteen grains of carbolic acid to the ounce of water, with which a little glycerin is mixed. About five grains of fused potassa may be added to the ounce of liquid with advantage. Tar ointment and sulphur ointment are also valuable. Arsenic given internally seems at times serviceable. If the disease is manifestly due to a gouty tendency, colchicum, a properly regulated diet and exercise are important adjuvants. Relief has sometimes been obtained by introducing a conical bougie into the rectum.

Inflammation of the Rectum.

The normal pouches of the mucous membrane of the rectum sometimes become enlarged and distended, owing to protracted retention of the feces. This condition causes pain and itching in the rectal region. There is in this disease, however, no spasm of the sphincter, such as occurs in anal fissure. The treatment consists in drawing down the enlarged pouches with a blunt hook and clipping off the folds of mucous membrane, so that the fecal matter cannot be retained.

Inflammation of the mucous membrane of the rectum is called proctitis and is a medical rather than a surgical condition, unless ulceration occurs. It may be due to gonorrhœa, to the use of the leaves of the poison ivy for cleansing the anus after defecation, and to foreign bodies inserted into the rectum. The symptoms are somewhat similar to dysentery. Tenesmus, rectal pain, and the discharge of bloody mucus or pus are indicative of proctitis. Ulcers of the rectum occur from dysentery, injury, syphilis and malignant disease.

The treatment of proctitis consists in removing the cause and in the use of mild astringent injections, such as nitrate of silver (gr. ij to v to the ounce of water) or sulphate of zinc (gr. v to the ounce), or in the introduction of suppositories of an anodyne and astringent composition. Ulceration requires treatment appropriate to ulceration elsewhere.

Foreign Bodies in the Rectum.

Indigestible articles which have been swallowed may become impacted in the rectum, because their exit is prevented by the sphincter muscle. On the other hand, foreign bodies may be pushed into the rectum through the sphincter by the individual himself, as a curious sort of masturbation, or by others during the patient's unconsciousness from alcohol. Articles of extraordinary size have thus been put in the rectum. Chronic inflammation of the rectum may be set up by foreign bodies, and, at times, simulate malignant disease of the part. Such foreign materials are to be removed by means of forceps or the fingers, after etherization of the patient and dilatation of the sphincter muscle. In some cases, where the foreign body is large, it has been necessary to deliver it with obstetric forceps. Incision of the sphincter muscle is justifiable if sufficient dilatation to permit extraction is impossible.

Impacted Feces.

Dilatation of the rectum is not unusual in old persons; and in this pouch-like dilatation fecal masses may remain and become compressed into a large, hard mass, which it is impossible for the muscular wall of the stretched rectum to expel through the anus. The irritation from the retained fecal mass may give rise to a mucous discharge which, becoming stained with fecal matter, causes the patient to think that he is suffering from diarrhœa. The diagnosis of impacted feces can only be made with certainty by examination with the finger introduced through the anus.

The symptoms are pain, tenesmus and chronic constipation; this last symptom, however, is concealed in cases in which the diarrhœa-like discharge, spoken of above, occurs. Laxatives and cathartics can be of no service in cases of impacted feces, because the condition is mechanical and it is impossible for the large mass to be extruded through the normal orifice; therefore, it must be broken up by means of instruments introduced through the anus. The handle of a spoon or a pair of forceps, by which the mass may be perforated and disintegrated, is an efficient aid to the surgeon's fingers. Repeated and copious injections of warm water and oil into the bowel will aid in softening and removing the mass thus broken into pieces.

Prolapse of the Rectum.

Pathology and Symptoms.—By prolapse of the rectum is meant protrusion of more or less of that portion of the intestine in a healthy condition, and not the mere pushing out of the mucous membrane, which occasionally occurs in connection with hemorrhoids. The mucous membrane of the rectum is loosely attached to the muscular coat, and therefore an inch or two of the mucous membrane may project through the anus without any change of location of the rest of the bowel. This prolapse of the mucous membrane alone is called partial prolapse of the rectum; whereas the term complete prolapse is applied when the rectum is turned inside out, as it were, by a process of invagination and all the coats form the external tumor.

Partial prolapse is, of necessity, limited in extent, because the amount of sliding between the coats is not indefinite. In complete prolapse, however, almost any length of the intestinal tube may be found external to the anus. The disease is most common in children and in aged persons, and is due to a weakened condition of all the tissues, although the exciting cause is straining. Stone in the bladder, urethral stricture, phimosis, dysentery, chronic constipation and polypus in the rectum may be causes, because of the abdominal straining and bearing down which they induce.

The diagnosis is very clear when complete prolapse of the rectum occurs. The smooth folds of the mucous membrane on the outside of the sausage-like tumor are characteristic. There is a groove around the mass at the site of the sphincter muscle. Partial prolapse presents some resemblance to a mass of internal hemorrhoids, but has not the bunched appearance that is exhibited by the purplish piles and the prolapsed mucous membrane accompanying them. A protruding rectal polypus is harder than prolapsed intestine and has a distinct pedicle.

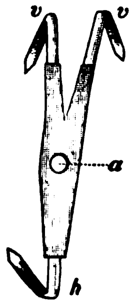
The prolapsed tissues at first appear outside the anus only after stool, but repetition of the protrusion occurs, and finally the disease may become so aggravated that the intestine slides outside of the body whenever the patient walks or assumes the upright position. The anus by this time has become so dilated that retention of the rectum is almost impossible. Sometimes the protruded gut becomes strangulated by the sphincter, but this is more apt to occur in the earlier than in the later stages.

Treatment.—The prolapsed rectum must be reduced when it first occurs by gentle, though firm, pressure with the fingers after anointing the protruded gut with some oleaginous preparation. During the reduction the patient should assume the knee-elbow position or be placed in a recumbent position upon one side. In the case of infants it answers well to place the child upon its abdomen across the lap of the nurse. Steady pressure may be required for several minutes. It is evident that the portion of the intestine which has been protruded last must be pushed up first. If these manipulations fail, reposition may often be obtained by introducing the finger, covered with a piece of lint, into the orifice of the protruded bowel and pushing it slowly upward into the intestine.

Support to the perineum and to the rectum should be given after reduction, by applying a T-bandage, which is a piece of muslin carried under the perineum with a second portion to go round the waist like a belt. After the replacement of the prolapsed rectum in an infant, support may sometimes be satisfactorily obtained by passing a deep suture through the tissues at the verge of the anus, thus narrowing the orifice. If the prolapsed rectum is strangulated by the sphincter, it may be necessary to dilate or cut that muscle, in order to prevent the occurrence of gangrene and permit the replacement of the gut.

To prevent the recurrence of prolapse after reduction requires a great deal of careful treatment. The patient should never be allowed to assume the sitting position when evacuating the contents of the bowels. He should be compelled to defecate when lying down upon the side or in a standing position. If the anus is drawn a little to one side with the finger as the fecal material is being evacuated, the tendency to prolapse is greatly diminished. The bowels should be kept in such a condition that constipation and the evacuation of hard masses may be avoided, since all straining is dangerous. Broad strips of adhesive plaster carried across the buttocks, so as to hold the two nates close together, is quite an efficient means of giving support to the rectum in small children. Astringent ointments or suppositories such as tannic acid (gr. xxx to the ounce), may be found effective; or astringent enemas containing zinc sulphate, alum or similar preparations, or rectal injections of cold water may be substituted for the ointments or suppositories. Glycerin suppositories will probably be found valuable in keeping the bowels open without producing straining. Under such a line of treatment cases occurring in infancy and cases of moderate severity in adults will probably be cured in a few months. The more inveterate cases require surgical treatment.

FIG. 395.



Apparatus for holding back a prolapse of the rectum: *a*, opening in the elastic inflatable pad for the anus; *h*, posterior strap; *v v*, the two anterior straps between the scrotum and thigh, the three straps are fastened to a pelvic belt. (TILLMANNS.)

If there is a small mass of mucous membrane protruding from the anus with no prolapse of the other coats of the bowel, a pair of scissors may be used to trim away the redundant tissue, in the hope that the resultant cicatricial contraction will produce cure. In more severe cases fuming nitric acid may be applied to the mucous membrane of the intestines, so as to produce sloughing and cicatricial contraction. The acid should be thoroughly applied to the entire surface of the protruded part of the intestine, excepting a circular strip extending about half an inch from the anus. Another method is clamping, with a hemorrhoid clamp, a longitudinal portion of the mucous membrane; this is subsequently cut off and the stump seared with the red hot cautery iron. Three or four such longitudinal folds may be removed. The operation will result in cicatricial contraction of the dilated gut; and by the adhesions produced between the rectal wall and surrounding tissues the tendency to prolapse is prevented.

The orifice of the anus, which has become dilated in all chronic cases, may be reduced by cutting out a V-shaped portion of the sphincter at the posterior part or at the sides and suturing; and thus cause retention of the relaxed rectal structures. I have operated with satisfaction by cutting out V-shaped portions of the sphincter and of the entire posterior wall of the rectum; the two triangles having a common base at the back of the anal opening. Catgut sutures were then applied within the gut so as to bring its divided walls together and through the sphincter muscle and skin externally.

Some cases have been treated by opening the abdomen and stitching the sigmoid flexure to the anterior wall of the abdomen, so as to keep the rectum drawn upwards.

FIG. 396.

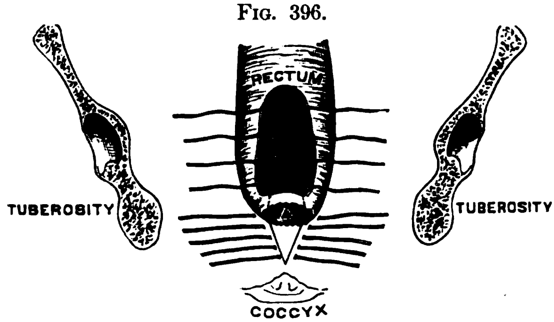


Diagram of author's method of operating for prolapse of rectum. A window in the anterior wall of the rectum exhibits the lines of excision and the sutures in the posterior wall.

When no operation will be permitted by the patient a certain amount of comfort may be obtained by wearing an anal truss. This consists of a belt, to which is attached a spring going between the buttocks and holding a pad against the anus.

Hemorrhoids.

Pathology.—The term hemorrhoid or pile is applied to several varieties of tumors about the verge of the anus. Unfortunately, this want of accuracy in the use of the term creates confusion in the pathology and treatment of anal conditions. It would be better if the tumors called internal hemorrhoids were the only ones to which the name hemorrhoid was applied; while to the various affections called external hemorrhoids better descriptive names might be given.

An internal hemorrhoid is a vascular tumor or angeioma, situated beneath the mucous membrane of the lower portion of the rectum and usually not higher than one or two inches from the anus; ordinarily, these tumors lie just within the anal opening.

The dilated veins, capillaries and small arteries constituting the essential structure of the pile may be held together by so much thickened connective tissue as to give the tumor quite a hard consistence. Repeated attacks of inflammation have a tendency to increase the cellular connective tissue and to obliterate some of the vascular channels, and thereby increase the bulk and hardness of the tumor. Prolapse of the mucous membrane in the region of the hemorrhoidal tumor may also occur through the anus and increase the bulk of the mass.

Anything tending to increase the blood pressure about the lower end of the rectum may cause internal hemorrhoids. Obstruction to circulation arising from disease of the heart, lungs or liver, or from an overloaded colon may give rise to hemorrhoids. Downward pressure upon the pelvic contents by contraction of the diaphragm and abdominal muscles increases the congestion in the inferior hemorrhoidal vessels. It is this mechanism which gives rise to hemorrhoids in cases of enlarged prostate gland, stricture of the urethra, stone in the bladder, phimosis, carcinoma or stricture of the rectum and in prolonged and frequent straining at stool.

Symptoms.—The presence of hemorrhoidal tumors in the rectum gives rise to pain, itching, a feeling of weight, tenesmus and other symptoms of discomfort. Pain, in fact, may radiate to the genital organs and in other directions. At first these symptoms are not very marked, but after a time they increase and there is a tendency for the tumors to protrude through the anus when the patient is at stool. This will require him to use his fingers to replace the growths within the rectum. Finally, it is not unusual for a portion of the mucous membrane of the bowel to be prolapsed with the hemorrhoids. Such a protruding mass may, by contraction of the sphincter muscle, become strangulated, whereupon it becomes much swollen and painful and the seat of inflammation. Occasionally gangrene of the protruding portion occurs. When the congestion of the growths becomes very great during straining at stool, rupture of the thinned mucous membrane covering the dilated vessels of which hemorrhoids consist may cause hemorrhage. Sometimes the bleeding is only a slight staining, at other times the fecal masses are coated with blood; while on still other occasions there may be a spurting hemorrhage of several ounces, when the patient endeavors to evacuate the contents of the bowels. This may also happen when there is no fecal mass extruded, because the desire to go to stool is felt from the swollen condition of the mucous membrane of the rectum. The blood which flows from hemorrhoids is redder than blood which has escaped, for any cause, from the bowels higher up than the rectum, since the latter is altered in character and made darker by intestinal secretions.

In long standing disease the sphincter becomes relaxed and does not resist the pressure from above and allows the protrusion of the piles to exist almost constantly. The bleeding often relieves the pain and other local symptoms, but if occurring frequently, as it does in extreme cases, it will lead to dangerous anæmia of the patient.

Diagnosis.—The diagnosis of hemorrhoids where they are protruding is simple enough. The difference between this disease and prolapse of the rectum has already been mentioned. When, however, the hemorrhoidal tumors are collapsed and not distended with blood, the surgeon's fingers may scarcely recognize them. A diagnosis must then be made by careful examination after the rectum has been emptied of its contents by enemas. The patient, while lying upon his side, should be ordered to bear down as if at stool, while the surgeon draws the anus open with his fingers. If hemorrhoids exist, a red or purplish shining tumor, with a more or less irregular surface, will protrude. There may be one or several such vascular masses. Between the sphincter and the tumors there is usually a deep groove. The inner surface of the protruding growth usually appears somewhat bluer than the surface near the anus. Such tumors may show ulceration from which bloody serum escapes.

Treatment.—Palliative treatment consists in carefully regulating the bowels, so as to prevent the rectum from becoming blocked with hardened feces. Alcoholic stimulation in excess and other errors in regard to food and drink may often lead to increased discomfort to those subject to piles. Compound licorice powder, confection of senna, saline cathartics and other laxatives answer very well for regulating the condition of the bowels. Locally the patient should use mild astringent ointments, which should be applied to the anus and pushed up into the rectum so as to come in contact with the mucous membrane. One drachm of tannic acid to the ounce of simple ointment is beneficial, and the ointment of galls combined with an equal amount of the ointment of stramonium will often be found effectual. The ointment of the nitrate of mercury mixed with seven parts of simple ointment is another good application. Enemas of the tincture of the chloride of iron (ten minims to the ounce of water), and a somewhat similar enema made of the subsulphate of iron are also valuable. Suppositories of glycerin may perhaps be found convenient in keeping the bowels open and at the same time prove a good application for the affected structures.

When the tumors are in a state of inflammation, at which time, of course, the symptoms are aggravated, an enema of five minims of the tincture of opium and half an ounce of starch-water will give great comfort, as will also the insertion of a one grain suppository of opium. Hot water fomentations should be applied to the anus, and the patient kept in bed, with the bowels made slightly loose with laxatives. If the piles are protruded and strangulated, they must be pushed back into the rectum, even if etherization and stretching of the sphincter are necessary for the accomplishment of the object.

When palliative means fail to give relief, when repeated attacks have rendered the tumor so large that more or less discomfort is constantly felt and when repeated hemorrhage shows a tendency to break down the patient's health, a radical operation is demanded. Such an operation, if properly done, causes a permanent cure. It should not be undertaken, of course, when the hemorrhoids are due to pregnancy, and perhaps not when they are secondary symptoms resulting from stricture or malignant disease of the rectum. In the last two cases the primary disease should be treated as the initial step in the management of the case.

Moderately severe cases of hemorrhoids may at times be cured by simple dilatation of the sphincter by means of the surgeon's two thumbs inserted into the anus and then separated with as much force as he can bring to bear upon them. This operation requires the administration of ether and should be thoroughly done. It often results in such change in the circulation of the hemorrhoidal vessels as to cure the patient's disease. Small hemorrhoids may be cured by a few applications of strong nitric acid used as a caustic or by puncture with a red hot cautery iron. Injection of carbolic acid (gr. xxx to f℥j of glycerin), by means of a hypodermic syringe, into the hemorrhoidal tumor is employed by some surgeons. The patient need not remain in bed for the carbolic acid method of treatment. About four minims are injected into each pile. The operator treats one or two piles at a time. The treatment is protracted and not always satisfactory. It is essential that the fluid be placed in the center of the hemorrhoid; and not close to the surface, since in such an event it is liable to cause sloughing with subsequent ulceration.

Of all the operations proposed for the radical cure of the more severe cases of hemorrhoidal disease, the best is probably excision and cauterization. The patient's bowels should be well emptied by a laxative taken the night before and a large enema of soapsuds given a few hours before the operation. He is then placed in the lithotomy position; that is, upon his back with his knees and hips flexed. The surgeon, as a preliminary step, should widely dilate the anus by stretching it with all his force by means of his two thumbs, which are inserted into the bowel. A portion of the large mass of hemorrhoidal tissue and prolapsed mucous membrane is then drawn down with a volsella forceps. A clamp, consisting of two blades of ivory protected by steel strips on the outer surface and which can be screwed firmly together, is then placed upon the base of the pile and

FIG. 397.

Clamp for hemorrhoids.

screwed tightly, so as to prevent hemorrhage when the tumor is cut off with a pair of scissors. The surgeon then cuts away the mass protruding from the blades of the clamp, leaving about a quarter of an inch near the clamp. This stump is left in order that there may be some tissue left to sear with the hot iron, which is now applied to prevent hemorrhage from the vascular tissues when the clamp is removed. The cautery iron should be heated to a red heat, so as to sear the tissues and occlude the open mouths of the vessels. As soon as the probability of hemorrhage is thus prevented, the clamp is removed and the stump allowed to recede into the rectum. The other tumors are successively treated in the same manner until all have been excised and seared. This operation removes the hemorrhoidal tissue, prevents hemorrhage and gives an aseptic surface which cannot readily become infected by micro-organisms in the bowels or upon the outer surface of the anus. It is thorough, efficient and a less troublesome operation than the other usual methods.

The patient should have his bowels moved about the fourth day by means of a mild laxative, such as castor oil. Even in severe cases the patient need seldom remain in bed for more than five days, or in the house for more than ten days. Retention of urine requiring catheterization does not often occur after this operation. If the operator has not the hemorrhoidal clamp figured in the diagram, the operation can be satisfactorily performed by the use of an ordinary pair of pincers for the clamp and a red hot poker in place of the cautery iron or Paquelin thermo-cautery.

Some surgeons make an incision around the internal margin of the anus and dissect out the hemorrhoidal tissue and mucous membrane for a half an inch or more above the anus. This removes a cylinder of hemorrhoidal tissue. The edge of mucous membrane is then stitched to the skin. The operation is a very satisfactory one.

Ligation of the hemorrhoidal masses so that sloughing will cause their detachment is an inferior method of operating.

External Hemorrhoids.

Pathology and Symptoms.—The term external hemorrhoids is applied to three different conditions occurring at the verge of the anus external to the sphincter. The three forms have been called thrombotic hemorrhoids, œdematous hemorrhoids and cutaneous hemorrhoids.

A thrombotic hemorrhoid is a blood clot beneath the muco-cutaneous covering at the verge of the anus, due to rupture of one of the small veins or to inflammation and thrombosis occurring in a subcutaneous vein. During straining at stool a small tumor the size of a pea may appear from rupture of a small vessel, and on examination show a purplish color through the thin skin. On the other hand, the clot may be due to inflammation of one of the veins in this locality, which has arisen secondarily to infection of a small crack or laceration in the cutaneous tissue at the verge of the anus. The first form, due to rupture of a small vein, may cause some little pain and soon disappear. If inflammation occurs around the blood clot painful symptoms arise and even suppuration may occur. The symptoms then are similar to those arising from the second form of thrombotic pile, which begins as an inflammation.

The so-called œdematous pile is simply an inflammation, which may be quite severe, of the muco-cutaneous crevices and elevations which are normally present about the anus, due to the normal puckering of the skin in that region. Such inflammation gives rise to pain, a bearing down sensation, and swelling, and is the condition usually present when one of the laity speaks of an attack of piles. The condition is simply one of inflammation of the tissue about the anus and is in no sense related to the other forms of pile mentioned, except that it occupies the same locality. The term piles, as used by the laity, is often also the condition called pruritus of the anus, either alone or associated with one of the forms of internal or external hemorrhoids.

The third condition to which the name external pile has been applied is a hypertrophy of the muco-cutaneous folds outside of the anus, giving rise to pedunculated tumors or tabs of muco-cutaneous and cellular tissue. The hypertrophy results from previous attacks of inflammation of these folds, such as described under the heading œdematous hemorrhoids. These enlarged cutaneous elevations give no trouble under ordinary circumstances, but when they become inflamed they cause great discomfort and symptoms similar to those produced by the thrombotic and œdematous tumors just mentioned.

Treatment.—It will be seen that the pathology of external hemorrhoidal tumors is quite different from that of internal hemorrhoids, and therefore it will not surprise the reader to find that the two diseases are treated in different manners. The thrombotic form is best managed by incising the pea shaped tumor and scraping out the small clot, after which the anus should be bathed with an antiseptic solution and anointed with a slightly astringent ointment. The ointment of the oxide of zinc, with which twenty grains of carbolic acid to the ounce have been mixed, answers exceedingly well.

Œdematous piles are to be treated by bathing the anus with warm water, and applying a similar ointment of the oxide of zinc and carbolic acid or one consisting of about ten grains of the yellow oxide of mercury ointment to an ounce of simple ointment. In both cases the evacuations from the bowels should be kept soft, so as to prevent pain at defecation.

The cutaneous piles should be let alone if they cause no trouble. Under other circumstances they should be cut off with a pair of scissors. They should never be ligated; for while ligation is applicable to internal hemorrhoids, although inferior to excision and cauterization or to removal by dissection, it is not adapted to these cutaneous tumors.

Cutaneous hemorrhoids frequently co-exist with internal hemorrhoids. When such a combination exists, the internal hemorrhoids may be treated; and the cutaneous ones clipped away at the same operation. It must be understood that a danger after operations on internal hemorrhoids is concealed hemorrhage into the rectum, which is the reason for using the clamp and the cautery iron. In the external tumors, however, there is no special danger from hemorrhage, because they are not angeiomas. If any occurs after excision, the external position of the bleeding point renders it amenable to treatment by means of ligation or some form of pressure. When clipping away cutaneous hemorrhoids the operation should be conducted and the wounds treated antiseptically.

Rectal Abscess.

Pathology.—Abscesses may occur in the cutaneous tissue about the anus (marginal); in the ischio-rectal space, which is the fossa between the ischium and the rectal tube (ischio-rectal); in the tissue between the mucous membrane and the muscular coat of the bowel (intra-mural); and in the pelvis surrounding the rectal wall (peri-rectal). There may occur also a gangrenous cellulitis about the rectum, giving symptoms not unlike those of peri-rectal abscess.

The predisposing causes of abscess in these special locations are external injury, irritation or puncture of the rectal wall by foreign substances introduced into the rectum through the anus, inflammation due to small portions of hardened feces or to indigestible substances swallowed becoming impacted in the folds of the mucous membrane, and breaking down of tissue from want of resistance to pyogenic infection. In all cases of acute abscess the presence of pyogenic bacteria is a necessary causative factor. Tubercular infection may cause a chronic, or so-called cold, abscess.

Symptoms.—Marginal abscesses are similar to other superficial abscesses, both in symptoms and treatment. Such abscesses may be mistaken for piles unless the surgeon makes an ocular examination. The ischio-rectal abscess, which is the most common form in this region, begins as a hard mass between the anus and the tuberosity of the ischium. Aching and throbbing, with pricking sensations, are felt; the skin becomes hard, red, and brawny, and finally these symptoms are succeeded by fluctuation and evidences of pointing.

Intra-mural abscesses are usually overlooked until they burst and discharge pus into the bowel, whence it is evacuated. Peri-rectal abscesses are often similarly overlooked. The sensation of weight and fulness and the pelvic discomfort associated with this condition are in such cases frequently attributed to other lesions. Rigor occurring in the course of such symptoms should put the surgeon on his guard as to the possibility of suppuration taking place in this region. The finger introduced in the rectum may detect swelling or a fluctuating tumor in cases of intra-mural or peri-rectal abscess. The latter, of course, is much more dangerous than the former, and may be secondary to malignant disease or rectal stricture. Such abscesses bursting into the peritoneum would probably lead to a fatal issue, unless the surgeon immediately opened the abdomen and washed out the pelvis.

Treatment.—All rectal abscesses should be opened as early as possible; and if it is thought that suppuration is about to take place, an incision, even before the formation of pus, is justifiable. In the event of pus not being given an opportunity to discharge through an opening made by operation, a great deal of burrowing usually takes place before spontaneous evacuation occurs, and, in the ischio-rectal form, an anal fistule is very apt to remain.

Intra-mural abscesses may be evacuated by tearing through the mucous membrane with the finger-nail or by puncturing it with a knife introduced through a speculum. The ischio-rectal and the peri-rectal forms should be opened by free incision made through the skin, after which the abscess cavity should be curetted. If the curetting can be done thoroughly, the cavity may then be sewed up by deep sutures, with the hope of obtaining immediate union. If there is any doubt as to the aseptic condition of the curetted cavity, a drainage tube had better be introduced before the wound is closed. Rectal abscess thus treated will usually recover without the formation of an anal fistule.

Anal Fistule.

Pathology.—An anal fistule is a communication between the surface of the buttock and the interior of the rectum by means of a narrow pus secreting track. It results from an ischio-rectal or a peri-rectal abscess; this perhaps has not been opened early enough to prevent the formation of an orifice into the bowel as well as upon the surface of the skin. After such internal orifice has been established there is difficulty in spontaneous healing of the pus secreting tract, because small particles of feces get into the fistule from the caliber of the bowel, and because frequent movements of the sphincter muscle interfere with cicatrization.

The usual form of fistule has, as before stated, an opening upon the skin and an internal opening within the bowel. This is called complete fistule. Occasionally the fistulous track runs from the surface into the cellular tissue surrounding the rectum, but has no opening into the bowel. At other times there is an opening from the bowel leading into the abscess cavity or suppurating tract in the tissues surrounding the rectum, but with no opening upon the skin. These are incomplete fistules. These last two forms require similar treatment to the complete anal fistule, though they vary somewhat in symptoms. Incomplete external anal fistule may be due to a wound received from without. The incomplete internal fistule is hard to recognize, because

FIG. 398.

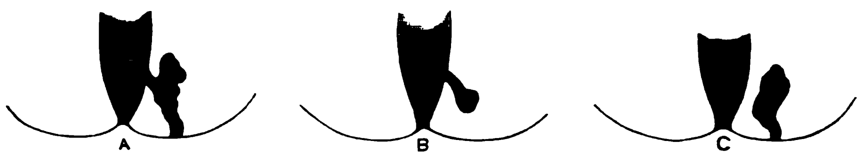


Diagram of three forms of anal fistule.
A. Complete fistule. *B.* Incomplete internal fistule. *C.* Incomplete external fistule.

there is no external indication of the tumor, except when the cavity in the tissues around the rectum fills up with pus and makes a slight bulging of the skin. This can be made to disappear by pressing upon the cutaneous surface and forcing the accumulated pus through the internal opening into the rectum. The diagnosis in such cases may sometimes be confirmed by feeling with the finger in the rectum the ragged orifice through which the communication between the cavity and the bowel is kept up. In complete anal fistules the rectal opening is usually within an inch of the anus, but the pus secreting pouch or pocket situated in the ischio-rectal space may extend to a higher point than this on the outside of the rectum. This is readily understood, because at the time of the formation of the abscess the pus may have burrowed upward along the rectum before the abscess pointed and finally evacuated itself on the skin or into the rectum. In searching for the internal orifice of an anal fistule, the surgeon should feel with the finger, or look through the speculum on all sides of the bowel just within the internal sphincter. The internal opening is usually single, even when the buttock is riddled by sinuses running in all directions. The internal orifice will usually be found to be the same for all these sinuses when a probe is successfully passed into the various cutaneous openings. The rectal opening may be upon the side of the rectum furthest from the external or cutaneous orifice, because the pus has burrowed around the gut. It must be remembered that a sinus opening far down the thigh may, when opened up, be found to lead to the rectum. On the other hand, the surgeon should not forget that a sinus in the neighborhood of the anus may be due to caries or necrosis of the tuberosity of the ischium or of the coccyx, and have no connection whatever with the rectum. Usually, however, sinuses in the neighborhood of the anus will be found, on careful exploration, to be anal fistules. Sometimes anal fistules are due to tubercular ulceration. These are likely to have large openings into the bowel.

Symptoms.—Anal fistules, when complete, are recognized by the existence of a slight purulent or sero-purulent discharge and by the discharge of gas and feces through the abnormal track. The external orifice will occasionally become closed and remain so for several days, perhaps for a week or two, when a slight increase of pain and some swelling will be followed by a reopening of the closed orifice, the discharge of a small amount of pus and subsidence of the active symptoms. A similar closure may occur in incomplete external fistules, though in these there will at no time be escape of gas or feces. Incomplete internal fistules exhibit at times an intermittent discharge of pus into the rectum and from the anus, especially when pressure is made upon the skin.

Treatment.—Injecting the anal fistule with stimulating solutions is usually unavailing. An operation is almost always necessary for a cure. Fistule resulting from stricture or malignant disease of the rectum should not be subjected to operation, unless it is evident that the primary disease can be dealt with or that the fistulous complication adds markedly to the patient's discomfort. Anal fistule occurring in a patient with tuberculosis of the lungs should be treated on the same principles that would guide the surgeon in operating upon any other surgical condition in a tubercular subject.

The patient's intestinal canal should be thoroughly emptied by laxatives and enemas before the operation. During the operation for anal fistule the patient is kept in the lithotomy position or in the elbow-knee position. The surgeon then introduces the forefinger of his left hand into the rectum and feels for the dimple or slight elevation which indicates the internal orifice of the fistulous track. This, in most cases, is just inside the internal sphincter. A grooved director, slightly bent at the point, is then introduced into the external orifice and along the pus secreting track until it emerges through the orifice in the rectum. Ordinarily, it is possible for the surgeon to bend the director with the finger which is in the rectum until the point of the instrument comes out at the anus. A bistoury is then carried along the groove of the director so as to divide the sphincter muscle and all other structures between the two openings. Any other communicating fistules or sinuses should then be laid open by incisions through the skin, but no second opening into the rectum should be made. After all the tracks have thus been laid open and exposed to view, it will be seen that all communicate through the various ramifications with one rectal opening. The membrane lining all these sinuses must be scraped out with a curette until healthy tissue has been reached. They should then be washed out with corrosive sublimate solution (about 1 : 2000), and the walls brought together with catgut sutures. This method converts a chronic suppurating surface into a healthy one, makes the wound aseptic and, by division of the sphincter muscle, prevents muscular movements of the divided structures, thus giving great assistance to the healing process. An antiseptic dressing should then be applied and movement of the bowels prevented for about a week. The treatment of tubercular fistules is practically the same as in those due to ordinary causes.

If it happens that no internal orifice can be found, when the surgeon has his finger in the rectum, and the point of the director has failed to find one, the end of that instrument may be pushed through the mucous membrane at any convenient point and the sphincter and other structures divided and treated as above. If the orifice, when found, is very high up in the intestines it may be well to cut through the sphincter and other structures with a probe pointed bistoury or scissors, since the point of the director cannot be bent so as to protrude at the anus. Let the operator be careful not to tear up the healthy cellular tissue with a small probe point, in his search for an internal orifice, but remember that in the vast majority of cases the rectal opening is not further than one inch from the anus. In incomplete internal fistule the internal orifice should be found and the tissues, including the sphincter and skin, divided. In no case should the sphincter muscle be divided in more than one place, since such multiple division may lead to fecal incontinence. In women the division should not be made through the anterior portion of the muscle. When it is impossible to scrape out the fistulous tracts thoroughly and approximate them with sutures, it is proper to plug the wound with antiseptic gauze in order to make it granulate from the bottom and prevent a recurrence of the fistule.

Recto-vesical, Recto-urethral and Recto-vaginal Fistules.

A communication between the rectum and the bladder, urethra or vagina may occur as a congenital malformation. Such fistules, at times, result from ulceration, malignant disease or injury. Whether congenital or acquired, the abnormal communication is recognized by the unnatural course which the feces or urine take during discharge. If the orifice is small, a small portion only of these excretions will pass through the abnormal channel. If the condition is not due to malignant disease, attempts at closure should be made by cauterization with nitrate of silver, the actual cautery or by plastic operation. Judicious cauterization and retention of the patient in such recumbent position as will prevent the urine and feces from getting into the abnormal channel will greatly aid the surgeon's efforts at occluding the abnormal fistulous aperture. Sometimes it is well to temporarily make another abnormal opening in order to divert the urine and feces during the closure of the original defect. This opening is usually placed in such a position that it can subsequently be easily treated by the surgeon.

A speculum somewhat similar to Sims's vaginal speculum, if used in the rectum, will permit the surgeon's manipulations to be carried on with considerable ease. The plastic devices used for this condition are similar to those employed in gynecological practice, when abnormal vaginal openings are to be closed.

Anal Fissure.

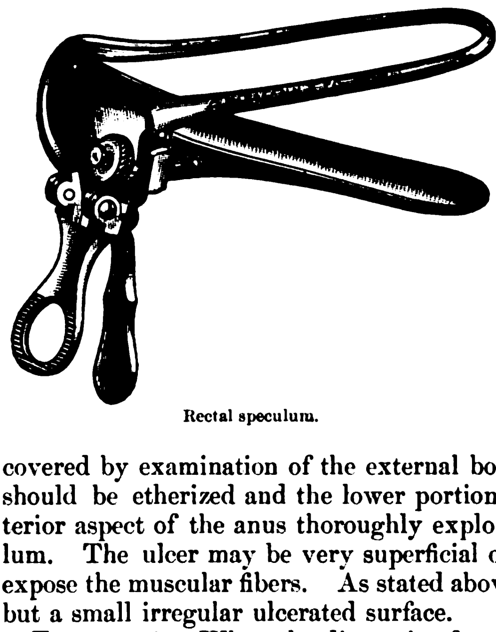
Pathology.—Among the various forms of ulceration of the anus and rectum is a peculiar ulcer to which the name anal fissure is applied. It is so different in its symptoms and treatment from the other forms of anal and rectal ulcers that it is better to discuss it separately.

Anal fissure is a local disease occurring in patients who are otherwise in good health. It is in reality either a small linear ulcer just within the verge of the anus involving the mucous membrane covering the sphincter or a small ulcer not larger than the little finger nail involving the mucous membrane of the rectum just above the sphincter. Such ulcers usually occur at the posterior or coccygeal portion of the anus. A peculiarity of the condition is the intense pain that occurs immediately after defecation, and which is due to spasm of the sphincter muscle. An anal fissure frequently begins as a small crack in the mucous membrane, due to the evacuation of hardened feces causing a tear in the tissue named. This fails to heal because of the constant motion of the sphincter muscle; or possibly because a tab of hypertrophied mucous membrane or a small rectal polypus coming in contact with it prevents cicatrization. At times small and superficial eczematous ulcers may occur upon the outer aspect of the anus. These are due to a want of cleanliness or to contact with leucorrhœal discharges. This slight condition is quite different from anal fissure, is unaccompanied by the intense pain of the latter and is easily cured by cleanliness and the use of oxide of zinc ointment or some similar astringent application.

Symptoms.—The symptoms of anal fissure are remarkable, because of their severity, notwithstanding the insignificant appearance of the lesion. The pain, which is the chief symptom, is intense and smarting and occurs immediately after defecation. This pain may last for a few minutes or it may continue for many hours. It may radiate toward the coccyx and sacrum. It finally becomes a dull ache before disappearing. There is then no return of pain until defecation is repeated; after each stool, however, the agonizing pain occurs. Sometimes a slight discharge of a muco-purulent character or a slight bleeding may be a coincident symptom. The manner in which the pain is reflected occasionally causes the patient to attribute the suffering to disease of the bladder or the urethra. The bearing down sensation, or tenesmus, accompanying anal fissure is sometimes remarkable. The dread of intense pain after defecation causes the patient to refrain from emptying the rectum, and chronic constipation therefore occurs as a secondary symptom.

Spasm of the sphincter muscle is the occasion of the agonizing distress and always exists in true anal fissure. The elevator muscles of the anus may also be involved in the spasmodic condition. In all instances of severe pain after stool, anal fissure should be suspected and a thorough examination be at once instituted. The irritable condition of the sphincter may result in such contraction of the anus when an examination is attempted that it will be impossible to pass the surgeon's finger into the rectum without etherization. If the presence of a fissure or linear ulcer is not discovered by examination of the external border of the anus, the patient should be etherized and the lower portion of the rectum and the interior aspect of the anus thoroughly explored by the finger and speculum. The ulcer may be very superficial or it may be deep enough to expose the muscular fibers. As stated above it is sometimes not linear, but a small irregular ulcerated surface.

FIG. 399.



Rectal speculum.

Treatment.—When the disease is of recent date, cure may occasionally be effected by maintaining a softened condition of the feces by the use of laxatives; by washing the parts after each act of defecation; and by smearing the anus and lower portion of the rectum with the ointment of oxide of zinc or an ointment containing the red oxide of mercury (gr. xv to the ounce). When this treatment fails, and it always will fail in the more chronic cases, operative procedures are required. The operation is so unimportant and the relief so great and immediate that it should not be postponed. It is ordinarily sufficient to etherize the patient and thoroughly paralyze the sphincter muscle by stretching it with the two thumbs. This dilatation should be done thoroughly and with all the power which the surgeon can exert by introducing his two thumbs and forcibly separating them, usually in a lateral direction. Some of the fibers of the sphincter muscle are probably ruptured by this manœuvre. Another method, which is said to be more effectual than dilatation, is to incise about one third the thickness of the sphincter with a bistoury. The incision is always made through the base of the ulcer, beginning a little above its upper border and terminating at the muco-cutaneous junction at the exterior of the anus. A speculum is usually needed to enable the surgeon to perform this operation dextrously. One of the forms of ointment mentioned for mild cases may then be applied.

When simple dilatation of the anus has been selected as a means of cure, it is well to scrape away with the finger nail, or with a curette, the granulations and indurated tissue forming the base of the ulcer. Any small tab of mucous membrane, polypoid growth or small fistule complicating the condition should be excised or incised at the same time that the selected operation is performed.

Ulceration of the Anus and Rectum.

Pathology.—Ulceration about the anus and rectum may be syphilitic, malignant, tuberculous or dysenteric; or it may be due to injury from hardened feces or a syringe improperly used or to foreign bodies. In old people there occurs an ulceration which appears to be due to chronic venous congestion and is similar, therefore, in pathology to the senile ulceration which occasionally shows itself in the legs. It must not be forgotten, moreover, that chancre and chancroids may be found at the anus. The ordinary syphilitic ulcer of the rectum belongs to the tertiary or to the congenital stage of syphilis. Gonorrhœa ot the rectum may lead to ulceration.

Symptoms.—Irregular diarrhœa, purulent discharge, pain, tenesmus and other symptoms resembling dysentery are the clinical features of rectal ulceration. The discharges often consist of material resembling yeast, or at times coffee-grounds, mixed with more or less mucus and pus. Ulceration in the upper part of the rectum is far less painful than a small ulcer at the lower part, as has been described in another paragraph; nor does great pain accompany the latter affection when the ulceration at the lower part of the rectum is extensive. Examination with the speculum or long rectal tube reveals the condition of the mucous membrane of the rectum; and digital examination conveys to the surgeon's fingers the sensation of rough irregularities and stiffened rectal walls quite different from health. There may be irregular distortion of the tube, and even stricture may occur.

Treatment.—It is essential in managing such a condition to keep the intestinal excreta soft and to use astringent and anodyne enemas and suppositories. The recumbent position may be valuable in severe cases, as it prevents abnormal congestion of the pelvic viscera. Washing out the rectum with large enemas of warm water containing boro-glyceride (1 to 30) and other non-poisonous antiseptics is a valuable means of getting rid of irritating secretions in the rectum; drying the ulcer and powdering it with a mixture of oxide of zinc (gr. iij), mild chloride of mercury (gr. xx), and powdered starch (ʒij) is good treatment. An enema containing ten drops of the tincture of opium to the ounce of starch water will often relieve the distressing pain. In tuberculous ulcers iodoform in powder or suppository is indicated; ten grains would probably be a sufficient, as well as a safe, amount in most circumstances to introduce into the rectum.

Syphilitic cases will always demand antisyphilitic remedies in addition to or instead of the tonics generally needed in ulcerations here. When great pain exists it may be necessary to stretch or divide the sphincter muscle to relieve the spasm present. In some extensive ulcerations the pain from the passage of feces over the diseased surface is so great that lumbar colostomy or excision of the lower portion of the rectum is demanded. These important operations, however, are not often required by the symptoms. Scraping away the ulcerated tissue with a curette or cauterizing the ulcer with a red-hot iron or fuming nitric acid is often sufficient.

Stricture of the Rectum.

Pathology.—Malignant disease is often the cause of stricture of the rectum, but contractions of the rectum due to fibrous formations will here be alone considered. These contractions are due to chronic inflammation or to such prolonged irritation of the muscular fibers in the rectal wall as to cause them to undergo a sort of fibroid degeneration. The coats of the rectum at the seat of coarctation are thickened or welded together either by a new fibrous tissue or an increase of the normal fibrous tissue. Ulceration of the mucous membrane is not uncommon in the vicinity of the stricture, and dilatation of the tube naturally takes place above the stricture from retention of fecal masses at that point.

The stricture when involving less than an inch of the tube is denominated an annular or ring stricture; when a greater length of the intestine is contracted, the term tubular stricture is applied. Inflammation and ulceration of the rectum as well as pelvic inflammations subsequent to labor may be the exciting cause of the fibrous degeneration which results in contraction of the gut.

Symptoms.—The first symptom of stricture of the rectum is difficulty in defecation, which is usually considered by the patient to be simply functional constipation. Finally the fecal masses discharged become smaller in diameter, resembling, perhaps, the size and shape of a lead pencil. At other times, however, the extruded material consists of small irregular masses, without definite shape. Occasionally they may even be ribbon shape. Flattened or tape-like feces, however, occur also from irritability of the sphincter without there being any stricture of the rectum. The small nodules of feces, called scybala, so usual in constipation, must not be mistaken for evidence of stricture. A bearing down sensation and a feeling of defecation being incomplete are marked features. Diarrhœa, alternating with constipation and painful defecation, will, perhaps, supervene. When ulceration occurs as a complication of fibrous stricture, mucus and blood will probably be mingled with the feces, and the solid material passed will be small in amount and accompanied with the yeasty or coffee-ground discharges mentioned as a symptom of ulceration of the rectum. The desire to go to stool is apt to occur soon after the ingestion of food or liquid. The effort at stool is followed by little result, and is soon succeeded by a repetition of the tenesmic sensation, showing that the rectum has not been fully emptied.

Dyspeptic symptoms, such as the accumulation of flatus, become more or less prominent. Abscess or fistule in the vicinity of the stricture may cause the careless surgeon to operate for its cure without discovering that the true cause of this condition is a stricture. Retention of feces, great emaciation, excoriation of the anus due to discharges, intestinal obstruction leading to peritonitis, and finally death may result from long continued fibrous stricture of the rectum.

A definite diagnosis can only be made by exploring the rectum carefully with an oiled finger or speculum. If the stricture is within three or four inches of the anus, it can be felt. There is usually less than the normal contractility of the sphincter and rectum, and below the point of obstruction the rectum has a tendency to be dilated like a distended balloon. This is not due to retained feces in this part of the gut, for none are retained there. The tip of the finger may discover a sort of diaphragm in which there is a small opening or it may feel a funnel-shaped thickening of the rectum leading up to a small orifice. The introduction of a sound with an acorn shaped head will enable the surgeon to determine whether the contraction is annular or tubular. If the disease is situated beyond the reach of the finger, it is necessary to use the long rectal speculum, such as that recommended by Kelly, because the rectal bougie used for examination gives uncertain information and may become entangled in the mucous folds, which line the rectum, or be arrested by the promontory of the sacrum.

When certainty of the existence of a suspected high stricture is rigidly demanded a very small hand, well oiled, may be pushed into the rectum and thrust up to the sigmoid flexure. Acute obstruction of the intestine may supervene, when the stricture of the rectum does not entirely occlude the caliber of the organ, by undigested food becoming impacted in the narrow opening. It must be remembered also that there is a phantom stricture of the rectum, as there exists a similar condition of the œsophagus, and that an enlarged prostate gland or a displaced uterus may push its wall inward and create a condition resembling stricture.

Treatment.—The feces in all forms of rectal strictures should be kept in a soft condition by the use of laxatives and enemas, and an attempt be made to restore the caliber of the gut by gradual dilatation. This is undertaken by passing a well oiled bougie through the contracted portion every other day and allowing the instrument to remain in position for a few minutes; or perhaps an hour, if pain does not contra-indicate the longer period. The bougie should be small, for no bougie that requires force should ever be passed through a stricture of the rectum. Any attempt to force a large bougie through the diseased area or to dilate the stricture rapidly with the finger or bougie, is liable to cause inflammation or rupture of the intestine. If no pain of moment is produced by the small bougie, larger sizes may be successively substituted for the smaller instruments every four or five days. At the end of six or eight weeks a much larger bougie than that originally used will probably be comfortably received, and much relief will be given to the patient from the dilatation thus effected. It is essential that no active inflammatory conditions be induced by the dilatations. After the surgeon has given up attendance upon the case the patient should introduce the bougie for himself about twice a week. This should be continued for many months in order to prevent recurrence of the contraction. In annular stricture this method of treatment often produces cure, but it is usually of little avail in the more serious tubular strictures.

In the event of failure of gradual dilatation in the treatment of annular stricture, internal incision of the annular band may be practiced, provided that the stricture is quite limited in its extent. If the stricture is extensive in area, internal incision is not free from risk, because the contact of the large wound with pus and feces, in a position where free drainage is not obtainable, is liable to give rise to serious inflammation and burrowing of pus. When, however, a small and shallow incision is made in the lesser degrees of stricture, such untoward complications are not to be expected. It therefore becomes necessary in the more extended annular strictures and in tubular strictures, to perform linear proctotomy, which is a complete division of the rectal wall and the tissues behind it. After this operation granulation slowly closes the wound, while the caliber of the gut is maintained by the use of bougies. An incision is made, either from the skin or from the interior of the gut, which divides the stricture, the rectal wall below and all structures between the anus and the coccyx. The wound is packed with antiseptic gauze and frequently washed out with antiseptic solutions. Bougieing should begin at the end of the first week.

Bad tubular strictures are not amenable to treatment by any of these measures, though the simple form of tubular stricture may sometimes be so treated. Excision of the strictured portion of the rectum is possible, by making a resection of the coccyx and sacrum similar to the operation done for getting access to the rectum, when it is to be extirpated for high carcinoma. Temporary relief from pain and distress during defecation through the diseased gut is, however, obtainable by left inguinal colostomy, which establishes an artificial anus and permits the extrusion of the feces at that point. This operation gives great relief, and is not as serious a procedure as would at first be supposed. It should not be delayed until the patient is exhausted by suffering.

Malignant Disease of the Anus and Rectum.

Pathology.—Cylindrical epithelioma is the form of malignant disease which nearly always occurs in the rectum and at the anus, although sarcoma and scirrhus occasionally attack this locality. The malignant affection usually assumes an infiltrated form, though occasionally the growth is a distinct tumor, projecting into the caliber of the rectum, with the mucous membrane over it remaining for a long time free from ulceration. The infiltrated form begins between the mucous membrane and the muscular coat, and ulceration occurs quite early.

Symptoms.—Malignant disease of the rectum may be present for a considerable time before the symptoms are conspicuous; then pain, bleeding, muco-purulent discharge, diarrhœa and symptoms of stricture supervene. The clinical history of malignant disease of the rectal tube is, in fact, very like that of fibrous stricture or ulceration in the same locality. When the anus alone is attacked, the symptoms are similar to rectal disease, but are more patent. A diagnosis between malignant disease and fibrous stricture of the rectum is sometimes difficult. In the former condition, however, the mucous membrane between the seat of disease and the anus is usually less ulcerated than in stricture. The course of malignant disease also is more rapid than that of stricture of a non-malignant kind. A finger introduced into the rectum can feel the diseased area, if it be not more than four inches from the anus. Ordinarily the nodular character of the rectal wall is marked, although it happens sometimes that a soft fungous mass is felt.

Villous tumor of the rectum, which is an innocent growth, is soft and velvety to the touch, though thoroughly resistant. In this respect it differs from the fungous form of epithelioma, which is not resistant, has a harsh feel and is surrounded by indurated tissue. This subjacent induration is not found in villous tumor. The discharge from villous tumor is a sticky, rather clear, mucoid fluid; but it is not purulent and does not have a dark appearance like coffee grounds. These are characteristics of the discharge in case of rectal epithelioma.

Fistulous tracks connecting the rectum with the bladder, urethra or vagina are not uncommon in advanced malignant disease. Pressure of the malignant growth upon the iliac veins may cause œdema of the legs. Death occurs from exhaustion or from intestinal obstruction similar to that which takes place in fibrous strictures.

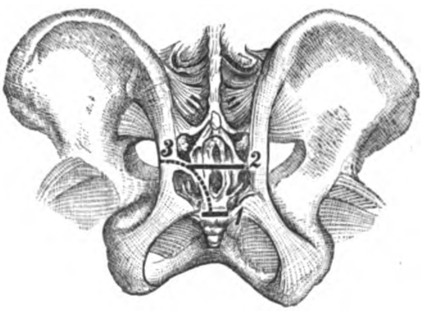
Treatment.—The treatment of malignant disease of the rectum should be directed to keeping the amount of fecal matter small and the bowels sufficiently loose to avoid impaction of fecal masses above the stricture or ulcerated surface. To this end food leaving small undigested residue and mild laxatives are to be employed. A small amount of opium is at times necessary as an anodyne. The anus should be kept free from irritation, due to contact with the acrid discharges, by frequent bathing and the use of oxide of zinc powder mixed with starch (twenty grains to the ounce), or of some other soothing application applied externally. Warm water enemas thrown over the seat of the disease by means of a small rectal tube or a catheter passed beyond the malignant mass will be of service by cleansing the rectum and facilitating evacuation of fecal matter lodged above the diseased area.

These palliative measures should not be relied upon, however, when it is possible to remove the diseased tissue by excision of the rectum. This operation is easy of accomplishment in suitable cases and gives great relief to the patient as well as prolongation of life. It is essential that the rectum be not tied down to the surrounding structures through malignant infiltration outside the rectal wall; and the general health of the patient should be in fair condition, before he is subjected to the risks of operative complications. Numerous cases are upon record in which there has been no return of the disease for a number of years after excision of the rectum.

Three or four days should be employed in getting the bowels emptied of feces and in cleansing the rectum with detergent enemas. In some cases it is well to do a preliminary inguinal colostomy a week before, in order to prevent contact of feces with the wound of operation, when the rectum is extirpated.

At the time of the operation the patient, whose bowels have been previously thoroughly emptied, is put in the lithotomy position. The sphincter and skin behind it are divided by a straight incision extending backward to the coccyx. A semilunar cutaneous incision is made around each side of the anal sphincter, beginning at the front of the posterior wound just made and terminating in the perineum in front of the anus. The finger is then inserted behind the rectum and used to tear up the attachments of the rectum posteriorly and laterally. The intestine is separated from the vagina or urethra and bladder in front by careful dissection with a knife, because the finger would be liable to do damage if used for that purpose. In men it is well to place a bougie in the urethra and bladder in order that the location of these structures may be clearly perceived. After the rectum has been thus detached from the surrounding tissues to a point above the seat of disease, it is drawn down and cut across with scissors at a point

FIG. 400.



Excision of the rectum: 1, with extirpation of the coccyx; 2, with transverse resection of the lower portion of the sacrum, after BARDENHEUER; and 3, with resection of the left border of the sacrum after Kraske. (Diagrammatic.) (TILLMANNS.)

about an inch above the disease. In this manner the rectal tube and sphincter muscle are completely removed. After hemorrhage has been stopped the wound is packed with antiseptic gauze. No attempt should be made to draw down the intestine and stitch it to the skin. Such a procedure interferes with drainage and is liable to do damage to the peritoneum above. The cavity slowly fills up with granulation tissue and a sort of pseudo mucous membrane is developed between the lower end of the intestine and the cutaneous surface. The patient regains control of the contents of the intestine in about two months. After the first two or three weeks it is well to use the bougie to prevent cicatricial contraction causing stricture.

When the malignant disease is situated in the upper part of the rectum, it is necessary to resect the coccyx or a part of the sacrum as well as the coccyx, to get access to the disease and accomplish radical removal. The patient is laid upon his right side, and a cut made in the median line from the middle of the sacrum to the anus. The coccyx is removed, the sacro-sciatic ligaments divided and the left side of the sacrum chiseled away from the level of the third foramen to the lower end. The nerves emerging from the foramina are avoided by making the excision along a line concave toward the left. The sacral canal is not opened. This opens the pelvis and exposes the rectum. The patient is then turned on his back and the diseased portion of bowel removed. The stump of bowel is sometimes stitched to the skin. It may not be possible to draw it down. Provision for free drainage must be made. The bowels should not be allowed to move for several days.

In those cases in which excision is not justifiable, left inguinal colostomy should be done, and not delayed too long, since it adds greatly to the comfort of the patient and prolongs life even in cases of great severity. It is to be employed to relieve pain due to the passage of feces over the ulcerated surface, as well as in cases of malignant stricture.

Non-malignant Rectal Tumors.

Pathology.—Fibrous and adenoid tumors having a pedicle are at times found in the rectum, and are then called rectal polypi. Fibroid rectal polypus is developed beneath the mucous membrane; while adenoid polypus originates in the mucous membrane itself and may have a very long pedicle. Rectal polypus is a comparatively rare disease, but is more common in children than in adults. The tumor is apt to be protruded at stool, when it may be mistaken for prolapse of the rectum or for piles. The fact that hemorrhage is one of the symptoms of rectal polypus adds to the liability of the disease being mistaken for hemorrhoids. Anal fissure is occasionally complicated with small rectal polypus.

Villous tumor of the rectum is an innocent growth, adenoid in character, but has a less marked pedicle than a polypus. It has been described in connection with rectal carcinoma. It may be present for many years without causing much disturbance, except a sensation of fulness in the rectum, and occasional hemorrhage.

Treatment.—The sphincter muscle of the rectum should be dilated, and the polypoid tumor drawn down and twisted off with strong forceps. Twisting of the pedicle is judicious in order to avoid the possible occurrence of hemorrhage. If the tumor is sessile such removal by torsion may be impossible, in which case clamping and cauterization, as employed in removing piles, may be used.

The proper treatment of villous disease is dilatation of the sphincter and removal of the growth with clamp and cautery or by ligation. Curetting may be attempted, if precautions are taken to avoid subsequent hemorrhage by packing the rectum thoroughly with gauze after the operation.

CHAPTER XXV.

DISEASES OF THE URINARY ORGANS.

DISEASES AND INJURIES OF THE KIDNEY.

Methods of Examination of the Kidney.

THE condition of the kidneys is determined by chemical and microscopic examination of the urine, general symptomatology, palpation of the renal region, inspection of the orifices of the ureters by cystoscopy and ureteral catheterization. Bimanual pressure upon the loin and hypochondrium will enable the surgeon to feel the kidney in persons not obese who lie supine with the abdominal muscles relaxed. As a deep inspiration is taken the kidney is forced down between the examiner's hands. In thin patients the tissues at the side below the ribs may be grasped with the fingers and thumb of one hand in such a way that the lower portion of the kidney is easily palpated as the diaphragm descends. The intestines should be empty and the patient should breathe quietly with an open mouth to relax the abdominal walls. Incision into the loin is an easy and not a dangerous way to inspect the kidney. When information is demanded this step is proper. Intraperitoneal examination is not often adopted, but is available. Catheterization of the ureters permits an examination of the secretion of each kidney separately. This information has been sought for by compressing one ureter with a finger in the rectum or vagina or a pad on the abdomen. The bladder is then washed out and allowed to receive the urine from one kidney alone for twenty minutes or more. By a lever put into the rectum to elevate the floor of the bladder, a sort of urinary watershed is created that keeps the urine from the two kidneys separate. The two specimens may be separately drawn off by a properly arranged double catheter. This is the principle of the ingenious instrument of Harris. The fluid escaping from each ureter can be seen by means of the cystoscope.

Congenital Malformations.

One kidney may be absent; or the two may be fused into one mass, sometimes having a horseshoe shape. There may be two ureters to one kidney, or the method of implantation of the ureter may be anomalous. The kidney may occupy an unusual position in the abdomen; or float about loosely, having a sort of mesonephron or pedicle. The usual place to find a misplaced kidney is behind the bladder or over the promontory of the sacrum. Cystic disease of the kidney may be congenital.

Movable and Floating Kidney.

Definition.—A movable kidney slides up and down and perhaps laterally, behind the peritoneum. It is unlike a floating kidney, which is usually a congenital condition and floats about within the peritoneal sac. The floating kidney has a sort of pedicle or mesonephron. The renal vessels are longer than normal in both cases. Before operation it is often impossible to differentiate one form from the other.

Causes.—In the acquired cases the condition is due to loose connective tissue attachments of a large kidney, injuries, traction or pressure of tumors or pregnancy. The condition is very common in women and particularly in those who have borne many children. Floating kidney is usually a congenital anomaly and movable kidney is usually acquired.

Symptoms.—Pain of varying intensity may prohibit bodily movements. It is of a dragging character and is often associated with mental despondency and digestive disorders. The patient has a sensation of a moving object in the abdomen. The pain may be relieved by pressure or certain postures. If the ureter becomes twisted or kinked by the movements of the kidney, intense pain, swelling of the renal pelvis and kidney and suppression of urine may occur. Hydronephrosis or renal atrophy may be thus induced. Palpation will perhaps reveal a movable tumor resembling the kidney in shape. This may be pushed into the normal site of the organ with the hands or may spontaneously resume it when the patient lies down. The movable organ is best felt when the patient stands up and bends slightly forward.

Treatment.—Imprudent muscular exertion should be avoided. Tight lacing of corsets is liable to increase the mobility. The kidney may perhaps be kept in position by an abdominal bandage with a proper pad. Keeping the patient recumbent for several weeks, until the increase of fatty tissue around the organ makes it more stable, may be judicious treatment in mild cases. The employment of measures to relieve the neurasthenic symptoms, improve the digestion and get the patient interested in other matters than her own sensations will often lead to a cessation of pain and anxiety. In severe cases and those not thus cured, nephropexy, sometimes called neprorrhaphy, is proper. In this operation an incision is made in the loin, and the kidney is stitched to the lumbar fascia by means of three or four silk or formaldehyde catgut sutures passed through the capsule and substance of the kidney. The stitches should be about a half inch apart. If this fails and the serious nature of the case demands it, removal of the organ may be justified, if the certain existence of the second kidney is first established.

Hydronephrosis.

Pathology.—Hydronephrosis is a distention of the pelvis and calices of the kidney, due to an accumulation of urine from congenital or acquired obstruction in the urinary passages. The mechanical interference with the current may be partial or complete, and situated anywhere between the kidney and the urinary meatus. The obstruction is most commonly found in the ureter; and may be a renal calculus impacted in that, tube pressure from a tumor outside of it or a stricture of the ureter. An over-distended bladder, a stricture of the urethra or phymosis may cause hydronephrosis. The substance of the kidney may atrophy as the result of pressure; the ureter and kidney may be converted into a huge sac with thick walls and external adhesions; and the contents may suppurate, converting the hydronephrosis into a pyonephrosis. Rupture may occur, or the sac may empty itself intermittently into the bladder. The fluid is usually urine of low specific gravity, but may become colloid or grumous material.

Symptoms.—The symptoms depend on the cause. Acute obstruction, as in twisting of the ureter of a floating kidney, causes great pain and sudden appearance of a tumor. Chronic obstruction gives rise to few symptoms until the swelling becomes apparent. Increased percussion dulness in loin and abdomen, decrease in urine, and a lobulated, fluctuating tumor with the colon lying in front of it would suggest hydronephrosis. General symptoms are usually absent, unless uræmia occurs from interference with excretion in double hydronephrosis. Sudden subsidence of the tumor with passage of a large amount of urine would make the existence of an intermittent hydronephrosis probable. A ruptured cyst would give characteristic symptoms and a probable secondary peritonitis.

Treatment.—Relief of obstruction is sometimes possible and this cures the condition. Gentle massage may remove an obstructing blood clot or small calculus in the ureter. In other cases incision and drainage through the loin or abdomen is the proper operation. This may leave a urinary fistule, for the cure of which nephrectomy may subsequently become necessary. Dilatation of the ureter may be possible by catheterization from the bladder; or plastic operations may enlarge the caliber of the ureter or remove a valve like obstruction. Aspiration alone is not likely to make a permanent cure. Congenital hydronephrosis is apt to be fatal.

Suppurative Inflammations.

Pathology.—Non-suppurative inflammations of the kidney belong to the domain of medicine. The upper urinary organs are subject to three forms of bacterial infection, which are important to the surgeon. They are gonorrhœal, septic and tuberculous. The micro-organisms gain entrance to ureter, renal pelvis and the kidney itself by wounds, by the blood current, and, especially, by ascent along the mucous membrane of the urethra, bladder and ureter.

Ureteritis and nephritis are terms used to signify inflammation of the ureter and kidney respectively. Pyelitis is the term used to indicate inflammation of the pelvis of the kidney. Any one of these conditions may be present without the other; but it usually happens that sooner or later the process involves the adjacent portion of the urinary tract. Compound terms are employed to indicate this occurrence; thus pyelo-nephritis. When a sac is formed from the pelvis, ureter and kidney and contains pus, the condition is called pyonephrosis. It is a combination of obstruction to escape of urine and suppuration. As the three infections cause suppurative or quasi suppurative conditions, they may be considered together. The resulting pathological changes in the kidney are enlargement, purulent or cheesy deposits and degeneration. A kidney, the seat of these changes, was formerly called a "surgical kidney," without much knowledge of its causation or pathology. Suppuration occurring around the kidney in its fatty envelope is called a perinephric abscess and may accompany or exist independent of suppurative nephritis. It must also be remembered that catarrhal inflammations of the ureter and pelvis of the kidney may occur, which do not go on to suppuration. The suppurative conditions may be acute or chronic. Tubercular nephritis is usually chronic.

Symptoms.—Gonorrhœal pyelitis occasionally arises secondary to gonorrhœal cystitis and ureteritis; and is exhibited by chills, fever, pain, tenderness in the renal region and along the ureter, and the passage of purulent urine. The cytoscope will show the pus flowing from the ureteral orifice into the bladder. The pain may be felt down in the scrotum and testicle.

Suppurative nephritis may be caused by infection of the kidney itself and the abscess so caused may require active surgical treatment. Perinephric abscess may be a secondary result of gonorrhœal pyelitis.

Septic pyelitis, pyelo-nephritis and nephritis are not infrequent results of septic cystitis, accompanied by interference with urination from calculus, enlarged prostate and stricture of the urethra. The possibility of these conditions having occurred secondarily should be remembered in the treatment of all chronic affections of the bladder; and especially when the patient is beyond middle life. All operations on the urethra and bladder should be done aseptically to prevent the occurrence of these complications.

The symptoms in acute cases are the same as those just mentioned in gonorrheal infection of the same structures; in chronic cases the advent of the disease may be unnoticed, for the bladder symptoms will be so much more prominent. Septic invasion of the kidney, pelvis and ureter may occur from injury; from the blood current in some general infection; and as a complication of the injurious irritation of a renal calculus. Typhoid fever, osteomyelitis, diphtheria and pyemia are perhaps the septicæmias most likely to cause septic nephritis and pyelitis. In the great majority of cases the disease is an ascending affection due to septic invasion through the urethral route.

Treatment.—The treatment of these conditions is cure or amelioration of the causative affection, with the internal administration of salol, boric acid, benzoic acid, santal oil and other antiseptics; the external application of guaiacol or counter irritants; and, if possible, irrigation of the pelvis, of the kidney with sterile salt solution or antiseptics by catheterization of the ureters. Sometimes permanent drainage of the bladder by cystotomy may lessen the inflammation in the upper portion of the urinary tract. These measures may be beneficial in the catarrhal cases or suppurative cases of mild degree; but when abscesses have formed in the kidney, they are of little service. Then lumbar nephrotomy and drainage are proper. Subsequently nephrectomy may or may not be required. In calculous pyelo-nephritis lumbar incision and nephro-lithotomy should be done as soon as a diagnosis is made. In septic cases not due to calculus, the tendency is to delay operation too long. Supportive measures are always indicated in these asthenic conditions. When pyonephrosis occurs, whether secondary to hydronephrosis or to pyelitis, incision and drainage is the only rational treatment. The loin usually affords a better route than the abdomen. After the pus has been emptied and the sac has had time to shrink, it may be well to consider the propriety of nephrectomy. It is generally best to defer this graver operation until the constitutional disturbance due to the suppuration has subsided under drainage. The nephrectomy is then easier and safer.

Perinephritis.

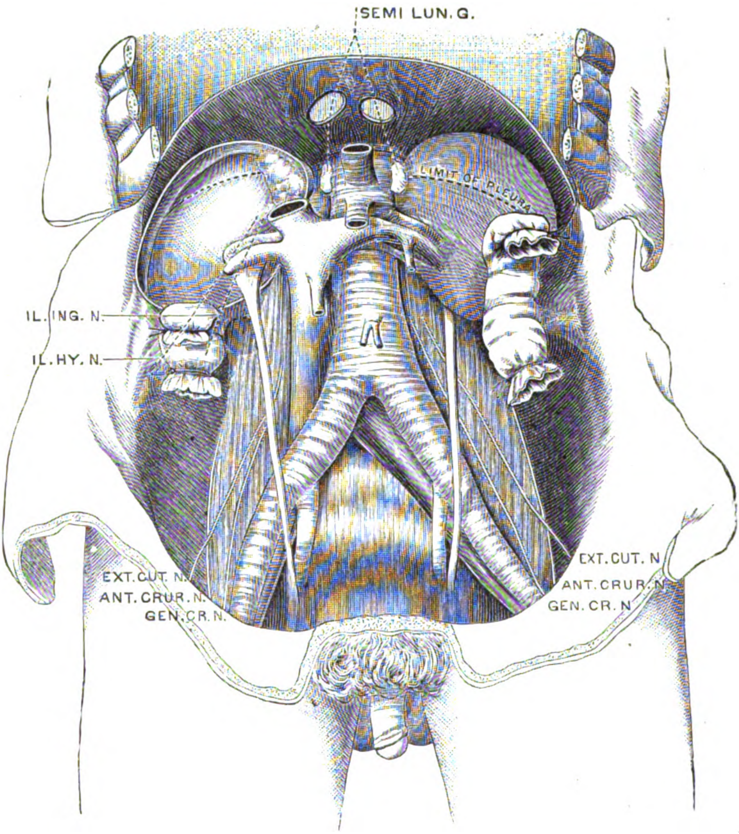
Definition.—Inflammation of the cellulo-adipose tissue surrounding the kidneys is called perinephritis; and may be plastic or suppurative. In the latter case a perinephric abscess results.

Pathology.—The affection may be secondary to septic or gonorrhœal pyelitis or nephritis, tuberculosis of the kidney, injuries of that organ and renal calculi, or to inflammatory diseases involving the retro-peritoneal space originating in the appendix or other abdominal organs. It may be secondary to purulent inflammation of the pleura; or to infective causes in the urethra, bladder or ureter. It is seldom a primary disease. In the suppurative form the pus may burrow extensively; and yet leave the kidney free from involvement, if no disease originally existed in that organ.

Symptoms.—Pain in the loin, similar to that of gall stone and not unlike that of appendicitis, may be a marked symptom. Increased dullness, a sense of resistance on palpation, local œdema or swelling in the loin, retraction of the testicle, flexion of the hip from psoas spasm, radiating pain accompanied perhaps by a dull aching in the region of the kidney, irritability of the bladder and pleuritis at the base of the lung are symptoms of perinephritis. If perinephric abscess occurs, the constitutional and local symptoms of pus arise; otherwise the symptoms disappear as resolution occurs. The abscess may rupture externally or into the peritoneal cavity, thorax or one of the adjacent hollow viscera. The spasm of the psoas muscle may simulate incipient tubercular coxitis.

Treatment.—Counter-irritation, local depletion by leeches or cups and treatment of the causative condition will be beneficial in non-suppurative cases. If pus is about to form or has formed, a free lumbar incision should be promptly made and drainage by a large rubber tube established. The incision will relieve tension and deplete the inflamed

FIG. 401.



The perinephric region. (From a dissection by the Author.)

tissue even if pus has not yet been formed and will therefore be beneficial. Search should be made for calculi or pus pockets in the kidney and its pelvis, at the time the incision is made. Urinary fistule is not common, after this operation, unless there is disease of the kidney.

Tuberculosis of the Kidney.

Tuberculosis of this organ may occur as part of a general tuberculosis, but it is then of little surgical import. It is the localized infection that usually comes to the surgeon's notice. It may be primary and cause infection of the ureter, bladder and lower urinary tract; or the disease may occur below first. It is said to occur at any period of life, but more frequently in youth. The symptoms are indefinite, until pus and blood in the urine, dull pain in the loin, and perhaps attacks of renal colic, from plugs of cheesy material obstructing the ureter, attract attention. Calculi in the kidney or its pelvis are sometimes associated with renal tuberculosis. Tubercle bacilli may be found in the urine but their detection is difficult. A large tumor may form from the infiltration of the kidney with tubercular material and inflammation of the perinephric tissue induced secondarily. The amount of blood in the urine is less than often occurs in simple renal calculus; but the physical depression in tuberculosis is greater. The disease may be bilateral. The treatment is that which is usual in tuberculosis elsewhere, with nephrotomy to remove the puriform and cheesy deposits by irrigation and curetting. Nephrectomy is often advisable if the integrity of the other kidney is assured.

Renal Calculus.

Pathology.—Stone in the kidney may occur at any age, and is occasionally a congenital condition. Renal calculi vary in size from sand-like particles to a mass weighing one or more ounces, and in number from one to hundreds. Uric acid, urates and oxalates are the substances of which kidney stones are usually composed; but they may consist of phosphates, cystin or xanthin. A predisposition to the deposit of uric acid or conditions tending to cause decomposition of the urine are the usual causes of calculus. Inflammatory affections of the pelvis or kidney may therefore induce their occurrence. A blood clot, a mass of mucus or pus or a particle of tissue may serve as a nucleus upon which the urinary salts are deposited. The calculus may be formed in the substance of the kidney or in the pelvis, may remain quiet in its original site, cause ulceration and be discharged into the perinephric tissues, pass down the ureter into the bladder, or become impacted in the ureter causing hydronephrosis or partial obstruction. If the stone reach the bladder, it may remain there and become the nucleus of a cystic calculus or may be extruded through the urethra. The passage of the stone along the ureter is liable to cause spasmodic pain called renal colic. This may also occur from unsuccessful attempts of the stone to leave the pelvis and enter the ureter. Suppurative conditions are often associated with the presence of calculi in the kidney or pelvis. A small stone in the substance of the kidney is likely to give more pain than a larger one in the pelvis, unless it obstruct the opening into the ureter.

Symptoms.—Nephro-lithiasis, or the formation of renal calculi, gives rise to pain, hematuria, pyuria, passage of calculous material in the urine, frequent urination, attacks of colicky pain in the region of the ureter, nausea, vomiting and diminution or suppression of urine. The pain in the lumbar region is often increased by motion or jarring such as occurs when riding in a wagon or railroad car, and frequently radiates to the testicle, penis or thigh. Deep percussion of the loin may cause stabbing pain. The colic of renal concretion may occur when the stone is not in the ureter; and is then probably a spasm due to irritation of the pelvis. Renal colic may simulate intestinal colic and be associated with similar digestive symptoms. The urine may contain albumin or other evidences of inflammation; and sometimes shows an excess of the chemical constituents of which the concretion is formed. The use of skiagraphy may show the presence of a stone. Some calculi cause no marked shadow when subjected to the X-rays.

Attacks of renal colic may come on when no disease of the urinary organs was suspected. In gouty subjects this occurrence is not very rare. Exertion may have brought on the attack, but no such cause need be present. The intense pain may cause chill, sweating, vomiting and syncope, and is accompanied by tenesmus of the bladder, frequent desire to urinate and the passage of bloody urine. The passage of the stone into the bladder or its return to the pelvis, if it have only entered the ureter, is followed by instant relief of the agonizing pain. Pain in the kidney without an evident lesion has been called nephralgia or neuralgia of the kidney.

Treatment.—Renal colic should be treated with anodynes, hot applications to the loin and abdomen and even general anæsthesia. An impacted stone may demand ureterotomy by the lumbar or abdominal route. The tendency to the formation of stone in the kidney should be counteracted by regulation of the diet, abundant exercise and the ingestion of large amounts of water, as is wise in gouty conditions in other regions. Small concretions may be washed out of the kidney and the formation of others may be perhaps prevented. Acetate or nitrate of sodium or of potassium may be employed. Piperazine and lithium salts may be tried. The presence of a stone evidently too large to pass along the ureter calls for the operation of nephro-lithotomy. The incision is made in the loin, and the pelvis and kidney explored. If a stone is felt, an incision is made into the pelvis or kidney, and its removal effected. If no calculus is felt, the pelvis should be opened and the finger or a probe introduced into the calices. It is well to pass a flexible probe down the ureter into the bladder, lest an impacted stone be the cause of the symptoms. Nephrotomy has relieved pain in the kidney when no stone and no evidence of lesion was found. It has been suggested that this pain might be due to a swollen kidney and that incision cured the condition by relieving tension.

Tumors of the Kidney.

Renal tumors may be cystic or solid. The former are retention cysts, hydatid cysts or examples of extensive cystic degeneration. The fœtal cystic kidney is frequently bilateral. Hydatid disease is a rare parasitic affection in this country. The cyst may become very large and presents symptoms similar to those seen in hydatid disease elsewhere. Hydronephrosis and pyonephrosis cause great increase in the size of the kidney and its pelvis, but are not properly classed as tumors. The symptoms of cystic tumor of the kidney, except in the case of large hydatid cysts, are obscure. In hydatid disease the characteristic hooklets of the echinococcus or daughter cysts may occasionally be found in the urine or in the discharges occurring from a ruptured cyst. When treatment is demanded, incision of the cyst, of whatever kind it may be, evacuation, drainage and stitching of its wall to the skin are proper.

Solid tumors of the kidney are benign or malignant. The former are not common, but include fibromas, myxomas, lipomas and adenomas; and usually originate in the tissue around the kidney. The latter include both carcinomas and sacromas. If primary, they remain a long time enclosed in the kidney capsule before invading surrounding tissues. The symptoms are obscure, except when the growth has become large. Pain, bloody urine, swelling, sometimes the presence of portions of the growth in the urine and loss of health may aid the surgeon in making a diagnosis. Exploratory incision is often the only method of reaching a definite conclusion. The treatment is nephrectomy.

Wounds of the Kidney.

Wounds of the kidney, whether open or subcutaneous, are serious lesions, because of the vascularity and important function of the organ and its relation to the peritoneum and large blood vessels. Hemorrhage, urinary infiltration, uremia and septic peritonitis are complications liable to occur when the kidney is injured. Contusion and laceration may occur without external wound; and gunshot, incised and other deep wounds may cause the renal injury to be connected with a wound of the skin. Septic infection is then probable. The symptoms are shock, nausea and pain; escape of blood from the wound in the skin or from the bladder during urination, or into the retroperitoneal space or the peritoneal sac; obstruction perhaps of the ureter or bladder with blood clots; suppuration and sloughing from extravasation of urine around the kidney; septic peritonitis, and fluctuation due to urine and blood behind the peritoneum. Injuries not involving the peritoneum are less dangerous than those in which the peritoneal sac is in communication with the damaged kidney. Suppression of urine or uremia may supervene, or urine may escape from the external wound.

Treatment consists in stopping hemorrhage, which may cause death by anæmia, though no external bleeding is noticeable; preventing extravasation and decomposition of urine, and averting septic inflammation. The kidney should be exposed by a lumbar incision, if the peritoneum is known to be intact; by an abdominal incision, if the opposite condition is probable. Tears or cuts in the kidney should be sutured which will stop parenchymatous bleeding, large vessels should be ligated or clamped, wounds in the pelvis and ureter stitched, and provision for drainage made. Kidney wounds heal easily, those in the pelvis or ureter may leave a fistule or be slow in closing permanently. If the kidney is badly damaged, the hemorrhage from the large vessels may demand nephrectomy.

OPERATIONS UPON THE KIDNEY.

Nephropexy.

Nephropexy, or fixation of a movable kidney, should not be termed nephrorrhaphy, which is properly a suturing of a wound of the kidney. The latter term is, however, still used for stitching the kidney to the lumbar fascia. The patient is laid upon the abdomen and unaffected side, with a hard pillow placed under the abdomen in such a way as to make the space between the twelfth rib and iliac crest as wide as possible over the movable kidney. A four and a half inch incision is then made parallel to the twelfth rib and about a finger's breadth below it. This is deepened until the fatty envelope of the kidney is reached. The kidney is then uncovered and stitched to the lumbar fascia, by four or five sutures of chromicized or formaldehyde catgut introduced by means of a curved needle. The stitches should go into the kidney substance. The sutures are cut off short and the wound closed, with a drainage tube in its lower angle. The patient should remain in bed for four or five weeks and lie on the back so as to avoid displacement of the organ while the adhesions are recent. It is important to cut *below* the twelfth rib.

Nephrotomy and Nephro-lithotomy.

Incision of the kidney, called nephrotomy, is done to open cysts or abscesses, to remove renal calculi, to explore the organ or its calices and pelvis for calculi and to drain tubercular cavities. The incision is that mentioned for nephropexy. More room may be obtained by adding to the oblique incision a second cut from its center to the iliac crest. When the kidney has been exposed, the cyst or abscess is laid open and drainage by means of a rubber tube established. If the sac is large, it should be stitched to the parietal wound. If a calculus is felt in the pelvis or substance of the organ, an incision is made directly over it and it is removed. This operation is termed nephro-lithotomy. If the presence of a calculus is suspected, the kidney, lifted from its bed, is held by the left hand and a split made into it along its convex edge. This must be long enough to admit the finger, which is inserted to explore the kidney, the calices and the pelvis. The bleeding from the kidney substance soon stops under pressure, though it is at first abundant. The external wound is closed after the insertion of a drainage tube, which is to be removed in a few days. Nephrotomy by the abdominal route is unusual, except when a cyst is large and projects forward. Urinary fistule after nephrotomy is rare, unless the calculus has not been removed or the suppurative disease persists.

Nephrectomy.

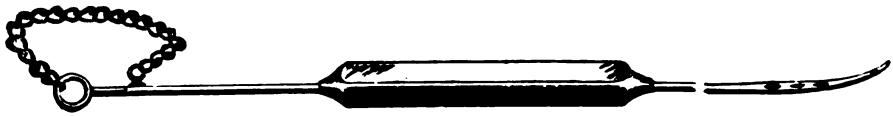
Nephrectomy, or removal of the kidney, should never be undertaken until the presence of a second kidney is proved by catheterization or inspection. The lumbar route is preferable to incision through the anterior abdominal wall; the latter is only to be adopted when the kidney is greatly enlarged, or when injury to other viscera or the necessity of inspecting the other kidney make cœliotomy desirable. The double incision just described is made, the kidney isolated, and the pedicle secured by strong silk ligatures. If possible, the renal artery and the ureter should be tied separately. The stump of the latter should be sterilized by being cauterized with undiluted carbolic acid. Care should be taken not to drag too vigorously on the vessels during these manipulations. The operation is performed for tubercular and malignant disease, sometimes for chronic suppurative nephritis, and occasionally for extensive laceration of the kidney. It is possible to remove nearly the whole length of a diseased ureter at the same time. Abdominal nephrectomy is performed by an incision in the median line or over the kidney. The colon is pushed outward, the posterior layer of peritoneum divided and the kidney exposed. The vessels and ureter are then ligated and divided. The stump of the ureter is buried under the peritoneum. A counter-opening through the loin may sometimes be advisable for efficient drainage of the hollow left by the extirpation of a diseased kidney.

DISEASES AND INJURIES OF THE URETER.

The ureter may be obstructed by impacted renal calculi, blood clots, fragments of tumor or tubercular deposits from a diseased kidney, or by a cicatricial stenosis due to injury or inflammation. Its affections are usually secondary to disease of the bladder or kidney. It may be ruptured subcutaneously or wounded in abdominal and pelvic operations and injuries. Obstruction causes symptoms similar to those occurring in renal colic; injury causes extravasation of urine, which may lead to peritonitis or a fluctuating tumor followed by sloughing of the tissues. If a ureter has been wounded in abdominal or pelvic operations, the wound should be closed by Lembert sutures. If it has been completely divided, it should be implanted into the bladder or into the lower portion of itself. In the former operation, a small incision is made in the bladder wall and the upper end of the cut ureter pushed through it and stitched firmly to the peritoneal surface of the bladder. The lower end of the ureter should be ligated, to prevent urine escaping from the bladder by regurgitation. Instead of implantation into the bladder, the lower end of the divided ureter may be tied and the upper end inserted into a lateral slit made in the lower portion below the point of ligation. Sutures will retain the two portions in their new relation and adhesive imflammation make a permanent union. Subcutaneous injuries causing extravasation of urine in the tissues of the back require a deep lumbar incision for drainage. If the urine flows into the peritoneum, cœliotomy and drainage must be immediately instituted.

Catheterization of the ureters is performed in women by putting the patient in the knee-elbow position, dilating the urethra, inserting the finger, and passing a ureteral catheter along the floor of the bladder under direction of the finger. This may be more easily done, by using a urethral speculum and a head mirror to locate the orifice of the ureter. In the male ureteral catheterization is more difficult. It can be done by special combinations of the cystoscope and the ureteral catheter; or by opening the bladder first by the suprapubic or perineal route. Inspection of the condition of the orifice of the ure-

FIG. 402.



Ureteral catheter.

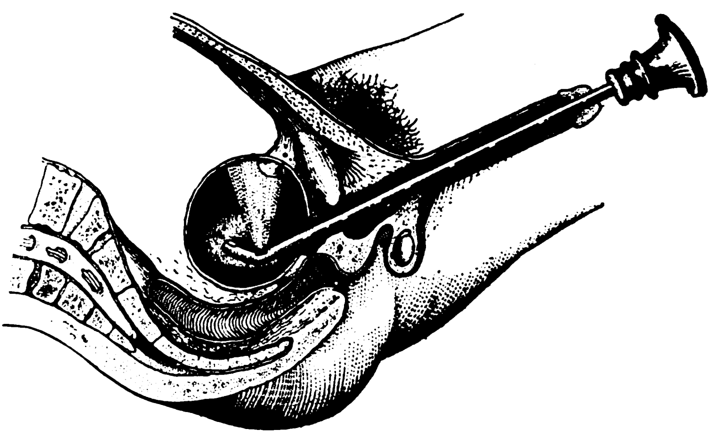
ter is easily accomplished by means of the cystoscope. Ureteral catheterization is employed to obtain and test the secretion from one kidney, to diagnosticate obstruction, to medicate the renal pelvis and to render prominent the position of the ureters and avoid injury during intra-abdominal operations.

DISEASES AND INJURIES OF THE BLADDER.

Methods of Examination.

The bladder is explored by the introduction of a metal instrument, called a sound or stone searcher, with which irregularity of its wall or

FIG. 403.



Illumination of anterior vesical wall by Nitze's cystoscope.

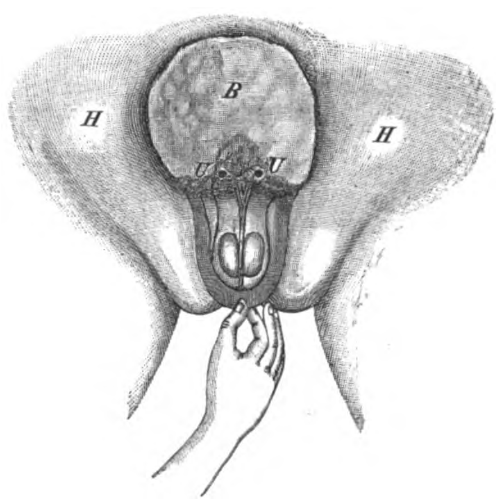
a contained body, like a calculus or tumor, is recognized. Palpation by means of a finger in the rectum, or vagina and bimanual examination, with one hand on the hypogastrium while a finger of the other hand is in the vagina or rectum, may at times furnish valuable information. Dilatation of the female urethra will permit the introduction of an examining finger. A similar exploration in men can only be made after suprapubic or perineal cystotomy. The electric cystoscope, which consists of a hollow tube, or small telescope, with a prism and an electric lamp at the end, permits the interior of the bladder to be seen and changes in its color or contour determined.

Congenital Malformations.

The chief malformations of the bladder are absence of the anterior wall, called exstrophy, a division of the viscus into two cavities by a septum, and persistent patency of the urachus.

Exstrophy of the bladder is due to incomplete union of the anterior wall of the abdomen and of the bladder in the middle line. There is an absence of union of the pelvis at the symphysis of the pubes and often a condition of inguinal hernia on one or both sides. In the male the penis is usually in a condition of epispadias. The deformity occurs more frequently in males than females. The deformity of the genital organs associated with exstrophy of the bladder may cause the true sex of the child to be mistaken. Cases of supposed hermaphroditism are usually instances of exstrophy of the bladder. The intra-abdominal pressure usually causes the posterior wall of the bladder to bulge forwards through the unclosed anterior wall and appear as a red prominence, between the imperfectly developed penis or vulva and the site of the navel. The navel may be absent. The mucous membrane of the bladder becomes inflamed from exposure to friction and the urine, which is seen escaping from the ureters, trickles over the perineum and thighs.

FIG. 404.

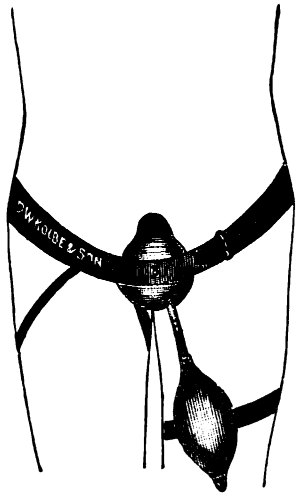


Exstrophy of the bladder combined with epispadias: *B*, posterior wall of the bladder; *U*, orifices of the ureters; *H*, inguinal hernia on each side. (TILLMANNS.)

The condition of the patient is a distressing one. The deformity may be alleviated by a plastic operation when the child is old enough; or some form of urinal made of rubber may be worn.

Patent Urachus.—The tubular canal which in the fœtus leads from the top of the bladder to the umbilicus may not become obliterated. If it remain patulous throughout its entire length urine may escape from the navel during urination. It may remain tubular in only a portion of its extent, and the condition be unsuspected until it is revealed during an abdominal section late in life. The occurrence of cystic dilatation of a patent urachus, and the extrusion of calculi from it at the navel are possibilities to be remembered. Eczematous irritation at the umbilicus should arouse a suspicion that the urachus may not have been obliterated. If a patent urachus is divided in a cœliotomy it must be ligated or sutured lest the urine escape from the bladder and cause peritonitis. If a patent urachus give annoyance it may be dissected out, ligated close to the bladder, and thus excised.

FIG. 405.



Urinal for exstrophy.

Displacements of the Bladder.

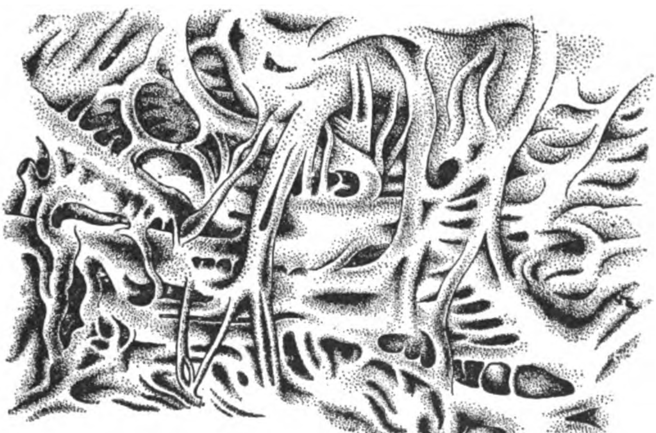
The bladder may be inverted through the urethra, causing a red tumor with a constricted base, from the surface of which mucus and urine flows. This condition is seldom seen except in children. The bladder wall, which has been turned inside out, should be gently reduced through the urethra by manipulation. Part of the bladder may be contained in large scrotal or inguinal hernias. Women who have borne children, especially if the perineum has been torn, may have the bladder sag downward into the vagina and even protrude from the vaginal outlet. This condition, called cystocele, is to be treated by removing elliptical portions of the vaginal mucous membrane over the bladder and stitching the edges of the wound so made. The perineum should also be reconstructed by a plastic operation.

Cystitis.

Pathology.—Inflammation of the urinary bladder, termed cystitis, may be acute or chronic, superficial or interstitial, and may be sufficiently severe to result in gangrene. It is due, except in the localized form which is the result of an aseptic wound, to bacterial infection. The colon bacillus and other pyogenic organisms, the gonococcus and the tubercle bacillus are the usual causative agents. It appears to be established that cystitis does not occur in a normal bladder even when pyogenic bacteria reach its mucous membrane, unless the normal resistance of the tissues has been lowered by some disturbance of nutrition or circulation. This lowered resistance may be produced by retention of urine, calculus, enlarged prostate gland, tight urethral stricture and paraplegia. The deduction from this statement is that cystitis not due to the gonococcus or the tubercle bacillus is always a secondary condition ; and hence the surgeon should seek with diligence for the primary affection. This is usually localized in the genito-urinary tract; but may be constitutional, as in the cases due to lithæmia. Primary infections in the urethra, ureters or kidney will usually be found to have existed before the cystitis occurred; unless septic instruments have introduced the germs into the bladder, or an injury has permitted easy transit from the bowel. Infection through the blood stream is possible, but uncommon. It is believed by some that the ingestion of cantharides and the terebinthinate preparations may cause cystitis. This is probably erroneous. The so-called catarrhal cystitis, not due to bacterial causes, is probably apocryphal. Abscess of the bladder walls, pericystic inflammation and a diphtheritic inflammation leading to desquamation and necrosis of the epithelium and mucous membrane may occur.

Symptoms.—All forms of cystitis are characterized by frequency and urgency of urination, pain in urination and the constant presence of pus in the urine. The acute form is accompanied at times by chills, fever, and severe burning pain in the bladder and perineum, extending to the head of the penis and down the thighs. The bladder may endeavor to empty itself every few minutes, even if it contains very little

FIG. 406.



Internal appearance of the bladder in some cases of inveterate cystitis; mucosa sacculated by columns of hypertrophied submucous and muscular tissue. (LAUNOIS.)

urine. This vesical tenesmus is accompanied by increased pain. There may be, on the other hand, retention of urine; the passage of a little blood as the last drops of urine are voided; or spasmodic contraction of the sphincter, so that only a little urine escapes at each attempt to empty the bladder. At the beginning of the disease the pus in the urine may be scarcely recognizable; but soon the urine becomes cloudy or milky, very fetid, highly ammoniacal, and separates on standing into a thick, tenacious precipitate of pus, mucus and crystals and a thin, supernatant liquid. Pressure on the hypogastrium is very painful. Recovery occurs in about two weeks, the acute inflammation is succeeded by the chronic form, or death takes place. The prostatic urethra is often inflamed when cystitis is present.

The symptoms in chronic cystitis are similar, but not so urgent. There are usually no marked constitutional symptoms, unless an acute exacerbation occurs. The bladder symptoms are often combined with the special symptoms of a causative urethral stricture, vesical calculus or tumor. The frequency of urination in chronic cystitis may amount to incontinence. The bladder wall finally becomes thickened, and irregularly ribbed and sacculated on its mucous aspect; and the cavity of the viscus much diminished by the contraction and hypertrophy of the muscular wall. Chronic cystitis is often intractable and lasts for years, finally leading to secondary inflammation of the ureters and kidneys.

Nervous irritability, unaccompanied by inflammation, occurs in neurasthenic patients, and needs treatment directed to the nervous system and mind. It is sometimes associated with lithæmia.

Treatment.—The cause of the cystitis, or prostato-cystitis, must be removed to insure cure or improvement; but the patient's sufferings may be alleviated by treatment while the cause is being sought. In acute cases, rest in bed, with the pelvis elevated, leeches to the perineum and hypogastrium, hot fomentations to the same regions, and hot hip baths will relieve pain and perhaps encourage the flow of retained urine. Catheterization to relieve retention may be necessary, but is exceedingly painful. Alkaline drinks to dilute and lessen the acidity of the urine and laxatives will often be useful. Anodynes by suppository will give comfort and relieve the vesical tenesmus. As it is the decomposition of the urea which furnishes the ammonia found in ammoniacal decomposition of urine, an attempt should be made to lessen the excretion of urea by rest and excluding meat from the dietary. An exclusive milk diet is valuable.

Potassium citrate, salol, boric acid, benzoic acid, santal oil, copaiba, buchu and pareira are useful internal remedies in chronic, as well as acute, cystitis. If this line of treatment fails, irrigation of the bladder is indicated in chronic cases. A soft rubber catheter should be used with gentleness. It is wise to wash out the urethra before entering the bladder. This is done by allowing a warm normal salt solution to flow gently, from a fountain syringe, into the urethra and escape alongside of the catheter as it is gently pushed inward. This renders the introduction of germs into the bladder less probable, and is wise before the introduction of an instrument into the bladder for any purpose. Then the bladder is washed out by the introduction of a fluid ounce and a half or two fluid ounces of the solution selected for local medication. This is the quantity to be introduced, which should be allowed to flow out before any more is introduced. Repeated irrigations with this small quantity is better than an attempt to have a large amount introduced. Solution of silver nitrate (gr. j–v ad f℥j) is the best medicament.

The weaker solution should be used at first. The pain from using a weak solution will soon subside. Solutions of potassium permanganate (1 : 2000) or carbolic acid (1 : 500) may be employed. Great pain and irritability in cystitis may be temporarily relieved by injecting into the bladder a solution of morphia (gr. j ad f℥j) or cocaine hydrochlorate (gr. v ad f℥j). Of the latter fifteen drops deposited with a deep urethral syringe at the neck of the bladder will be sufficient. These remedies must be used with caution.

It has been stated that salol in doses of five or ten grains three or four times a day may be useful in rendering the urine antiseptic ; and it has been proposed to administer this drug, boric acid or some similar remedy several days prior to operative treatment upon the normal or inflamed bladder.

When the treatment outlined has been ineffectual, in either acute or chronic cases, the bladder must be put at rest and freely drained by a perineal or suprapubic cystotomy. In cases of foreign body, calculus or tumor within the organ, the suprapubic route is usually best. After cystotomy and the insertion of a drainage tube, daily irrigation is employed.

Tuberculosis of the Bladder.

This condition is not as rare as was formerly supposed. It is usually secondary to tuberculosis in the kidney, epididymis, prostatic urethra or elsewhere. The symptoms are like those of calculus ; but bloody urine is more common than in vesical calculus. Severe hemorrhage indicates that ulceration of the mucous membrane has occurred. The early symptoms are often insidious. The detection of tubercle bacilli in the urine is very difficult. Cystoscopic examination may show miliary deposits or ulceration. The pain is said to be referred to the middle of the penis instead of being felt at the end of the organ as in vesical stone. It has been averred that cases of cystitis in which the urine when aseptically drawn gives no cultures on ordinary nutritive media, are probably tuberculous. The treatment consists in building up the general health, putting the bladder at rest by suprapubic lithotomy and perhaps curetting the tubercular wall. Guaiacol and creosote are recommended as internal remedies.

Vesical Neuroses.

Neuralgia, nervous irritability, paralysis and atony of the bladder are conditions usually due to general causes. They may be misnomers, the result of a careless or unsuccessful search for the cause of the symptoms. Incipient tuberculosis or inflammation of the bladder or an unrecognized peripheral irritation, such as anal fissure, may be the cause of the symptoms.

Tumors of the Bladder.

Pathology.—Vesical tumors are not rare. The chief varieties are papillomas and fibromas, which are benign, and carcinomas and sarcomas which are malignant. They may be pedunculated or sessile, if growing from the internal surface of the wall. When the bladder is involved secondarily by malignant disease of neighboring organs, the wall becomes infiltrated externally. Intravesical neoplasms have a tendency to occur near the base of the bladder. They may become encrusted with urinary deposits and resemble calculi.

Symptoms.—The symptoms are hemorrhage, pain and the evidences of cystitis. The bleeding, which occurs whether the tumor be benign or malignant, differs from that seen in stone in the bladder, by occurring independently of exercise, being abundant and showing a tendency to increase in frequency. The bladder may become full of clots. The pain is reflected, as in foreign bodies in the bladder, to the genitals, rectum and thighs, and is greater in malignant than in non-malignant growths. Pieces of the tumor may obstruct the urethra and give great pain by causing retention of urine.

Cystitis occurs as a complication, though often not until late. The diagnosis between a benign and a malignant growth is often impossible. A tumor in a young person causing much bleeding but little pain is likely to be benign; one in an old patient causing constant and severe pain is probably malignant. The diagnosis between tumor, stone and tuberculosis is often difficult. Digital examination by rectum or vagina, aided by pressure in the hypogastric region, may show a thickening in the bladder wall. In women the finger may be introduced through the dilated urethra for exploratory purposes. In the male a suprapubic incision is sometimes made for this purpose, and utilized for the removal of the growth if one be found. The extrusion of pieces of the tumor through the urethra, and inspection of the growth by means of the cystoscope are conclusive. Benign tumors are said to be more likely to have a pink color, and malignant ones a gray color when seen with the cystoscope.

Treatment.—The treatment consists in relieving pain and hemorrhage by the usual methods and removing the growth as early as possible by a suprapubic opening. Localized growths should be scraped out or excised, with some of the bladder wall if necessary. Greatly infiltrated growths are practically inoperable; but a suprapubic drain will relieve pain and prevent urethral obstruction with clots of blood and fragments of tumor. The blood clots in cases not operated upon may be removed through a large catheter, if broken up with warm water; to which pepsin or other digestive substances may be added.

Stone in the Bladder.

Pathology.—Vesical calculus is found more frequently in men than in women; and occurs at all ages. It may be congenital. In some countries stone in the bladder is much more common than in others. The reason is not clear; though the frequency of the occurrence has been attributed to drinking limestone water. The presence of stone in the bladder is associated with a tendency to excessive elimination of the urinary salts and a local condition which causes these salts to conglomerate. The excessive use of meat as a diet, want of exercise and the ingestion of alcoholic beverages seems to have an influence in causing renal and vesical calculi. Habits of life which promote indigestion, gout, and lithæmic conditions seem to favor the occurrence of the disease. Heredity may exert an influence.

Any condition of the urinary tract, tending to favor chronic retention of urine, especially if alkaline fermentation occur, will be likely to cause the formation of stone. This is the etiology of bladder calculi associated with hypertrophy of the prostate gland, urethral stricture and chronic cystitis. Some stones in the bladder were originally renal calculi, which reached the bladder but were not carried out through the urethra with the urine. They arise from the same sort of diathetic and local causes as those originating in the bladder. The uric acid and calcium oxalate stones found in the bladder are usually, if not always, of renal origin. Foreign bodies in the bladder, such as pieces of catheter, or silk sutures, which may have ulcerated through the wall from without, may form a nucleus upon which urinary salts are deposited. The nucleus of a stone may be inspissated pus, a blood clot, a mass of mucus or epithelium, or a crystal deposited from the urine. Upon the nucleus is deposited layer after layer of precipitated material. As the character of the urine changes from time to time the successive layers differ in chemical composition. A stone when sawed in half will show the stratification due to the various depositions of the same or various constituents of the urine. A single stone may form or there may be many. The more quickly formed and the softer stones are those more apt to be multiple. Vesical calculi vary in size and weight from small sandy particles to several ounces. The average weight is from three to six drachms. A stone may be very hard or as soft as dried clay. The calcium oxalate and the uric acid stones are hard, the phosphatic stones are soft. The shape depends on the position of origin and detention and also on the shape of the nucleus. As a rule calculi are spheroidal or ellipsoidal, but somewhat flattened perhaps on two sides. The surface may be smooth, granular or tubercular. Multiple stones are apt to be faceted.

If calculi are not removed from the bladder, cystitis is pretty sure to occur sooner or later. Ulceration may occur and the stone escape into the tissues outside of the bladder. Small stones may be passed through the urethra, become impacted in that canal or ulcerate through its walls into the perineum or scrotum. Sometimes a vesical calculus is caught in a hollow or ulceration in the bladder wall and becomes imprisoned or encysted there. Stones may undergo spontaneous fracture in the bladder.

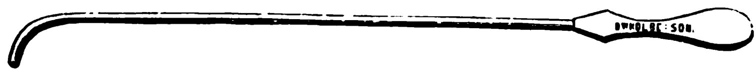
Varieties.—The stones composed of uric acid and urates are the most frequent, but phosphatic stones and those composed of calcium oxalate are not unusual. Pure uric acid stones are hard and yellowish, reddish or brown in color. They generally arise in the kidney, because increased formation of uric acid occurs in the urine. The acid is precipitated because there is insufficient alkalinity of the urine to keep it in solution. The urate stones are made up of sodium, ammonium and magnesium urate ; and are often covered with a deposit of calcium oxalate or ammonio-magnesium phosphate. Urate stones are likely to occur in urine which has undergone alkaline fermentation, as happens in cystitis. Phosphatic stones consist of calcium phosphate (earthy phosphates); ammonio-magnesium phosphate (triple phosphates); or of these different phosphates in varying proportions (mixed or fusible phosphates). The phosphates which are soluble in normal urine, which is acid, are precipitated when the urine becomes alkaline. Phosphatic stones are grayish white and soft. Uric acid stones are more common in youth and middle age; phosphatic stones at a later period of life. Oxalate of calcium is deposited by acid fermentation of urine. This calculus is very hard, of a brown color and has a very rough tubercular surface. It has therefore been called the mulberry calculus and is very irritating. It is of slow formation. Rare varieties of calculus are those composed of calcium carbonate, cystic oxide or xanthic oxide. Organic materials, such as epithelium, blood and pigment, aid in making up the bulk of a vesical stone.

Symptoms.—A small stone, which is not accompanied by cystitis or which lies quiet in a pocket away from the sensitive neck of the bladder, may cause no marked symptoms. Otherwise abnormalities of micturition, pain, blood and pus in the urine, vesical tenesmus, hemorrhoids and rectal prolapse may be present in greater or less severity. Deposits of urates in the urine or renal colic may have been premonitory symptoms. Frequency of urination, irresistible desire to urinate, pain at the end of the act, sudden cessation of flow as if the stone fell against the outlet of the bladder, or impossibility of emptying the bladder unless the patient lie upon the side, back or abdomen, should always raise the suspicion of vesical calculus. Pain may be felt in the perineum, rectum, urethra and especially at the end of the penis. It is less when the patient is recumbent or lying with the hips elevated, worse when he is jolted in a wagon or on cars. Incontinence of urine and priapism are common symptoms in children and the prepuce may become long and redundant from constant pulling to lessen pain. There may be agonizing tenesmus when the stone is grasped by the bladder at the end of urination. Small pieces of stone may be passed in the urine. The urine may be normal in quality and all symptoms may be absent, though a stone of considerable size exist in the bladder.

Diagnosis.—Stone in the bladder may complicate other diseases and other diseases of the bladder and adjacent organs may simulate stone. Rectal or vaginal palpation may seem to point to the presence of a stone; but its recognition depends upon touching it with a metallic sound or stone searcher, seeing it with a cystoscope or feeling it with the finger introduced through a suprapubic incision or through the female urethra.

When a patient is sounded for stone, he lies on his back with the pelvis slightly elevated and the bladder containing about five fluid ounces of urine or warm sterile water. The stone searcher, or sound, is a solid steel instrument with a curve at the end. Its size should be about 13 of the French scale for adults, about 9 for children. Anæsthesia may be necessary in children, and occasionally in adults.

FIG. 407.



One form of sound.

The sound is made aseptic, warmed, oiled and introduced through the urethra. The bladder is then explored systematically by pushing the end of the instrument slowly further and further into the bladder, while its point is gently turned by slight rotations of the handle. Each side of the bladder is thus examined for the purpose of obtaining the click caused by striking the stone with the metallic instrument. The contact is felt by the surgeon's hand, but the audible click is the absolute proof of the existence of a stony body within the bladder. The curved end of the sound is turned downwards, if no concretion is found by the first manœuvres and search made behind the prostate gland. If no stone is discovered by this device, a finger is inserted into the vagina or rectum or pressure made upon the hypogastrium while the sound explores the bladder again. If this fails to reveal the suspected stone, the bladder should be searched when empty. After this thorough examination the patient should be kept quiet a day or two, when the operation may be repeated. An anodyne or quinine, with or without an anodyne, may be given to prevent urethral fever. The stone may not be discovered because the sound has not passed beyond the prostatic urethra, because the bladder has forced out the water needed to distend it, because the stone is covered with pus or blood and gives no click, because it lies in a pocket of mucous membrane or bladder wall which the end of the sound fails to enter, or because it is in an inaccessible hollow behind an enlarged prostate gland. The grating sound or click is too sharp to be caused by contact with a tumor or thickened and ribbed mucous membrane; but tumors or tuberculous ulcers covered with concretion may sometimes deceive the examiner.

The size of a stone may sometimes be determined by carrying the end of the searcher over its surface or by feeling it through the rectum or vagina. A surer method is to grasp it between the jaws of a lithotrite. The presence of more than one stone may be determined sometimes by seizing one with a lithotrite and striking it against another. The character of the stone may occasionally be determined by a study of the urine and the sensations imparted to the examiner's hand when the stone is touched with the sound. A stone is probably encysted if the sound always comes in contact with it in the same part of the bladder. Some varieties of stone cause a shadow when subjected to the X-ray and their presence may be diagnosticated by skiagraphy.

Treatment.—Attempts to dissolve vesical stone by internal medication or injections into the bladder have been practically unavailing and are a waste of precious time. Theoretically, potassium citrate in doses amounting to two or three drachms daily or piperazine in daily amounts of fifteen grains might be employed to dissolve uric acid calculi; but the practical usefulness of these drugs after a stone has formed is doubtful. Their administration to prevent the tendency to the formation of such stones is wise. Removal of the stone by operation and the treatment of accompanying conditions are therefore demanded as soon as a diagnosis is made. The two means by which a calculus is removed are lithotomy, or cutting into the bladder for stone, for which there are two routes, the suprapubic and perineal; and lithotrity, or crushing the stone into small particles while it is still in the bladder. The pulverized calculus after crushing may be removed at once at one sitting by a suction apparatus or be gradually washed out of the bladder by urination. The latter method of removing the calculous débris, to which the name lithotrity was formerly applied, has been almost abandoned in favor of removal by suction or siphoning, which is called rapid lithotrity or litholapaxy.

Before the performance of any of these operations the patient should be treated constitutionally for a few days, and his condition improved as much as possible. The administration by the mouth of salol or boric acid for a few days before operation may be of advantage in sterilizing the bladder through the action of these drugs on the chemical character of the urine. The probability of chronic infection of the kidneys in all cases of long standing should be remembered, for imperfect elimination by diseased kidneys may lead to disaster after a successfully performed operative removal of the stone. Stones are easily removed from the female bladder by dilating the urethra and using forceps for extraction or a lithotrite for crushing, if they be too large for extraction. If these methods are unsatisfactory, the operation called suprapubic lithotomy or an incision into the bladder through the vesico-vaginal septum will give opportunity for removing the calculus with forceps.

Stone is more difficult to remove from the male bladder; and the choice between litholapaxy and suprapubic lithotomy depends on the character of the case and the experience of the surgeon. Perineal lithotomy, even lateral perineal lithotomy, is now becoming somewhat uncommon. The rapidity, safeness and utility for stones of all sizes of the suprapubic cut make it the best operation for the surgeon of average experience in vesical calculus. Litholapaxy is done without a cutting operation, it is true; but it requires expensive instruments, not always obtainable, prolonged anesthesia, experience in manipulation, and in some cases may be ineffectual. It cannot be used in encysted stone nor in cases complicated with tumor of the bladder, bad stricture of the urethra, greatly enlarged prostate gland or severe disease of the kidneys; it is not readily applicable to very hard or very large stones; it may lead to septic injury of the bladder wall, and, if a fragment of stone remains, future trouble may arise from that fragment serving as a nucleus for another stone. It is a brilliant operation in appropriate cases in experienced hands, for the patient is cured in a day or two. Suprapubic lithotomy, however, is applicable to all cases, or to practically all cases. The chief objection is that it is a cutting operation, and a wound may become septic. Under modern methods this objection is unimportant. In the hands of a surgeon of average experience the operation is quick, safe and effective. Septic infection of severe grade will not occur; no especially complicated instruments are required. The longer convalescence is counterbalanced by the fact that the stone is sure to be completely and always removable, without reference to its size, hardness or position.

Foreign Bodies in the Bladder.

The foreign bodies found in the bladder are pieces of defective urethral instruments, which have broken while in use; materials inserted into the urethra for purposes of masturbation, which have been drawn into the bladder by the muscular coat of the urethra; soft rubber catheters; bullets and portions of clothing; and pieces of bone, sutures, fecal concretions and other substances which have perforated the bladder wall by ulceration. All foreign bodies are likely to cause cystitis and a tendency to the deposition of urinary salts upon them as nuclei. The symptoms are those of vesical stone. The treatment comprises waiting a little while for the urine in full flow to wash them out, which may happen even with a complete flexible rubber catheter; washing them out with the evacuating apparatus of the litholopaxy apparatus; or performing suprapubic cystotomy as for calculus. Some articles may be broken up with the lithotrite and be thus more readily extracted through the urethra.

Injuries of the Bladder.

Pathology.—Contusions of the bladder and wounds of its mucous membrane give rise to symptoms similar to cystitis and require corresponding treatment. Rupture, incision and other penetrating wounds whether due to gunshot injury, fracture of the pelvis or other cause are of great gravity. The injury may be extra- or intra-peritoneal. The extravasation of urine into the cellular tissue around the bladder or into the peritoneal cavity is the factor that makes these injuries so dangerous. Septic cellulitis or peritonitis is almost certain to occur.

Symptoms.—Shock, hypogastric pain, nausea, inability to urinate, vomiting, perhaps hiccough, and evidences of peritonitis or the swelling due to urinary infiltration are symptoms of penetrating wounds or ruptures of the bladder. The catheter may obtain bloody urine, pure blood without urine, or no fluid whatever. It may be impossible to get the point of the instrument into the bladder, because it is torn from the urethra, or the end of the catheter may go so deeply inwards that it is evident that it has emerged through the tear in the bladder wall and entered the peritoneal cavity. Diagnosis may be confirmed by injection of eight or ten fluid ounces of warm sterile water into the bladder. If the viscus is intact, this amount should cause it to rise above the pubes and give dullness there on percussion, and the full amount injected should be obtained when the water is drawn from the bladder. Instead of water, air filtered through a cotton plug may be pumped into the bladder with a bulb syringe. If the bladder is torn, the general peritoneal cavity will be distended instead of the bladder being inflated and making its presence evident in the hypogastrium.

Treatment.—If the rupture appears to be extra-peritoneal, urinary extravasation in the prevesical space or behind the bladder must be treated by incision into the suprapubic or perineal tissues and drainage. If the tear is intra-peritoneal, abdominal section close to the pubes, suture of the bladder wall, cleansing the peritoneal sac and drainage are to be done promptly.

Retention of Urine.

Pathology.—Retention of urine in the bladder must not be confused with suppression of urine, which is cessation of secretion of urine by the kidneys. Retention may be complete or incomplete and acute or chronic. Its causes are mechanical obstruction to the outflow from the bladder or want of muscular power in the bladder wall to propel the stream. Foreign bodies or calculi impacted in the urethra; urethral stricture, tumor or inflammation; enlarged prostate gland; pressure from disease outside of the urethra and blood clots in it may all act as obstructions to the flow of urine. Nervous conditions, causing spasmodic muscular closure of the urethra or bladder outlet or inducing atony or paralysis of the bladder, may be the cause of retention.

Symptoms.—The bladder when distended causes dullness on percussion and a round tumor above the pubes, except in cases of chronic cystitis with contracted walls. Then the symptoms of retention arise without dullness or appearance of the distended viscus above the pubes. In chronic retention the full bladder may extend above the navel and be mistaken for an abdominal tumor. It may contain several quarts of urine. Even such a distended bladder seldom ruptures unless subjected to traumatism. After the viscus becomes greatly distended, there is usually a leakage of urine through the urethra. This may be mistaken for a normal urination, though such dribbling is usually supposed to be incontinence. The surgeon must be watchful lest the patient or nurse deceive him unintentionally by stating that the bladder has been emptied. This so-called "incontinence of retention" is an overflow of a tensely filled bladder and demands the use of the catheter. In extreme retention due to chronic urethral obstruction, rupture of the distended urethra behind the obstruction may take place. Some cases of retention go on for weeks with very few symptoms, because the patient occasionally partially empties his bladder and thinks he has passed all the urine in it. The hydrostatic pressure in the ureters and kidney caused by retention of urine may lead to serious renal disease. The bladder after relief of retention by drawing off the urine, is very likely to become inflamed; and retention is likely to occur for a considerable time thereafter because of loss of power in the wall of the bladder.

The pain is great in acute retention of urine; less marked in chronic or slowly occurring distention. Bimanual examination by a hand on the abdomen and a finger in the rectum or vagina will reveal the presence of a fluctuating swelling. Long continued retention gives rise to asthenic symptoms from absorption or imperfect excretion of urinary constituents.

Treatment.—The introduction of a catheter, which must be aseptic is the treatment. In great distention, not more than about two thirds of the urine should be drawn off at first. A neglect of this precaution may lead to fatal results, from congestion of the kidneys due to sudden withdrawal of the hydrostatic pressure. Hemorrhage from the bladder may be similarly induced. If a catheter cannot be introduced, aspiration twice a day above the pubes, suprapubic cystotomy or perineal cystotomy is demanded. Aspiration and suprapubic cystotomy are readily performed under local anesthesia. In order not to empty the bladder too rapidly, it is well to perform aspiration first in great distention, even if cystotomy is to be done subsequently.

Suppression of Urine.

When the kidneys as the result of chronic disease, congestion, surgical shock, general anesthesia or other causes cease to secrete urine, death from uræmia is imminent. No urine is found in the bladder by catheterization, and symptoms of acute uræmia occur. Dry or wet cups to the lumbar region, Turkish baths, pilocarpin, digitalis and nitroglycerine should be energetically employed. In urgent cases nephrotomy of one or both kidneys is justifiable.

Incontinence of Urine.

True incontinence occurs when the urine escapes from the bladder as soon as it enters it. It is due to atony or paralysis, the result of cerebral or spinal disease; over dilation of the urethra; and tumor or enlarged prostate interfering with proper action of the sphincter muscle. It must be treated in accordance with its cause. Children sometimes suffer from a nocturnal incontinence due to imperfect action of the sphincter. The condition is apparently associated with reflex irritation from seat worms, phymosis or indigestion, or with excessive irritability of the bladder or alterations in the urine. Elevation of the pelvis to throw the urine away from the sensitive portion of the bladder, belladonna, and bougies introduced into the bladder are proper therapeutic measures. The so-called "incontinence of retention" has been discussed under retention of urine and demands immediate resort to catheterization.

Hæmaturia; Pneumo-uria; Chyluria.

Blood in the urine is usually due to disease or injury of the urinary tract; but may occur as a symptom of scurvy, purpura, some fevers, malaria, and as an evidence of toxic conditions due to carbolic acid, cantharides or turpentine. Certain parasites in the kidney or the lower urinary tract, such as the filaria sanguinis and Bilharzia hæmatobia, cause bloody urine. If the blood remain in contact with the urine for a long time the corpuscles decompose and cause smoky urine. When the blood comes from the kidney it is apt to be intimately mixed with the urine and cause smoky urine; if it comes from the ureter, it may be in long clots or casts or cause smoky discoloration of the urine. Blood from the bladder or prostate is passed after or with the last portion of the urine, while that escaping from the urethra is passed between the acts of urination or before the urine appears at the time of urination. Urethral hemorrhage may furnish pure blood or long clots or casts of the urethral canal. The cause must be treated, but quinia and ergot may be beneficial in obscure cases. Clots allowed to remain in the bladder may cause retention or by decomposition lead to septic symptoms. They should be dissolved by digestive ferments, broken up and evacuated by the evacuator of the lithotrity apparatus or extracted by suprapubic cystotomy.

Pneumo-uria, or escape of gas with the urine, is due to air introduced by instruments, to gaseous products of decomposition in the contents of the bladder, or to a fistule between the intestinal canal or surface of the body and the bladder.

Chyluria, or escape of milky looking urine, is due to a communication between the lymphatic vessels and the urinary tract. It is usually the result of the presence of the filaria sanguinis hominis, a parasitic worm, in the lymphatic system.

OPERATIONS UPON THE BLADDER.

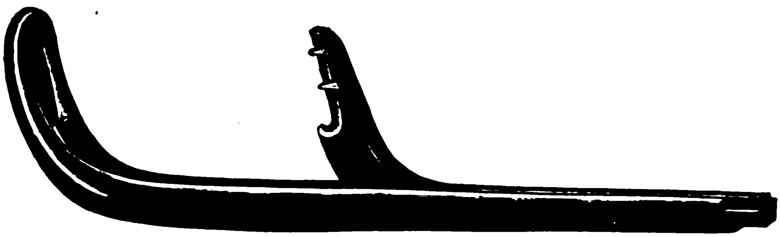
Aspiration.

The pubes is shaved and sterilized; and the needle of the aspirator is thrust through the wall of the abdomen in the median line, about an inch above the pubic bone, directly into the distended bladder. The urine flows without the attachment of the suction apparatus. Freezing the skin is all that is necessary to avoid pain. There is little pain even without this local anæsthesia, if the needle is sharp and thrust through the skin with a quick plunge.

Litholapaxy.

Rapid lithotrity, or litholapaxy, is the crushing and removal of a stone at one operation. If the stone is small the operation may be done without general anæsthesia by injecting into the bladder four grains of cocaine hydrochlorate dissolved in four fluid ounces of water. In protracted or difficult cases, general anæsthesia is required. The rectum must be empty and the bladder should contain from four to six fluid ounces of warm sterile fluid. It is well to have the pelvis of the patient slightly elevated; and the bladder should have been irrigated a few times in the preceding days to make it at least relatively aseptic. Oil is then injected into the urethra, and the lithotrite, well anointed with glycerin, introduced into the bladder. A tape or rubber drainage tube

FIG. 408.



Forbes's lithotrite.

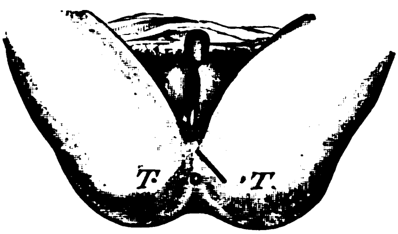
may be tied around the root of the penis to prevent escape of the water in the bladder. The shaft of the instrument is held at an angle of about 45° with the operating table and with its beak depressing a little the floor of the bladder. The male blade is drawn out about an inch and a pause made to allow the stone to fall between the jaws of the lithotrite. If it is caught, the lithotrite is locked, after a slight movement has been made to insure that no mucous membrane has been caught on the jaws along with the calculus. The male and female blades are then slowly screwed together to break the stone. Other stones or the fragments are seized successively and ground into small particles. If the surgeon fails to catch the stone, the lithotrite is turned from side to side in the bladder with its jaws open until the stone is grasped. It may be necessary to invert the beak of the instrument, in order to seize a stone lying behind the prostate gland. The finger of an assistant inserted into the rectum may aid in locating or seizing the calculus. The lithotrite should be removed after it is found that no fragments remain to be crushed, and the tube of the evacuator inserted. When its point has entered the bladder, connection is opened between the bulb which should be filled with water and the tube. The air from the tube enters the bulb and can be allowed

FIG. 409.

Guyon's evacuator for litholapaxy.

to escape. Warm sterile water is then used to wash the ground up stone from the bladder, by the pumping process. When no sandy material can be obtained, the evacuating tube is withdrawn, after the bladder has been thoroughly irrigated. The patient will have perhaps some evidences of traumatic cystitis for a few days. This is treated on general principles. Care must be taken not to force too much water into the bladder at one time. It is often wise to use the stone searcher or sound after the operation to see that no piece of stone has been left in the bladder.

FIG. 410.

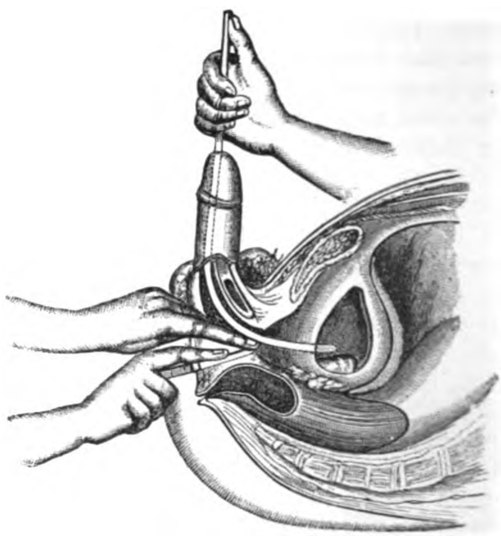


Lateral perineal lithotomy: *T*, tuberosity of the ischium. (TILLMANNS.)

Perineal Lithotomy.

Subpubic, or perineal, lithotomy is an incision made into the bladder through the perineum for the removal of stone. When the bladder is opened for other reasons than the extraction of stone the term used is cystotomy. The perineal incision may be in the median line, on one side of the median line or cross the median line so as to be on both sides. These variations are called median, lateral and bilateral lithotomy respectively. The method most usually employed is lateral lithotomy on the left side. The left side of the perineum is selected because it is most convenient for persons operating with the right hand.

FIG. 411.

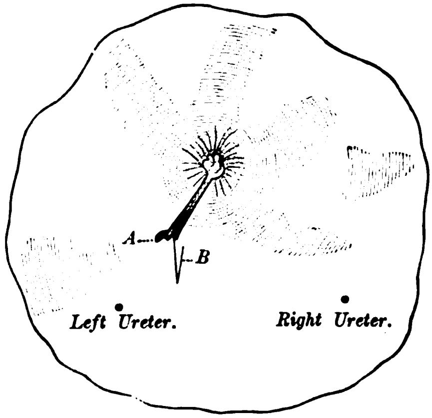


Division of the prostatic portion of the urethra in lateral lithotomy. (TILLMANNS.)

After the perineum has been shaved and the bowels well emptied the patient is anæsthetized and placed with the buttocks on the edge of the operating table. The knees and hips are flexed and the thighs abducted. This position is maintained by assistants holding the limbs, by using some form of "crutch" or by tying the hands and feet together. The surgeon sits between the knees of the patient, facing the perineum. A lithotomy staff which has a lateral groove running along its convex surface and side is inserted through the urethra into the bladder.

An assistant holds the staff so that it is hooked up under the pubes and in the median line, with the convex portion of the curve pressing a little forwards into the perineum. The surgeon then makes an incision, from a point in the raphe of the perineum about an inch and a quarter in front of the margin of the anus, obliquely downwards and outwards to the patient's left to a point between the tuberosity of the ischium and the anus, but nearer the tuberosity than the anus. The forefinger of the left hand is inserted into the wound to feel for the staff; after which the tissues are cut more deeply until the finger, acting as a guide from time to time, comes almost in contact with the staff and recognizes its groove. The point of the straight blade knife is then engaged in the groove and pushed along the groove backwards and upwards into the bladder. The edge of the knife is turned a little to the left by the groove in the staff and makes an oblique cut through the membranous urethra, the prostate gland and the neck of the bladder. As it enters the bladder the water gushes out. Then the surgeon withdraws his knife, inserts his left forefinger into the wound, and, as the staff is taken out of the urethra, thrusts his finger tip into the bladder and feels for the

FIG. 412.



Lateral lithotomy. Incision of the neck of the bladder as seen from within. *A* is a rent in the wall made by introduction of the finger. *B* is an extension of the incision involving only the mucous membrane. (STIMSON.)

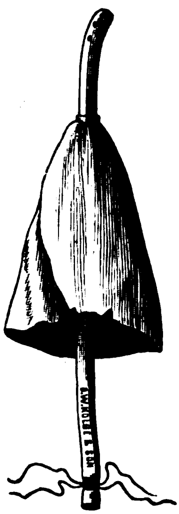
FIG. 413.

Grooved staff for lithotomy.

stone. Keeping his finger on the stone he inserts with his right hand the extraction forceps alongside of his finger, until the wound becomes too small for both. Then he pulls out the guiding finger, inserts the forceps and, grasping the stone in its smallest diameter, delivers it with a careful rocking motion. If the stone is too large to be easily taken out, it may be broken with a lithotrite introduced through the wound or the wound may be enlarged with a blunt point bistoury.

The chief dangers in this operation are wounding the rectum and failing to open the bladder by letting the point of the knife slip out of the groove of the staff. The tissue between the bladder and rectum may thus be opened. The point of the knife should be aimed, as it were, upwards and forwards towards the position of the navel. The wound is kept clean and urine flows from it until it heals by granulation. Sometimes swelling may close the wound for a day or two and the urine may then escape from the urethra by voluntary urination. Bleeding, whether primary or secondary, is to be stopped by hemostatic forceps and ligatures, or by a shirted catheter introduced into the wound and suitable gauze packing.

FIG. 414.



Shirted catheter.

Suprapubic Cystotomy or Lithotomy.

Suprapubic incision into the bladder is a very simple operation and is an excellent means of gaining access to a calculus, a vesical tumor or an enlarged prostate gland. It is the simplest method for the removal of stone in the bladder. The pubes is shaved, the patient put in the Trendelenburg position, which elevates the pelvis a foot or more from the table, and about six or eight fluid ounces of warm sterile water or weak antiseptic solution injected into the bladder. A tape or rubber band is lightly tied around the penis to prevent escape of the water. A vertical three inch incision is made in the middle line of the hypogastrium with its lower end at the symphysis. The rectus muscles are separated and operator's finger used to break through the tissue in front of the bladder just behind and above the pubic bones. The peritoneum has been carried upward upon the upper part of the bladder as it was distended with water. It is not seen. If it is seen, it is displaced upwards with the finger without being incised. The bladder, which is felt as a rounded tumor behind and above the bone, is then caught with two sutures, one on each side of the proposed incision. These untied sutures are used to draw the edges of the bladder wound to the surface during the extraction of the stone. A knife is then used to cut an inch incision in the bladder wall. Through this vertical opening the water escapes; the surgeon then explores the bladder with a finger, and extracts the stone with forceps, or removes the tumor or the hypertrophied middle lobe of the prostate with forceps or curette. A drainage tube is then inserted for drainage; or the wall of the bladder is sewed by sutures passed through the muscular, but not the mucous, coat. It is usually wise to put a drainage tube in the superficial part of the wound, even if the bladder is sewed; because if it leaks, septic infection of the prevesical tissue is sure to follow. If the skin wound is closed, it must be opened immediately, if the temperature rises, because it is probable that the fever is due to septic inflammation of this tissue. If the bladder and cutaneous wound is left open, this danger is avoided.

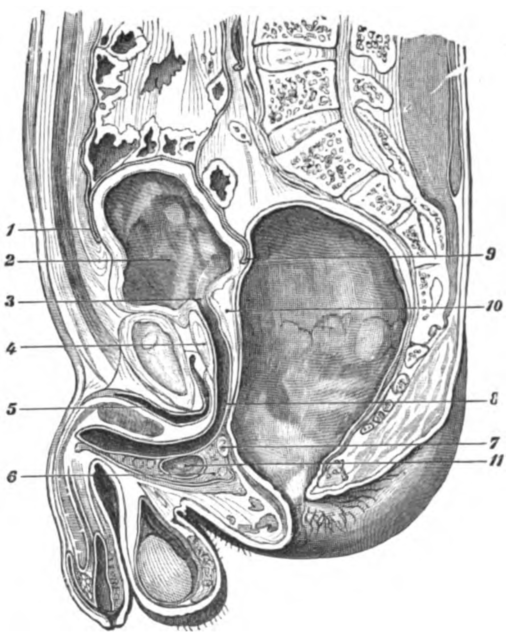
In cystotomy for cystitis permanent drainage is established by putting a large drainage tube or canula into the bladder. Suprapubic cystotomy may be modified by cutting the skin and rectus muscles transversely; but this requires that strong sutures be inserted into the muscles to overcome retraction. The exposure of the bladder is greater but is unnecessary. The bladder may be pushed upwards and forwards before operation by introducing a bag into the rectum and inflating it with air. This also is a needless complication.

DISEASES AND INJURIES OF THE PROSTATE GLAND.

Prostatitis.

Pathology.—The prostate gland, its utricle, the ampullæ, or dilated ends of the vasa deferentia, and the seminal vesicles are enclosed in a fibrous sheath, which probably is the reason that infections from the adjacent rectum seldom occur. Infections from the urethra, however, are common because the route is so direct along the continuous mucous membrane. The ordinary infections of the prostate and its appendages, as the seminal tubes and vesicles have been termed, are, as in the case of the bladder, gonorrhœal, septic and tubercular. Acute prostatitis is usually gonorrhœal and due to extension of the diseases from the urethra. It is also due to a combination of injury and sepsis resulting from abrasions and lacerations made with dirty urethral instruments, such as catheters, bougies and stone searchers. It follows cystitis or urethral stricture at times, and it may also occur as a sequel of typhoid fever, influenza and some other general diseases. Tubercular prostatitis is usually chronic and associated with

FIG. 415.



Section through a frozen body with the rectum much distended artificially. 1, peritoneal fold in front of bladder; 2, the bladder; 3, internal orifice of urethra; 4, prostate gland; 5, dorsal vein of penis; 6, bulbous urethra; 7, Cowper's glands; 8, upper end of membranous urethra; 9, recto-vesical fold of peritoneum; 10, prostate gland; 11, abscess in bulbous urethra. (GARSON.)

tuberculosis of the epididymis or the seminal vesicles or bladder. Septic and gonorrhœal prostatitis may be chronic at times, and prostatic calculi may give rise to a chronic inflammation. The inflammation in prostatitis may involve only the follicles or also the parenchyma of the gland. The latter is a much more serious disease and may end in prostatic abscess. Infectious phlebitis of the prostatic veins or infectious lymphangitis of the lymph vessels of the region may lead to periprostatic inflammation and abscess, which will perhaps spread extensively through the deep perineal tissues and the structures between the bladder and rectum. These deep inflammations are very dangerous and require prompt incision into the perineum.

Symptoms.—The fever, pain and urinary symptoms would be expected to be more pronounced in acute than in chronic inflammation, and they are. The pain of prostatitis is of a bearing down character and is felt in the perineum and rectum. Urination is frequent and causes pain in the prostatic region. The urine may be tinged with blood. Digital exploration by the rectum shows the prostate to be swollen and tender. It may have an elastic feel or give evidence of bogginess or fluctuation. The swollen prostate may cause retention of urine. Then catheterization will be exquisitely painful. Cystitis or urethritis may be present as complications. In acute cases gradual cessation of symptoms may occur, evidences of deep suppuration in the perineum may arise or the disease may become of a chronic type. A prostatic abscess is accompanied by severe constitutional symptoms, and may open into the urethra or rectum or through the perineum. In chronic cases, the symptoms are not unlike those of vesical or prostatic calculus. Sometimes the pain is felt in the sacral region. Urination may be followed by the discharge of prostatic secretion, which is a viscid grayish fluid which the patient, if despondent, is likely to call semen. This may occur at other times.

Treatment.—Laxatives, salol and alkaline remedies internally, with leeches or hot fomentations to the perineum, constitute the proper treatment for acute prostatitis. Perineal incision should be prompt on the first evidence of abscess. In chronic inflammation, leeching the perineum, blistering the same region and perhaps cold hip baths are to be employed, after removing as far as possible the stricture of the urethra or other cause of the chronic prostatitis. Constipation and alcoholic excesses should be prevented. Dilatation of the prostatic urethra with large bougies and stimulating the prostatic urethra with silver nitrate (gr. v–xx ad f℥j) may be beneficial. Tonics and cheering words may be of much benefit. Sexual desire, if decreased, and ejaculations, if premature, may not become normal until a long period of treatment has elapsed. Tubercular prostatitis demands general treatment, and incision and curetting if puriform collections occur.

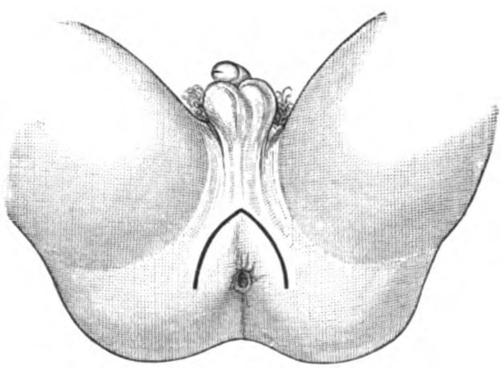
Prostatorrhœa.

A very mild form of chronic prostatitis occurs not infrequently in young men the subjects of masturbation and excessive sexual excitement. It has been termed prostatic catarrh and prostatorrhœa. The prostatic follicles discharge the colorless viscid fluid, which is their normal product, in unusual amount. This escapes after urination and during straining at stool. The patients, who are frequently young men suffering from sexual hypochondriasis, become greatly worried, thinking they are losing semen and are about to become impotent. It needs the treatment mentioned under chronic prostatitis.

Tuberculosis of the Prostate and Seminal Vesicles.

This affection has been mentioned in connection with prostatitis. The seminal vesicles are scarcely palpable through the rectum in the normal condition; but when they are the subject of inflammation (spermato-cystitis) or tuberculosis they can usually be felt with the finger in the rectum. Tubercular disease of the prostate and seminal vesicles is apt to be associated with the disease in the epididymis or bladder. It is possible to extirpate tubercular vesicles.

FIG. 416.



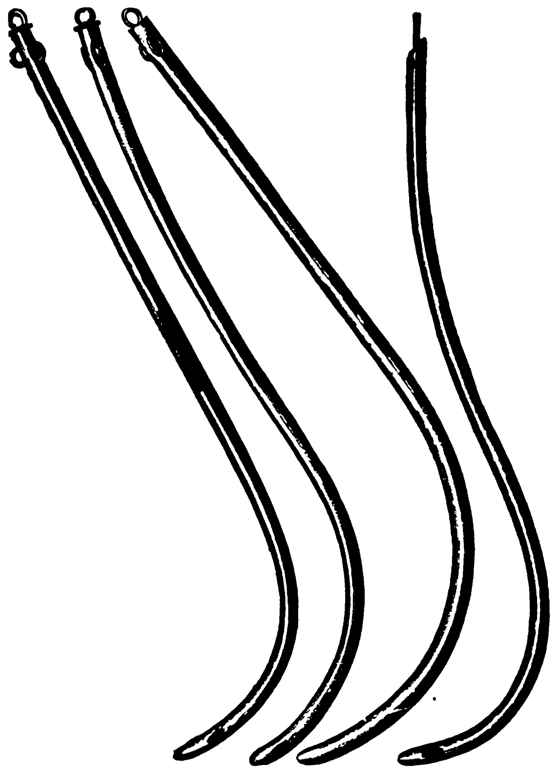
Incision for exposure of the prostate and seminal vesicles for operative treatment. (TILLMANNS.)

Hypertrophy of the Prostate Gland.

Pathology.—Diffuse enlargement may occur; or the hypertrophy may be localized, so as to be for practical purposes a tumor in the gland, projecting into the bladder. The glandular tissue and the stroma may both be increased or the pathological process may affect one structure to a greater extent than the other. Enlargement of the so-called third or middle lobe gives most interference with urination. It projects into the bladder and cannot be felt by rectal palpation. Chronic inflammation is probably the usual cause of hypertrophied prostate, except where a true benign or malignant tumor occurs. The disease is one of advancing years; but is often so insidious in its approach that its beginnings are not recognized until marked changes have occurred. It should be suspected when urinary symptoms arise in men over forty five years of age.

Hypertrophy of the prostate causes distortion of the prostatic urethra, which may become lengthened, narrowed or deviated; raises the level of the outlet of the bladder above the floor of that hollow organ; and interferes with venous return from the bladder, thus inducing chronic congestion. As a result of these mechanical disturbances, evacuation of the urine by the bladder is hindered. As a secondary result of this urinary obstruction, arise dilatation of the bladder and retention of residual urine, fibroid degeneration of the prostatic sphincter, thickening and degeneration of the wall of the bladder which gives rise to pockets between its muscular bands, dilatation of the ureters and pelves of the kidneys and damming up of urine in them, and inflammation of the bladder, ureters and kidneys with a tendency to calculous deposits, ammoniacal decomposition of the urine, septic processes, and uræmia. Some of these processes are favored by the use of dirty catheters, but may occur without such extraneous aid. Even a clean catheterization may lead to fatal symptoms if all the urine is drawn off at once after a prolonged retention. The sudden relief of pressure causes a sudden congestion of the kidneys and other urinary organs.

FIG. 417.

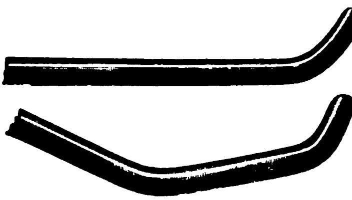


Prostatic catheters.

Symptoms.—Frequency of urination, especially at night, difficulty in starting the stream of urine and feebleness of the stream are often the first noticeable symptoms. Digestive symptoms and constipation may be observed. The urine may then become cloudy and give evidence of a slight superficial inflammation of the mucous membrane of the bladder. The patient urinates often, but feels as if the bladder was not entirely emptied. Then after exposure to cold or wet, indulgence in drinking or eating, or severe constipation, absolute retention occurs and the patient has to be catheterized. Instead of this event more active cystitis may supervene. One or other of these occurrences may first direct attention to the urinary abnormalities which have theretofore attracted no special attention. Chronic cystitis is from this time the usual outcome of the prostatic enlargement.

A patient who presents the symptoms mentioned may have stone in the bladder, tumor of the bladder or cystitis without enlarged prostate; but the prostate should be examined by rectal touch. If it seems somewhat enlarged and the patient is over forty five or fifty years, the probability of hypertrophy of the prostate being the cause of the symptoms is great. He should be asked to pass water; and then a soft rubber catheter should be introduced to see if there remains any residual urine. The presence in the bladder of a few fluid drachms of urine which were not passed by urination is evidence that the outlet is raised above the floor of the bladder. This means enlargement of the prostate. If it be not an enlargement from tuberculosis or malignant disease of the prostate, which must be excluded by other symptoms, it is the common so-called senile hypertrophy. Stone may be a sequence of the prostatic disease, and a sound should be used to exclude its presence in the depression behind the enlarged prostate. It is wise not to draw off all the residual urine at once, if the quantity be considerable; but to leave a few fluid ounces still in the bladder.

FIG. 418.



I, Mercier's prostatic catheter; *II*, Mercier's catheter biconde for hypertrophy of the prostate.

Treatment.—The general treatment is important and includes regular evacuations from the bowels, sufficient fresh air and exercise, protection from cold and dampness, avoidance of excess in eating and drinking, and the ingestion of comparatively large amounts of water. The objects of the local treatment are reduction of congestion and œdema of the prostatic region, complete evacuation of the urine, and the maintenance or production of an aseptic condition of the urinary tract. The passage of a large bougie once a week through the urethra and neck of the bladder; pressure exerted on the prostate by the finger in the rectum, so as to press out its secretion by drawing the finger over it from back to front; and hot water injections into bladder and rectum, with hot water baths, are valuable means for reducing congestive swelling. The patient may be taught to lie down and inject his own bladder with three or four ounces of water at a temperature of 105° F. If the urine cannot be completely passed voluntarily, the patient must be taught to use a flexible catheter and cautioned to sterilize it. He should know that it may be sucked into the bladder if he lets go of the outer end. If septic cystitis occurs, irrigation of the bladder with silver nitrate (gr. ¼–gr. j ad f℥ j) or a similar solution is to be employed, once every day or two, supplemented by hot water cleansings between times. It is wise to wash out the deep urethra with the fluid before carrying the end of the catheter into the bladder. This is readily done by allowing the fluid to flow from the fountain syringe before the end of the instrument passes the sphincter. The urethral contents are then washed out alongside of the catheter.

Salol, boric acid, benzoic acid and similar remedies may be employed, if the digestion is not upset by them.

If complete retention occurs which cannot be relieved by fomentations and hot hip baths, the surgeon must draw off the urine, but only about half at the first catheterization. He must use aseptic instruments. Soft catheters are safer than rigid ones; but the latter may be demanded. The finger in the rectum to lift up the prostate may aid the surgeon's efforts, by straightening the crooked prostatic urethra. If it is impossible to enter the bladder, suprapubic aspiration should be done, but only about half the urine should be drawn off at first. Catheterization may subsequently become easy. If repeated difficult catheterization is demanded, suprapubic incision with the insertion of a tube, to be worn for a short time or permanently, is the proper treatment. When the suprapubic incision is first made or at a later period, the projecting portion of prostate, which blocks the outlet, may be removed by scissors, snare or cautery, or by incising the mucous membrane and enucleating the tumor or third lobe. An assistant's finger in the rectum will aid by pushing up and steadying the prostate. Perineal prostatectomy is possible, but is less satisfactory than suprapubic prostatectomy. Tunneling through the hypertrophied gland, dividing the bar by galvano-caustic appliances, and other measures have been devised. Removal of the testicles and resection of a part of the deferent vessels have been advocated as available means of causing shrinkage of the prostate. They should not be employed as a routine measure; but may be available perhaps in cases where no calculi and no marked cystitis complicates the case.

Tumors of the Prostate Gland.

Tumors of the prostate are usually papillomas, cysts, carcinomas or sarcomas. They cause obstruction to urination and must be dealt with much as hypertrophy of that organ.

Prostatic Calculi.

Calculus in the follicles of the prostate is a not infrequent occurrence. There may be many stones. The symptoms are not distinctive except when a metallic instrument in the urethra gives a scraping sound or sensation. Symptoms of chronic prostatic or bladder trouble are present. Their removal is to be accomplished by perineal prostatomy or urethrotomy.

DISEASES AND INJURIES OF THE URETHRA.

Congenital Malformations.

Various malformations of the urethra may occur; but the commonest are epispadias, which is a defect in the roof of the canal, and hypospadias, a defect in the floor that causes the meatus to be not at the end of the penis, but on its lower surface. These conditions require plastic operations for their correction; but the result is often unsatisfactory.

Prolapse of the Urethra.

The mucous membrane of the urethra may be prolapsed through the female urethra, which is in such cases dilated. The swollen mucous membrane may cause retention of urine. If the protruding mass cannot be pushed back and kept in position, a plastic operation to remove redundant tissue and narrow the urethra must be performed.

Examination of the Urethra.

The urethral canal is examined by means of the urethroscope, or urethral endoscope, a metallic tube, into the outer end of which light is thrown by a head mirror or other means; by solid instruments, called bougies, which determine its calibre; and by chemical and microscopic examination of the secretion escaping from it. The bulbous bougie is especially valuable in determining the caliber of the tube; but the urethrometer is more accurate. The secretion of the urethra can be obtained without much mixture with the special secretions from the prostate, seminal vesicles and mucous membrane of the bladder by having the patient pass urine into three small glasses. If he pass about half a fluid ounce into the first glass it will contain the washings from the urethra with a little urine; if a second half ounce be passed into the second glass, it will give a fair idea of the character of the bladder urine. The surgeon may then insert a finger into the rectum and gently stroke the prostate gland and seminal vesicles so as to "milk" out their secretion into the posterior urethra. A little more urine passed into a glass will wash out these products. If it is desirable to see what is the character of the urine which lies in the bladder behind an enlarged prostate, a catheter may be used to draw this off, after voluntary evacuation of the bladder has been made as complete as possible.

Urethritis.

Inflammation of the urethra may occur as a consequence of injury, of contact with decomposed urine or acrid vaginal and uterine discharges, of excessive venery, and of the ingestion of drugs of a specially irritating character. Its chief cause, however, is infection with the gonococcus. This form is called specific infectious urethritis, or gonorrhœa, and is the most common variety. The symptoms and complications of urethritis from mechanical and chemical irritants are similar to, but less severe than those of gonorrhœa, or clap. The treatment of the non-specific disease is essentially the same. The diagnosis without microscopic examination and the finding of the gonococcus is uncertain. It is best not to call a case gonorrhœa without absolute proof, as it may cause unjustifiable suspicion of marital infidelity. A diplococcus is said to be found in cases not truly gonorrhœal which is indistinguishable from the gonococcus.

Urethral Gonorrhœa or Gonorrhœal Urethritis.

Pathology.—Gonorrhœal urethritis, or clap, is an acute specific infectious inflammation of the urethra, due to the gonococcus with which is usually associated some form of pyogenic germ. The disease is usually a mixed infection. In the female urethra the disease is less frequent and less important than in the male. The infection in woman is much more frequent as a specific vaginitis. The infection usually arises through sexual intercourse with an infected person. It may spread from the urethra to the seminal vesicles, epididymis, bladder and kidneys and from the vagina to the uterus, Fallopian tubes, ovaries and peritoneum. The infection may persist in the follicles and depressions of the mucous membrane when the general surface is free from the symptoms of disease. Infection of another individual may occur during coition from these hidden collections of the gonococcus. The germ may cause metastatic infections in serous and fibrous tissues by the blood stream.

Symptoms.—The symptoms occur after an incubation of about four days or between the second and fourteenth day after inoculation. Itching and smarting at the external meatus and along the urethra

FIG. 419.

Gonococci. *a*, cocci from a pure culture; *b*, secretion of gonorrhœal conjunctivitis, showing—epithelial cell covered with cocci; a pus cell with cocci in the protoplasm; a pus cell completely filled with cocci; a free mass of cocci in close proximity to a pus cell; *c*, scheme of development of gonococci. (BUMM.)

are felt, and a slight mucous discharge with burning during micturition is observed. These symptoms increase in severity for a couple of days, when the lips of the meatus become swollen and red, the prepuce œdematous, the glans inflamed and the mucous discharge becomes copious and purulent, perhaps tinged with blood. Urination causes intense scalding pain and may be difficult or impossible. The urine may escape from the meatus in a twisted or scattering stream. Painful erections with distortion of the inflamed penis, called chordee, occur, especially during sleep. Seminal emissions are frequent. Vesical irritation, pelvic discomfort and some febrile movement may accompany the local condition. Enlargement of the lymph nodes in the groins may occur. This condition continues for ten days or two weeks if untreated and then gradually subsides in the course of four or six weeks. The purulent discharge may persist longer than the other symptoms by several weeks. Sometimes a chronic inflammation with a thin watery discharge, small in amount, remains for months, and is aroused into acute activity by excesses in diet, alcohol drinking, excessive venery or exposure to cold.

Additional symptoms frequently occur which are often called complications. They include phymosis and paraphymosis and inflammation of the periurethral tissues, the glands of Cowper, the prostate, the seminal vesicles, the epididymis and the testicles, the bladder, the ureters and kidneys, the uterus, the oviducts and the ovaries. Arthritis, often called gonorrhœal rheumatism, affecting the fibrous and synovial membranes of the joints may occur as an acute or chronic affection. If acute, the disease lasts two or three months; if chronic it may persist for several years. The tendon sheaths and bursae may be infected, as may the cerebral meninges, the endocardium, pericardium, pleura, peritoneum and the muscles.

Any mucous membrane may be the seat of original infection, but the mucous membranes covered with cylindrical epithelium seem to offer a better soil than those covered with squamous epithelioma. Infection begins on a mucous surface. Infection of the conjunctiva causes a violent purulent inflammation very liable to destroy the cornea. Patients with urethritis should be warned not to infect the eyes by means of soiled fingers or towels. True pyæmia may at times result from a gonorrhœal urethritis.

It should be remembered that the gonorrhœal infection may become a general one, though starting in any mucous membrane, such as that of the urethra, rectum, nose, mouth or eye.

Treatment.—No means of destroying the infecting germ is known. The treatment is palliative and sometimes not effective in preventing a long illness. The patient should abstain from exercise, sexual excitement and stimulating food or drink; should keep the bowels open by laxatives; drink plenty of water to dilute the urine; avoid damming up the pus under the foreskin; wear a loose bag over the penis with a little absorbent cotton in the bottom; burn or sterilize by boiling all cloths soiled with the pus; and wash his hands after touching the penis or contaminated dressings. Calomel in quarter grain doses for a couple of days followed by salines for about a week will be good treatment. Santal oil, in twenty minim doses, cubebs or copaiba should be given unless the stomach becomes irritable under such medication. Hot water to the penis externally and by injection into the urethra is very valuable. The temperature should be about 105° to 115°. Boric acid solution (gr. v ad f℥j), zinc sulphate (gr. ss ad f℥j), hydrastin in saturated solution and other antiseptics and astringents may be used. As the severity of the inflammation subsides, rather stronger solutions may be adopted for injecting. The injections should be employed about six or ten times daily in the acute stage; but less frequently in the more chronic stage.

If the case persists for over eight weeks or so, as many do, it partakes of the character of chronic gonorrhœal urethritis. The discharge of a chronic gonorrhœal inflammation is sometimes not seen at the meatus, but is retained far back in the canal. To treat chronic gonorrhœa the location of the area of uncured infection must be found. It may be in the anterior urethra or the deep urethra. If in the latter, the prostate and seminal tubes are likely to be affected. By means of the urethroscope, bulbous and cylindrical bougies, rectal palpation of the seminal vesicles and tubes, and the passing of small quantities of urine into three glasses, the location of the disease is fixed. Then it is determined whether localized inflammation or submucous infiltration, stricture of the canal or imperfect drainage of diseased prostatic follicles and seminal vesicles is the lesion keeping up the trouble and discharge. Tonics, good hygiene, drinking plenty of water and avoiding excesses in tobacco, alcohol or food are important in these chronic cases. Local treatment with bougies, injections, applications through the urethroscope, and suppositories, with pressing or milking out the discharge from the prostate and vesicles, are most important.

Stricture of the Urethra.

Pathology.—Spasmodic stricture is a term used to designate a supposed narrowing of the urethra by spasm of the encircling muscular fibers, and to it is attributed trouble in introducing urethral instruments. It is a possible but not probable condition. The difficulty attributed to spasmodic stricture is usually a want of skill in introducing a catheter or bougie. Acute inflammatory swelling may cause coarctation of the urethra, but should not be called a stricture. Stricture therefore is a term that should be reserved for an organic diminution of the natural distensibility of the canal, because of an increase in the submucous connective tissue. This increase may be congenital or acquired. If acquired, it is due to inflammation or injury.

Organic stricture may be present at any age of life, but is not usual in women because of the anatomical construction of the female urethra. Stricture due to injury shows itself by symptoms soon after the receipt of the trauma, because the cicatricial contraction occurs promptly. Narrowing of the urethra, due to contraction of connective tissue, the result of gonorrhœal or other inflammatory processes, is a slow process. The change may be unsuspected and without marked symptoms for several years after the occurrence of the original disease. Stricture occurs anywhere except in the prostatic urethra; and several may exist in the same urethra. Gonorrhœa is the most frequent cause. Behind the stricture the urethra is likely to become dilated; and the retention of a few drops of urine there is liable to cause decomposition, ulceration of the mucous membrane, extravasation of urine and periurethral inflammation and abscess. The tendency is for the connective tissue to progressively contract, until the patient reaches the latter period of life; when fatty degeneration of the connective tissue is apt to occur. Traumatic strictures are pathologically similar to the other form but are tighter and harder to treat because the contractile tendency is greater.

Symptoms.—Increased frequency of urination, lessened size and force of stream and dribbling at the end of the act are caused by stricture. Other symptoms are scattering of the urine when passed, pain during seminal emission, dribbling of semen after erection is over, imperfect erection, premature ejaculation of semen and a muco-purulent discharge from the meatus. Examination with a bulbous bougie will prove the existence of the suspected stricture. Strictures behind the bulbous urethra should be searched for by conical rather than bulbous bougies. Exposure to cold or excesses in eating and drinking may cause sudden retention.

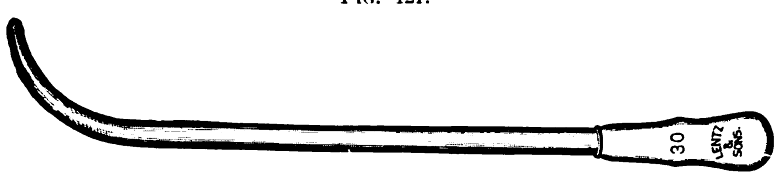
Treatment.—Strictures even when treated so successfully as to restore the normal caliber are likely to recur through subsequent contraction of the connective tissue. Patients should therefore be warned to have their strictures dilated occasionally, at least until they reach the age of fifty or fifty five years. Gradual dilatation and incision of the contracted tissue are the methods employed in treatment. Incision is called urethrotomy and may be done from within the urethra or from the outside. The former is internal urethrotomy, the latter external urethrotomy. Gradual dilatation is the best method and is successful

FIG. 420.

Metal bulbous bougie.

in a large proportion of nontraumatic strictures. It consists in passing into the urethra, previously irrigated, a conical bougie, of which the point will enter the strictured portion of the canal. This is pushed through the stricture slowly and carefully and allowed to remain for

FIG. 421.



Type of metal dilating bougie.

about five minutes. Then a larger bougie is employed until the pain or increasing difficulty is sufficient to cause the surgeon to desist. This operation is repeated about twice a week with gradually larger instruments until the caliber is that which will easily allow a bougie of No. 30 or No. 34 of the French scale to pass.

FIG. 422.

Filiform whalebone bougies.

Traumatic strictures and strictures within the glans penis will usually require urethrotomy. Strictures in which rupture and extravasation have occurred behind the contracted portion of the urethra necessitate external urethrotomy to provide for drainage and prevent sepsis. Traumatic strictures will usually require external urethrotomy. Strictures in the anterior part of the urethra and some in the deep urethra may be well managed by internal urethrotomy. In the deep urethra the danger of troublesome hemorrhage and of sepsis makes internal urethrotomy rather dangerous. It is probable that cases in this region which cannot be managed by gradual dilatation had better be treated by external urethrotomy. Internal urethrotomy may at times be done, and an external urethrotomy be performed in the perineum to drain the urine before it reaches the seat of the internal cutting operation.

Very tight strictures may be passed by thin whalebone bougies called filiform bougies. Some of these have a filiform end for several inches, and then become cylindrical. They are called whip bougies. In long and tortuous strictures in which filiform bougies are used, care must be taken not to make a false passage. If a filiform bougie goes through into the bladder, it may be allowed to remain for twenty four hours. The urine will drain along it; and the next day a larger one may perhaps be inserted. Impermeable strictures must be treated by perineal section, when perhaps a bougie can be inserted from behind. This retrograde dilatation is sometimes made in deep strictures by means of a suprapubic cystotomy.

Urethral or Urinary Fever.

The introduction of instruments into the urethra or bladder is frequently followed by high fever or chills and fever. This urinary or urethral fever sometimes lasts for a few hours only; at other times it is prolonged and may lead to asthenic symptoms and death. It apparently includes several conditions: septic infection through wounds caused by the instruments; septic infection of the higher urinary passages; intoxication, through lacerations of the mucous membrane, from toxic substances in the urine; congestion of the whole urinary tract occurring suddenly, because of a rapid withdrawal of the total amount of urine after prolonged retention; and perhaps reflex nervous disturbances.

Urinary fever is to be averted by aseptic instruments, gentle manipulation, irrigation of the urethra and cleansing the glans and lips of the meatus before the introduction of instruments, and the administration of an opium suppository immediately after the operation. Perhaps the administration for a day or so before of salol, boric acid or benzoic acid may be serviceable; and the administration of quinine or alcohol at the time of the operation may be wise. If the fever occurs, it should be treated by laxatives, rest and antiseptic irrigations of the bladder and urethra. A full bladder should never be entirely emptied at the first catheterization.

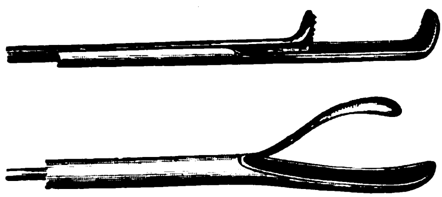
Urethral Fistules.

Openings on the surface communicating with the urethra and allowing urine to escape occur from abscesses and non-closure of wounds. The opening may communicate with several suppurating tracks or pus pockets. More than one orifice may be present on the penis, scrotum, perineum or thigh or in the rectum. The cause, whether it be a stricture, calculus or chronic suppuration, must be removed. Then the fistulous track will probably close. If it does not, it must be split up to its origin in the urethra; which may be closed by suture after freshening the edges, or the whole wound may be packed and made to granulate from the bottom. Sometimes a perineal section behind the fistule will aid in the cure by draining away the urine before it reaches the abnormal opening in the urethra.

Calculi and Foreign Bodies in the Urethra.

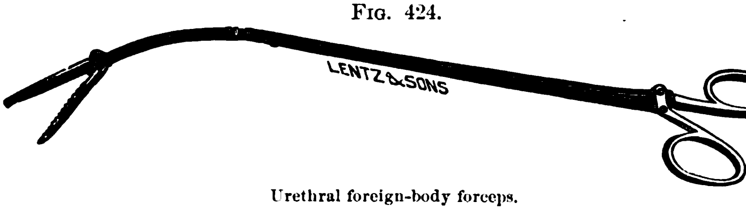
Small renal or vesical calculi may become lodged in the urethra, or similar calculi may be developed there. Foreign bodies may be intro-

FIG. 423.



Instruments for the extraction of foreign bodies from the urethra.

FIG. 424.



Urethral foreign-body forceps.

duced into the canal. They may obstruct urination. The history, the use of a sound, or palpation may make the diagnosis clear. Forceps or incision may be required to remove the stone or foreign body. To prevent the manipulations pushing the object into the bladder, a ligature, made of a piece of drainage tube, may be tied around the root of the penis, or a pin may be thrust transversely through the urethra.

Tumors of the Urethra.

Fibromas, angeiomas, papillomas, myxomas and other tumors may grow from the urethral walls. Malignant tumors are rare, except when they extend from other parts. Urethral tumors cause obstruction to urination, perhaps a discharge, pain and sometimes bleeding. They are diagnosticated by the urethral endoscope and palpation. They should be removed by forceps or by incision of the urethra. The polypoid excrescences occurring at the meatus of the female urethra, and called caruncles, give great pain. They should be excised under cocaine anæsthesia, and the wound should be cauterized.

Injuries of the Urethra.

Contusions and lacerations of the urethra are likely to be followed by hemorrhage, extravasation of urine, inflammatory obstruction to urination, sloughing and the occurrence finally of traumatic stricture. Rupture of the urethra may occur behind a stricture from ulceration and from pressure of the urine in attempts to empty the bladder. Laceration of the deep urethra may occur from falling astride of a fence or board. The tube may be cut off as if with a sharp instrument. Fracture of the pelvis may divide the urethra in a similar manner. Hemorrhage is to be stopped by cold applications, by pressure on the perineum obtained by sitting on a ball of yarn or a pad of gauze, or by the retention of a large bougie in the urethra to make pressure. When extravasation of urine into the perineal tissues or retention of urine has taken place, external urethrotomy down to the seat of injury should be done immediately. This drains the bladder and the inundated structures, and prevents sloughing and sepsis. Bougieing should be kept up during convalescence to prevent traumatic stricture.

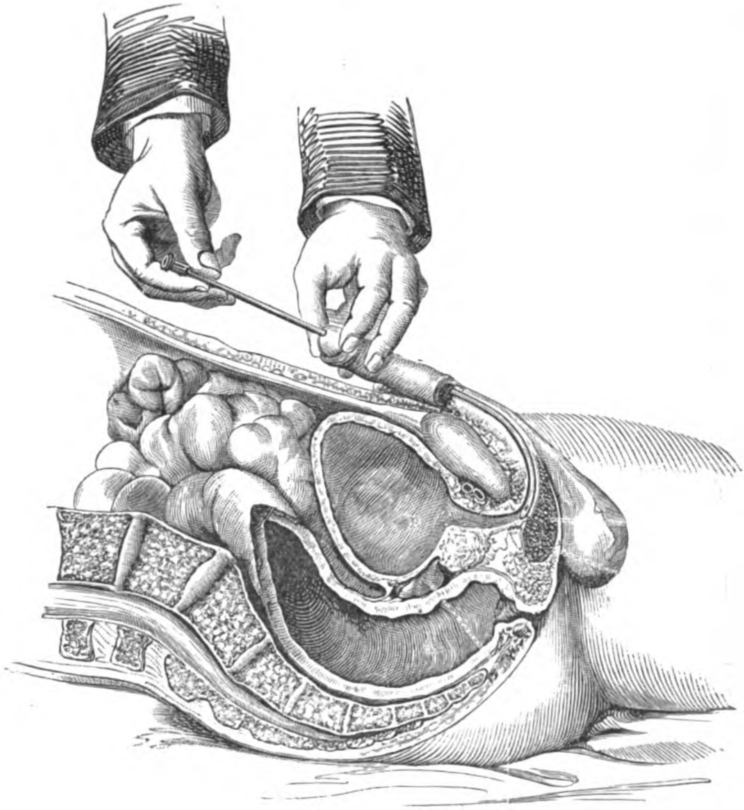
OPERATIONS UPON THE URETHRA.

Catheterization.

Catheters must be made aseptic before use. Metal, glass or rubber ones may be sterilized by boiling in 1 per cent. solution of sodium carbonate. Others may be made sterile by soaking in a 5 per cent. solution of carbolic acid. Formaldehyde has recently been successfully used for this purpose. It is difficult to keep the lumen and fenestræ of the instrument clean unless great care is taken.

The penis and meatus should be washed and sterilized before the catheter is introduced, and it is often well to wash out the anterior urethra with sterilized water carried through the catheter before the end of the instrument is pushed into the bladder. Urethral instruments should be warmed and anointed with sterilized oil, petrolatum or better boric acid and glycerine (gr. x ad f℥j) before being inserted. The soft rubber catheter is safest and cannot cause a false passage by being forced through the wall of the urethra. To introduce a soft catheter the surgeon should hold the penis vertical, as the patient lies recumbent, and make sufficient traction to straighten the folds in the urethra. The instrument is then slowly pushed into the urethra at the same time that the penis is, as it were, drawn over the catheter.

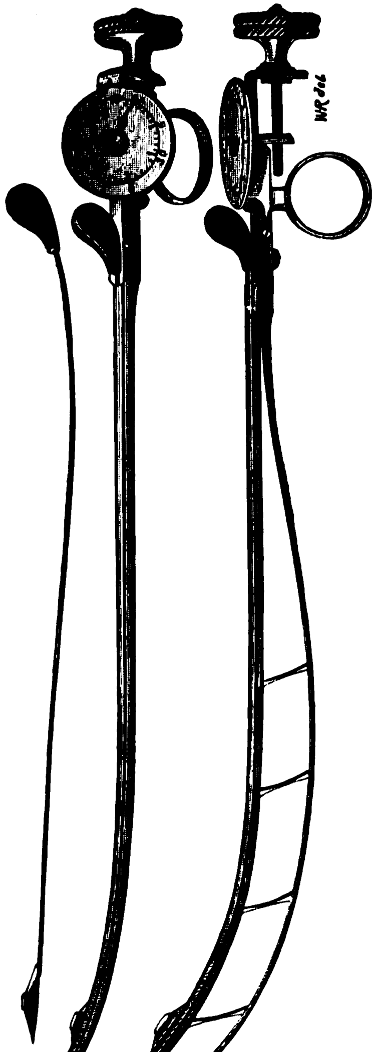
FIG. 425.



Introduction of the catheter. (VOILLEMIER.)

Rigid catheters and bougies and other solid instruments are inserted by having the penis held in a vertical position, as the patient lies on the bed; and then, as the instrument is pushed along the urethra, the penis is drawn up parallel to the anterior abdominal wall and slipped over the instrument as the latter is pushed gently towards the bladder. The outer end of the instrument must be kept exactly in the middle line and close to the surface of the abdomen. The effort should be to have the inner end of the catheter follow the upper wall of the urethra. When the inner end has reached the triangular ligament, it will be stopped unless the urethra is kept tense and the instrument exactly in the middle line. The outer end of the catheter and the

FIG. 426.



Urethrotomes. The instrument shown on the right is open, as it is when the urethra is put on the stretch ready to be cut. The instrument to the left is closed. A knife is shown on the extreme left separated from the shaft of the instrument.

penis are now made to describe a curve of about 180° forwards and downwards, so as to bring them between the thighs of the recumbent patient. The escape of urine or the possibility of moving the inner end laterally as well as up and down shows that the bladder has been entered. If it is desired to retain a catheter in the bladder for several days, a soft instrument should be employed and its end should just enter the bladder. By running a thread transversely through the catheter near the meatus and tying the thread to the hair of the pubes the ejection of the instrument is prevented. Adhesive plaster may be applied to the penis and the thread may be fastened to this. There is a possibility of a flexible catheter being sucked into the bladder, if it is not fastened externally. If difficulty is experienced in catheterization, a finger inserted in the rectum will be of much service in guiding the instrument through the deep urethra.

Catheterization of the female urethra is easy, if the orifice of the urethra is seen. It is best not to attempt catheterization without the aid of vision, for septic material from vaginal and vulvar mucus is very likely to be thus introduced into the bladder.

Anæsthesia is seldom needed for urethral operations. A few drops of cocaine solution (gr. x ad f℥j) may be injected into the deep urethra for local anæsthesia. Its toxic nature must be remembered for death has occurred from it.

Internal Urethrotomy.

For cutting a stricture by internal urethrotomy the urethretome is introduced to a point about a quarter of an inch behind the situation of the contraction. The distance of the stricture from the meatus has previously been recorded. The canal is then put upon the stretch by separating the dilating blades, the knife edge protruded an eighth of an inch and drawn through the rigid portion of the urethral wall. This stretching and cutting may need repetition to obtain the proper dimensions of the tube. The instrument is then withdrawn and a bougie used. The bougieing must be repeated every few days. The incisions in anterior strictures should be made on the floor of the urethra. In posterior strictures they should be made on the roof; but in these strictures external urethrotomy is safer and should, as a rule, be employed when gradual dilatation is not sufficient.

External Urethrotomy.

External urethrotomy, or perineal section, is very similar to perineal cystotomy in the middle line for the extraction of a vesical stone. At least this is the case when a staff, which should have a median groove, can be carried through the stricture into the bladder. An incision is then made in the median line of the perineum until the staff is uncovered, when the point of the knife is engaged in the groove and pushed along it so as to divide the contracted urethral wall. The external wound is then allowed to heal by the granulation process, while the urethra is kept dilated by the daily passage of bougies. When the stricture is so tortuous or tight that no instrument, not even a filiform bougie, can be passed into the bladder, the operation is much more difficult, for the urethra must be found without the advantage of a guide. Under such circumstances a bougie is passed down to the stricture, a perineal incision made, and the end of the bougie exposed. The urethra, which has been opened to uncover the end of the bougie just in front of the stricture, is held apart by two threads inserted into its wall at the sides of the opening. Careful dissection is then made from this spot backwards towards the apex of the prostate, but exactly in the middle line. When the cicatricial tissue causing the stricture is divided the dilated urethra behind it is finally reached. Incision into it is followed by a gush of urine. Cicatricial tissue is cut away, sinuses, if there be any, opened and curetted, and the perineal wound left to close by granulation. Constant bougieing must be maintained during convalescence. It has been proposed to resect the cicatricial portion of the urethra, after it has been exposed by the perineal section, and suture the two portions of the tube together. It has also been suggested to insert grafts of mucous membrane from the lower animals to make good the defect in the urethra. These plastic procedures have not been very satisfactory.

Dilatation of the Female Urethra.

Strictures of the female urethra are very unusual. The short tube is easily dilated by means of conical bougies. Cocaine solution makes the operation painless. Temporary incontinence of urine may follow dilatation. It is only permanent after very excessive dilatation.

CHAPTER XXVI.

SURGICAL DISEASES OF THE REPRODUCTIVE ORGANS.

DISEASES AND INJURIES OF THE SCROTUM.

WOUNDS of the scrotum present no special characteristics, except that great extravasation of blood and great swelling may occur because of the loose structure of the subcutaneous cellular tissue. They are treated on general principles.

Elephantiasis is a common disease in some tropical countries and consists in an enormous hyperplasia of the skin and subcutaneous tissue. In some cases the disease is due to the filaria sanguinis causing obstruction of the lymphatic vessels. This parasite is not always present in cases of scrotal elephantiasis. Treatment consists in excision of the hypertrophied tissues, after constriction at the base of the genitals to prevent bleeding during the operation. A plastic operation may be necessary to ensure cutaneous covering for the penis and testicles. Epithelioma occurs in the scrotum. It is said to be somewhat common in chimney sweeps and workers in paraffine, due doubtless to chronic irritation from the soot or paraffine. Cleanliness is a preventative. Operation is demanded when the disease occurs.

DISEASES AND INJURIES OF THE TESTIS AND SPERMATIC CORD.

Hydrocele.

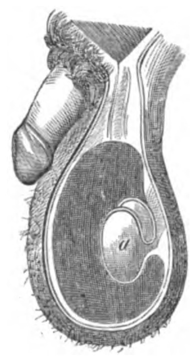
Pathology.—Hydrocele is a term applied to a collection of serous fluid in a sac. Thus hydrocele of the neck is a congenital or branchial cyst in the cervical region. Hydrocele of the vaginal tunic of the testicle is a serous distention of that normal cavity. Hydrocele of the spermatic cord is a similar collection in an unobliterated part of the vaginal process of peritoneum which in fœtal life descends through the inguinal canal with the testis. A similar hydrocele may occur in women in the peritoneal process or canal of Nuck which accompanies the round ligament into the inguinal canal. There are other varieties of hydrocele in the inguinal region, such as that communicating directly with the abdominal cavity, because the funicular process has never been shut off from the general peritoneal cavity by adhesions. Sometimes there may be a hydrocele inside of the abdominal wall and one outside, communicating with each other by a narrow tubular neck in the inguinal canal.

Hydroceles connected with the testicle and the cord are really acute or chronic inflammations of the serous membrane. The usual form is chronic, and to this, with its serous accumulation, has the name hydrocele been especially applied. Acute hydrocele is rarer, but may occur. It would be better, perhaps, to drop the term hydrocele entirely and speak of the condition as inflammation. As the testicle and the spermatic cord may become inflamed, so may the peritoneal process partially surrounding the testicle and that accompanying the cord become inflamed. The condition may be fibrinous, serous or suppurative. If it is serous, it gives rise to a hydrocele.

In congenital hydrocele the serous collection may still have a communication with the peritoneal cavity; may be contained in a distended portion of the serous process of the cord, which is shut off from the peritoneum; or may be confined to the proper tunic of the testicle. The last is the usual condition in the hydrocele of adults. If a communication with the peritoneal cavity persists, the fluid flows back into the abdomen when the child lies down. Spontaneous cure may occur a few weeks after birth by closure of the peritoneal communication at the inguinal canal. Hernia may accompany the congenital condition.

The causes of hydrocele of the acquired variety are injuries, gonorrhœa and disease of the testicle and epididymis.

FIG. 427.

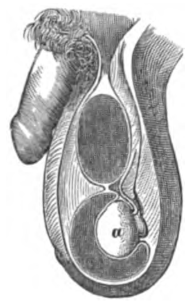


Hydrocele of the vaginal tunic of the testicle. *a*, testicle. (LINHART.)

The disease may be unilateral or bilateral and the amount of fluid in long standing cases of the proper tunic of the testicle may be twenty or thirty fluid ounces. In most cases the fluid is straw colored serum and highly albuminous. It may be turbid from admixture with inflammatory exudates of a fibrinous or purulent character, or reddish from the presence of blood. Sometimes communication with the testicle or epididymis, through a ruptured cyst of these organs or otherwise, is established; then spermatozoa in the hydrocele fluid may give it a milky color. The fluid may contain cholesterine crystals. In many cases the serous wall of the sac seems almost or quite normal; in other cases it is thickened, very tough and studded with few or many fibrinous bodies. Partitions of lymph may divide the sac into separate compartments. Usually the sac is pyriform and without partitions. Hydrocele of the spermatic cord, or encysted hydrocele of the cord, as it is often styled, does not become so large as that of the proper tunic of the testicle and is less common.

Symptoms.—As the inflammation is usually chronic, symptoms are not often marked until the weight of the fluid causes a dragging pain. Then the swelling in the scrotum in front of the testicle is perhaps first noticed. The enlargement of the affected side of the scrotum continues and assumes a pear shape form. On palpation an elastic mass is felt, evidently in front of the testicle which is at the lower and back part of the enlarged scrotum. An indistinct feeling of fluctuation is noticed and the upper end of the tumor is rounded and does not extend upwards into the inguinal canal. The swelling increases slowly from below upward and not from above downwards as a scrotal hernia. The scrotum, if made tense, will transmit the light of a candle held on the side of it opposite to the observer's eye. This test is best made by looking through a tube of paper pressed against the scrotum and held against the eye of the surgeon. Hydroceles with thick walls or containing bloody or cloudy fluid will not transmit light so as to give a pink color at the bottom of the tube. A hydrocele has no transmitted pulsation on coughing as a hernia; and has not the weight of a chronically inflamed testicle or one the seat of a sarcomatous degeneration. Large hydroceles may be complicated with inguinal hernia; they may cause the penis to be so covered with the skin drawn over it as to interfere with urination.

FIG. 428.



Encysted hydrocele of the cord. a, testicle. (WYETH.)

Hydrocele of the cord appears as a globular or oval, rather small tumor, more or less elastic or obscurely fluctuating, in the inguinal region. The tumor may be partially movable so as to seem to be reducible like an inguinal hernia; but it will be found that it only slips up and down in the inguinal canal and does not go inside of the belly wall. Many hydroceles of the cord are outside of the external ring and cannot be displaced so as to enter the inguinal canal.

Treatment.—The palliative treatment is to tap the sac with a small trocar or aspirating needle and, after withdrawing the fluid, to seal the puncture with collodion and a little piece of sterile gauze. The patient at once resumes his ordinary duties. The sac soon refills.

The radical treatment is to obliterate the sac, by causing adhesive inflammation of the opposing walls of the emptied serous cavity; or to dissect out the sac from its surroundings. After tapping the hydrocele, about ten or fifteen grains of carbolic acid liquefied by a few drops of glycerine may be injected by means of a long nozzle syringe through the canula into the serous cavity. This is by external manipulation rubbed thoroughly over the internal surface of the cavity. It destroys the secreting surface and causes a plastic inflammation which glues the walls together and no cavity remains. The canula is withdrawn as soon as the carbolic acid is injected. Care must be taken that no acid is spilled on the skin of the scrotum for it gives pain and cauterizes. Its application to the interior of the hydrocele gives little pain. The inflammation subsides in about ten days. During this time the patient need not be confined to bed.

Instead of this treatment by injection the sac may be incised, the fluid drained out, and the interior of the vaginal tunic packed with aseptic gauze. This causes granulation of the sac wall and gradual effacement of the sac. Another method is to dissect away a large portion of the sac wall or all of it, if the case be one of hydrocele of the cord, and close the wound with sutures. If a communication with the peritoneum exist, it may be closed by ligature, by packing with gauze or by compression with a pad. These operations must all be done in an aseptic manner. Very moderate irritation will cause obliteration of the sac in children. Sometimes tapping with a little scratching of the interior of the sac with the end of the trocar is sufficient.

Hydrocele of the cord and hydrocele of the canal of Nuck in women should be treated in one of the ways just mentioned.

Hematocele of the Vaginal Tunic.

Hemorrhage into the vaginal tunic occurs from injury. It resembles hydrocele in that there is a pyriform tumor present, which may fluctuate or be elastic, but which is not translucent and is heavier. The usual treatment for bleeding into a sac or for an extravasation is to be pursued. Elevation and cold applications are wise. If the blood is not absorbed, it may be evacuated by incision. The clots may suppurate, and rarely may become calcified.

Inflammation of the Spermatic Cord.

Inflammation of the cord may occur from infections of the testicle and epididymis and from injury. Congestion due to unsatisfied venereal desire may cause pain. The symptoms of congestion and inflammation are those common to these conditions, and the treatment is similar to that for orchitis and epididymitis.

Varicocele.

Pathology.—Varicosity of the veins of the pampiniform plexus and of the spermatic cord is called varicocele, and occurs not infrequently about the age of puberty. It is seldom seen except on the left side of the scrotum. The left spermatic vein is longer than the right, opens into the renal vein at a right angle, has no valve and is perhaps exposed to pressure by feces in the sigmoid flexure. These circumstances are supposed to be the cause of varicocele occurring on the left rather than the right side. Constipation, venery, relaxation of scrotal tissues and pressure from ill fitting hernial trusses may be the cause of varicocele.

Symptoms.—Dull aching or a dragging pain, and swelling in the scrotum, increased in hot weather when the scrotum is more relaxed, are the symptoms noticed by the patient. The belief of the populace that sexual impotence is associated with the condition causes much mental distress to the patient. Some tenderness, wasting and softness of the testicle may occur as a result of the venous engorgement. When the spermatic cord is grasped with the fingers it will be found to be surrounded by a mass of dilated veins feeling like a bunch of earth worms. The tumor made by the veins is compressible, very soft and disappears when the patient is recumbent. Pressure empties the veins, but coughing or any increase of intra-abdominal pressure increases their distention. Within the bunch of veins can be felt the straight, dense, almost wiry spermatic duct.

Treatment.—If the patient is not hypochondriacal, there will be little treatment needed other than regulation of the bowels, abstention from sexual excitement, cold bathing of the parts and the wearing in marked cases of a suspensory bandage to support the scrotum. Many moderate cases are not noticed by the patients until they become morbidly disturbed over sexual matters.

Under other circumstances operative treatment is proper. The scrotum may be retrenched by removing a large elliptical piece of skin and superficial fascia. This converts the relaxed scrotum into a sort of suspensory bandage which holds up the testicle and makes a moderate amount of pressure on the veins. This operation is quickly done with a special clamp, to hold the skin while excision and suturing are accomplished, or by simply clipping away the redundant tissues with scissors.

Subcutaneous ligation of the dilated veins, as is done in varicosity of the veins of the leg, is also a satisfactory operation. Care must be taken to isolate with the fingers the spermatic duct and the accompanying artery. The duct is felt through the skin as a dense cord; and the artery is so close to it that both are excluded, if the duct is protected from ligation.

The best operation, however, is excision of one or two inches of the dilated veins. An incision is made on the antero-external surface of the scrotum, the veins tied near the external abdominal ring and again close to the epididymis, and the intervening portion cut out. It is necessary to leave three or four small veins uninjured. The symptoms disappear and the testicle often becomes normal after this operation.

DISEASES AND INJURIES OF THE TESTICLE.

Malposition of the Testicle.

The testicle, owing to incomplete descent in fœtal life or irregularity in that process, may be absent from the scrotum on one or both sides. It may be retained in the abdominal cavity or inguinal canal or lie just outside of the external abdominal ring. It is apt to be undeveloped or atrophied. In very rare instances it is found in the perineum. If the organ is outside of the abdomen, attempts may be made to gradually push it down into the scrotum, as it is liable to receive injurious pressure. This is not urgently demanded and patient may never know of the malposition. If inflammation or malignant disease attack the misplaced organ, it should be excised. Hernia is sometimes associated with undescended testicle. The differential diagnosis of hernia, undescended testicle and hydrocele of the cord is important. The hernia should be controlled by a truss. It may be difficult to do this without removing the testicle.

Epididymitis and Orchitis.

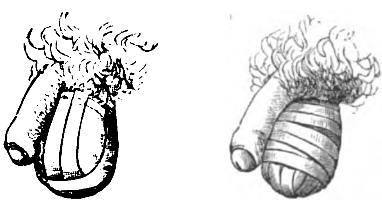
Inflammation of the epididymis may occur without inflammation of the secreting portion of the testicle, and inflammation of the latter without inflammation of the former, but they are often associated. The usual cause is gonorrhœal infection, though septic infection from instrumentation of the urethra in cases of enlarged prostate and stricture is not uncommon. Direct injury may also be a cause of epididymo-orchitis. When the disease is limited to the epididymis the tumefaction and other local symptoms are confined to the posterior part of the testicle. Typhoid fever, mumps and other general diseases may give rise to epididymitis and orchitis. The cause is of course an infection.

Symptoms.—Pain, exquisite tenderness, swelling and fever are symptoms in acute cases. The pain is of a sickening, dragging character and is often reflected to the loins, groins and thighs. The spermatic cord will probably be found swollen and tender. Inflammation of the vaginal tunic of the testicle, sometimes called acute hydrocele, may accompany the epididymo-orchitis and increase the swelling.

In gonorrhœal cases the urethral discharge may diminish or disappear at the time that the infection attacks the testicular structures. Abscess is not a very common result of the inflammation, but may occur, as may sloughing and extrusion of the secreting portion of the gland through the tunica albuginea.

In a week or ten days the acute symptoms subside; but some swelling, pain and tenderness may persist for a long time. Impotence may result if the epididymo-orchitis is double.

FIG. 429.



Method of strapping testicle. (SMITH.)

Treatment.—Rest in bed, elevation of the scrotum, leeches to the region of the spermatic cord, ichthyol, belladonna ointment, mercurial ointment, cold affusions and laxatives constitute the treatment in acute inflammation. In subacute or chronic cases strapping the testicle with adhesive plaster to make pressure is a good device. A rubber bandage or a suspensory bag may be used for the same purpose. Abscesses must be opened, curetted and drained. If the organ is riddled with pus cavities and its function evidently destroyed, castration is the radical treatment.

Tuberculosis of the Testicle.

Tuberculosis usually begins in that portion of the testicle called the epididymis. It is shown by shot like swellings without marked pain, followed by softening and puriform discharge. Sinuses remain where the tubercular deposits have softened and discharged through the skin of the scrotum. Secondary involvement of the prostate gland and seminal vesicles is of frequent occurrence. Excision of the diseased organ is usually the best treatment.

Tumors of the Testicle.

Sarcoma is the most common tumor of the testicle, occurring as a primary growth. Carcinoma sometimes occurs, however, as do non-malignant tumors, such as adenoma and chondroma. In the early stages all the solid tumors have similar symptoms. Cystic tumors resemble hydrocele in that they give on palpation a sensation of elastic fluctuation. Cystic degeneration may occur in sarcomatous growths of the testicle. Soft sarcoma may give an elastic sensation almost exactly like that of a tensely filled hydrocele of the vaginal tunic.

Testicular tumors are distinguished from hernia by absence of succussion on coughing, greater weight and the non-involvement of the inguinal canal in the swelling. They are not translucent like the ordinary hydrocele. A rapid enlargement of a tumor with constant pain, dilatation of the scrotal veins, induration of the lymph nodes of the groin and pelvis and rapid emaciation always point to malignant disease. Carcinoma is said to be more nodular than sarcoma. The only treatment is early enucleation of the testicle with amputation of the spermatic cord high up in the inguinal canal.

Disorders of Insemination.

Impotence, or inability to copulate, is due to malformation of the penis, premature ejaculation or imperfect erection and rigidity of the penis. Sterility is the absence of moving spermatozoa from the semen. When the genital center in the lumbar portion of the spinal cord is not sufficiently stimulated or its frequent stimulation has exhausted its energy, the penis does not become erect. This may occur from emotional or cerebral causes, disease of the spinal cord, excessive venery or masturbation, malnutrition of the whole body, or disturbances of the nerve endings in the genital organs, especially the testicles and prostate gland. The last cause is very common and usually results from inflammation of the organs mentioned. Ejaculation of semen may be premature from emotional causes or from disease of the ending of the nerves at the periphery. The commonest causes of impotence are gonorrhœal inflammation of the prostate, ampullæ and vesicles and excessive venery or masturbation. Most patients are despondent and hypochondriacal and lay much stress on slight symptoms, due to the chronic inflammation, or imagine a variety of symptoms which do not exist. The treatment consists in removing the cause of the difficulty by the means already discussed, encouraging the patient, prohibiting sexual excitement or intercourse, supplying mental and physical diversion; and using camphor monobromide, valerian, phosphorus and belladonna to quiet the nervous system, or tonics, such as strychnia, to stimulate the functions. The remedies must be chosen in accordance with the indications.

Sterility is due to absence of motile spermatozoa in the semen. This may result from lack of secretion in the testicles or obstruction to the exit of the spermatozoa. Inflammations of the epididymis, ejaculatory ducts and urethra are common causes of the latter condition. The treatment depends on the cause, and usually consists in relieving chronic inflammations. If the organs are free from inflammation and no spermatozoa exist in the semen, treatment is useless.

Involuntary discharges of semen, accompanied by erotic dreams, occur at night in healthy men who are continent. They occur at intervals varying from a few days to a month or more. They also occur in masturbators, those who indulge in sexual dalliance without intercourse, and those who have inflammation of the prostate and vesicles. Patients often become anxious and despondent over the loss of semen. Assurance that no harm comes from these losses, remedies to quiet the genital center, measures to lessen the congestion of the prostate, and avoidance of constipation are the requisites of treatment, when treatment is needed.

Spermatorrhœa is the name employed to describe an involuntary escape of semen from the urethra without venereal orgasm or erotic thoughts. It is a condition which occurs at times at the completion of defecation or urination in the most healthy men; and is due to the seminal vesicles being full of semen. It is a relatively rare condition, scarcely to be called a disease, for it is due to physiological causes. The escape of a little milk-like fluid, containing no spermatozoa, at the time of defecation is not spermatorrhœa but prostatorrhœa. It is due to a slight catarrhal inflammation of the prostate gland and deep urethra, and is a common condition. It has been described under the diseases of the prostate. Sometimes this prostatic fluid may have a little semen mixed with it, if the seminal vesicles are full or an emission has previously occurred within a short time. Neither spermatorrhœa nor prostatorrhœa are conditions of importance. The former needs no treatment, the latter that directed to relief of the prostatic irritation or catarrh.

Injuries of the Testicle.

Injuries of the testicle are to be treated as injuries elsewhere. They present no special symptoms except that the severity of the shock may be out of proportion to the injury, because of the great sympathetic nervous supply of the gland.

Excision of the Testicle.

Castration, or excision of the testicle, is required in malignant tumors of the organ and may be necessitated in tubercular disease and severe injuries. The operation is performed by a vertical incision on the antero-lateral aspect of the scrotum. The testis is freed from its cellular attachments, the spermatic cord tied in halves by a strong catgut ligature with which it is transfixed, and the organ then cut from the cord below the ligature. The artery in the stump may be tied by an additional ligature if it be thought necessary. The cord must be transfixed with a ligature before the testicle is cut from it, lest it retract into the inguinal canal and bleed seriously before it can be drawn down again into view.

DISEASES AND INJURIES OF THE PENIS.

Phimosis.

Pathology.—Tightness of the preputial orifice, rendering retraction of the foreskin over the glans impossible, is called phimosis. The condition may be congenital or due to inflammatory swelling of a normally wide and movable prepuce. Congenital phimosis is often accompanied by unnatural length of the foreskin. Adhesion of the mucous membrane of the prepuce to that of the glans is physiological in the infant. Separation gradually occurs as the child increases in age; but for this process to go on it is necessary that the opening in the foreskin be large enough to permit the glans to pass through it.

Phimosis permits the collection of smegma under the foreskin and the occurrence of irritation from decomposition; it may interfere with urination and perhaps cause reflex nervous symptoms from peripheral irritation. As a result of the straining during urination the prepuce becomes ballooned and some of the urine retained. This causes balanitis and posthitis. Often hernia and prolapse of the rectum are due to the straining resulting from a phimosis. Cleanliness is difficult and venereal infection more common in persons with phimosis. It may interfere with impregnation of the female. Inflammatory phimosis is not uncommon in gonorrhœa and venereal ulcers.

Treatment.—In children forcible retraction and stretching of the preputial orifice may be all that is necessary, if aided by separation of the adherent mucous surfaces by a probe or the fingers. In more severe cases and in adults, dorsal incision or circumcision is to be performed. Inflammatory phimosis may only require cold applications or other local remedies to reduce swelling.

The dorsal incision method consists in inserting a grooved director between the glans and the foreskin on the top of the penis and slitting the foreskin exactly in the middle line as far back as the corona. The corners of the prepuce are then rounded by additional cuts with the scissors. A few sutures may be used or omitted. This does well except where the prepuce is long as well as tight. If the phimosis is due to chancroids beneath the foreskin, it is desirable, before making the incision, to inject a solution of silver nitrate under the foreskin and to neutralize the excess of caustic by injecting a saturated solution of common salt. The caustic coagulates the secretions and prevents inoculation of the wound. The uncovered sores are then seared with fuming nitric acid. If the prepuce is long, circumcision is the proper operation.

Circumcision may be performed painlessly without general anæsthesia by tying a piece of rubber tube or a narrow strip of gauze around the root of the penis and injecting cocaine solution into the dorsum of the organ. The constriction prevents bleeding and incarcerates the cocaine. The foreskin is then drawn forwards and the covered glans held backwards, while a pair of scissors or a knife is used to cut off the foreskin in front of the point of the glans. The skin at once retracts, leaving a cuff of the less inelastic mucous membrane still

FIG. 430.

Levis's phimosis forceps.

covering the glans. This is split in the middle of the dorsum and any adhesions separated. All of the mucous membrane is then cut away, except a fringe a quarter or an eighth of an inch long close to the corona. The constriction is removed, bleeding stopped and the skin and edge of mucous membrane united with eight or ten fine catgut sutures. Special forceps may be used to evert the rigid mucous membrane or to hold the foreskin while it is amputated; but they are unnecessary. Gauze is used as a dressing, and has a button hole cut in it to allow the end of the penis to protrude in order to avoid soiling the dressing with urine. This may also be accomplished by drawing a condom or rubber finger stall, with the end cut off, over the dressing and gluing it to the surface of the glans with collodion. In adults, camphor, bromides and other remedies, to prevent erections, should be given. The frenum should be preserved, if possible.

FIG. 431.

Reduction of paraphimosis. (PHILLIPS.)

Paraphimosis.

When a foreskin is retracted and catches behind the corona, so that it cannot be slipped forward, the condition called paraphimosis exists. If the constriction is moderate or due to inflammatory swelling, no serious results accrue beyond pain, provided replacement is soon accomplished. If replacement is not prompt, violent inflammation of the glans and gangrene may result.

Treatment.—Reduction is to be attempted by oiling the glans and prepuce, and compressing the former with the fingers while the latter is drawn forwards with the other hand. If this is ineffectual, an incision should be made through the constriction caused by the foreskin. The cut should be made at the middle of the dorsum of the glans, from within outwards. If paraphimosis recurs, circumcision should be performed.

Inflammation of the Penis.

Inflammations of the whole penis, of the glans and of the prepuce are to be treated on general principles, by cleanliness, antiseptic solutions, drying powders and ointments; and by laxatives, and remedies to prevent erections. Herpes, a vesicular eruption on the glans or prepuce is accompanied by a burning or itching pain, and is chiefly of importance because it may be confounded with chancre or chancroid.

Chancroid or Venereal Ulcer.

Pathology.—This is a distinctly local lesion due to contagion, usually during sexual intercourse, found most commonly on the genitals, though it may occur anywhere. It causes no constitutional symptoms except of the septic type and it is not syphilitic. It is auto-inoculable and therefore there are likely to be more than one ulcer. It is probable that it is due to a specific virus. Suppuration is present from pyogenic germs. The infection is probably a mixed one. Involvement of the inguinal lymph nodes is very frequent, causing a bubo, which, as a rule, suppurates. The pus from the abscess so formed is very contagious.

Symptoms.—Chancroid begins within a few hours after inoculation as a red point or papule. This soon becomes a pustule and then an ulcer. The ulcer increases in extent and depth and in a few days forms an irregular excavation, with perhaps undermined edges, from which a grayish pus is discharged in abundance. This discharge differs from the serous discharge of a chancre, and the sore has not the indurated base of a chancre. A chancre, which is the initial lesion of syphilis, is practically a new growth. Chancroid is a destructive lesion, which often has a tendency to produce rapid local mortification in addition to the ulceration. It is then called a phagedenic chancroid. The phagedenic form may attack the tissues involved in the bubo, or inflamed inguinal nodes, as well as the original sore. The sloughing is particularly liable to occur in those debilitated by intemperance or other excesses. The diagnosis between chancre and chancroid has been discussed under syphilis. Herpes is a vesicular lesion, occasionally seen on the genitals, unlike chancre and with no destructive tendency, such as that often shown by chancroid.

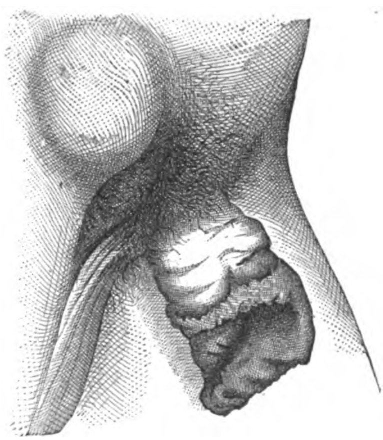
Treatment.—In mild cases cleanliness, solution of hydrogen dioxide and antiseptic powders, like iodoform, boric acid or calomel, will probably be sufficient. If the ulcer spreads, it should be cauterized with fuming nitric acid or the red hot iron and then treated as an ordinary ulcer. Solution of cocaine applied on cotton may be used as a local anæsthetic before cauterization. Scissors or the curette will sometimes be a quicker means of removing the infected tissue. The wound left must be cauterized to prevent reinoculation. Tonic and supporting treatment should be used. Suppurating buboes should be laid open, curetted, wiped out with undiluted carbolic acid or nitric acid and packed with gauze.

Tumors of the Penis.

The most common non-malignant tumor of the penis is papilloma, which occurs on the glans and prepuce. These warts are not syphilitic. They may be due to irritating urethral discharges. They should be clipped off with the scissors and the base touched with chromic or nitric acid or acid nitrate of mercury. The parts should be kept clean and dry by powdered boric acid, acetanilid, zinc oxide, tannic acid or calomel. Bleeding may be stopped with the actual cautery.

Malignant disease is usually epitheliomatous and attacks first the glans or prepuce. The lymph nodes in the groins and the tissues of the penis and scrotum finally become involved. In its early stage it may be mistaken for chancroid or syphilis. The treatment consists in amputation of the penis and removal of the inguinal lymph nodes.

FIG. 432.



Epithelioma of penis. (ASHHURST.)

Injuries of the Penis.

Ordinary injuries call for no special discussion. Rupture of the sheath of one or both cavernous bodies may occur, as the result of mechanical violence when the penis is erect. This is sometimes called fracture of the penis. It is a grave injury. Erection subsides at once, and extravasation of blood occurs into the tissues of the penis and perhaps into those of the scrotum and abdomen. The urethra may be ruptured at the same time and this may cause extravasation of urine. Pain, shock and nausea may be excessive. Suppuration and gangrene may occur. Traumatic stricture of the urethra and a deformed cicatricial penis may result from the injury. Free incisions should be made into the organ to give vent to the extravasated blood and urine, and the ordinary measures for treating traumatic inflammation should be adopted.

Excision or Amputation of the Penis.

This operation is done for malignant disease. A rubber band or piece of gauze is tied around the base of the organ to prevent hemorrhage. A circular amputation is then done, but the urethra is left about a half inch longer than the cavernous portions of the organ. The lower wall of the urethra is then split and its edges stitched to the skin at the sides and above. This prevents cicatricial stricture of the meatus. A catheter may be kept in the urethra and bladder for a day or two if necessary. If the amputation is done close to the pubes, as may be necessary in malignant disease, the patient may use a short catheter when he desires to urinate to avoid soiling his clothing. Instead of this he may have a perineal meatus formed so that he can urinate easily in the sitting posture. To do this, a median urethrotomy is made in the perineum and the urethral tube isolated, divided, and the portion towards the bladder stitched to the skin. The anterior portion may then be closed. In amputation near the pubes it is well to put a suture in the cavernous bodies before they are divided to prevent retraction into the tissues of the scrotum.

DISEASES AND INJURIES OF THE VULVA.

Adhesion of the labia of the vulva occurring as a congenital condition requires incision. Varix needs no treatment unless the size of the swelling demands excision of the veins. Rupture of a varicose vein may cause hemorrhage and require ligation or excision of the vein. Hematoma or blood in the vulvar tissues needs pressure and cold applications, or incision and removal of clots.

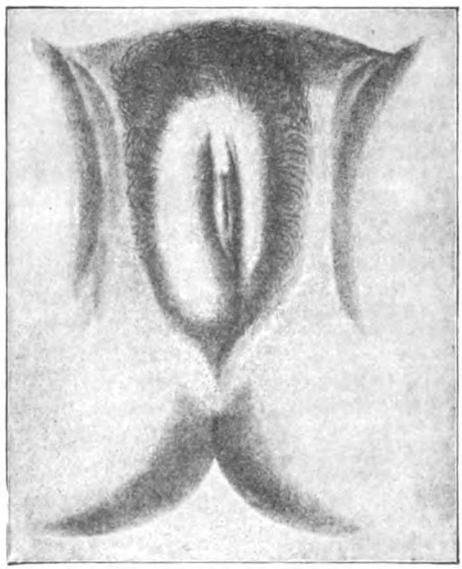
Inflammation of the Vulva.

Vulvitis occurs from the gonococcus, the pyogenic bacteria, irritating substances in the urine, particularly sugar, wounds and animal parasites. The symptoms are more apt to occur in those of uncleanly habits and those who are the subjects of vaginal discharges. The process may go on to ulceration, abscess or gangrene. Children of low vitality from inheritance or bad hygiene are liable to vulvar inflammation. It is easy to understand the occurrence of inflammatory processes in the irregular folds of mucous membrane which are difficult to keep clean. The itching found associated with sugar in the urine is practically an eczema. Local pain, fetid discharge and swelling are the common symptoms of vulvitis. Involvement of the lymph nodes in the groin may occur. Chancre and chancroid, tuberculosis, lupus and epithelioma occur and may cause ulceration. These forms of ulceration must not be mistaken for the simpler forms of vulvitis. Painful urination or retention of urine may occur from involvement of the urethra. Treatment consists in removing the cause, treating associated diseases, such as vaginitis, endometritis and diabetes, and insisting upon cleanliness combined with applications of mild antiseptic and astringent lotions. Hot water vaginal douching will be found valuable in many cases of vulvitis. Abscess and gangrene must be treated on general principles.

Inflammation of the Vulvo-Vaginal Glands.

The vulvo-vaginal glands, often called the glands of Bartholin, are two in number situated one on each side of the vaginal outlet. They communicate with the surface at the vulvo-vaginal junction by ducts about a half inch long. Gonorrhœal and other infections are liable to travel up these ducts and cause abscess. The symptoms are often severe, both locally and constitutionally. The treatment should be early incision through the labium followed by antiseptic irrigation and dressings. Inflammatory occlusion of the duct of one of these glands may cause a cystic tumor. This may cause very little trouble, but it occasionally suppurates. The cyst should be removed by dissection.

FIG. 433.



Abscess of gland of Bartholin. (ETHERIDGE.)

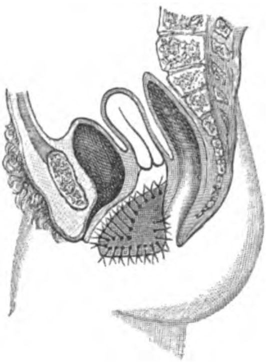
Tumors of the Vulva.

Papillomatous tumors, the result of irritation from gonorrhœal discharges, form cauliflower excrescences on the skin and mucous membrane. They may be large and are the seat of a profuse foul discharge which may be mixed with blood. They should be removed by knife or scissors and the wound cauterized. Epithelioma, lipoma, fibroma, and other tumors occur and require the usual treatment. Eliphantiasis of the labia and clitoris is more common than in the male genitals.

Injuries of the Vulva and Perineum.

Vulvar wounds require no special description. Laceration of the perineum frequently occurs during labor. The tear may merely rupture the fourchette or continue backwards any distance, even until it reaches the rectum by rupturing the fibers of the sphincter muscle. The laceration may involve the recto-vaginal septum to such an extent that the anterior wall of the rectum is divided for some distance above the anus. The symptoms depend upon the extent of the laceration and consist chiefly in a feeling of lack of support to the pelvic organs. In cases involving the sphincter incontinence of flatus and feces to a greater or less extent occurs. Tears of the perineum should be repaired by suture immediately after labor. Antiseptic precautions must be observed. Deep sutures of silkworm gut, silk or formaldehyde catgut are satisfactory for this purpose. The silkworm gut sutures should be cut so as to leave ends about three inches long because short ends stick into the tissues and give pain. A continuous buried catgut suture and a continuous superficial catgut suture, reinforced by a few points of silk suturing make a quick and satisfactory operation. The ends of the sphincter muscle must be carefully approximated by special sutures in cases where the sphincter muscle has been torn.

FIG. 434.



Perineorrhaphy: the newly formed perineum after triangular denudation. (TILLMANNS.)

Perineal tears which have not been subjected to immediate suture and have therefore cicatrized require removal of the cicatricial surface before the application of sutures. Various methods of denudation have been suggested. These vary greatly in the shape of the denuded area, but all aim to reëstablish the wedge shape recto-vaginal septum.

The illustration shows one of the methods often employed. After operation the patient should be kept in bed and warned not to widely separate the thighs. The urine should be drawn by a catheter and the parts kept aseptic. The bowels should be moved by laxatives after the first two or three days.

FIG. 435.

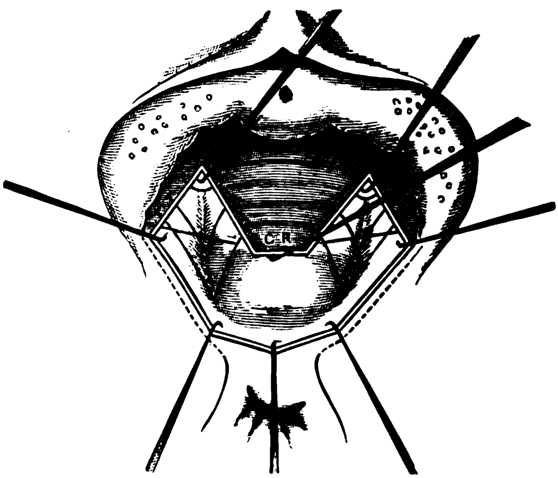


Diagram of denudation and suturing in operating for perineal laceration. (KELLY.)

DISEASES AND INJURIES OF THE VAGINA.

Congenital Abnormalities.

Congenital malformations of the vagina are of importance because of interference with menstruation, sexual intercourse and childbirth. The chief abnormalities are absence of the vagina, rudimentary vagina, double vagina, closure of the vaginal outlet, stricture of the tube and imperforate hymen. An anomalous communication between the bladder and rectum may exist. Stricture may be acquired, also, resulting from the healing of ulcers or wounds or the contraction of inflammatory deposits. Imperforate or persistent hymen is to be relieved by incision antiseptically performed. A large plug like dressing should be kept in the wound for a few days. Congenital and acquired strictures are to be treated by dilatation, perhaps combined with incision. Retained menses and other derangements of the female sexual organs demand careful physical exploration before active treatment is undertaken. In young unmarried women these examinations are best made when possible by women physicians, or through the rectum. Abnormal irritability of the external genitals, called vaginismus, causes great pain and muscular spasm of the sphincter of the vagina and pelvic muscles on attempts at coitus. It requires dilatation or excision of the hymen.

Vaginitis.

Inflammations of the vagina are similar in cause, symptoms and treatment to those of the vulva. In truth both parts are usually inflamed together. Gonorrhœal vaginitis is very common and is the cause of most cases of gonorrhœa in the male. The treatment consists in cleanliness and frequent copious douching with hot antiseptic solutions and astringent lotions. The ease with which the vagina can be cleansed and its walls kept apart by antiseptic plugs of gauze make gonorrhœa in the vagina much more readily curable than in the male urethra. The complications of gonorrhœal vaginitis are urethritis, cystitis, endometritis, salpingitis and inflammation of the vulvo-vaginal glands. Gonorrhœal vaginitis in the parturient woman is very dangerous to the eyes of the fœtus, because of the probability of infection of the conjunctiva causing purulent conjunctivitis and destructive inflammation of the cornea. The vaginitis should be cured before labor and the infant's eyes be given skillful attention immediately after birth.

Vaginal Fistules.

Vesico-vaginal, urethro-vaginal and recto-vaginal fistules occur from injuries during childbirth causing sloughing, and from ulceration or injuries. They need plastic operations for their closure.

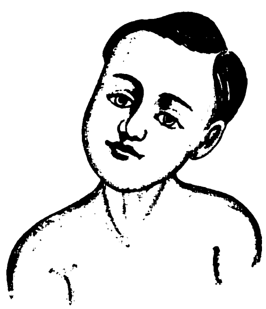
CHAPTER XXVII.

DEFORMITIES OR ORTHOPÆDIC SURGERY.

Torticollis or Wry-neck.

Pathology.—Wry-neck is the name given to rotary deviation of the head caused by contraction of the cervical muscles. The muscular spasm may be spastic, or permanent, or it may be spasmodic, and then it is usually accompanied by pain whenever the spasm producing the deformity occurs. Hysterical contraction of the cervical muscles may give rise to hysterical torticollis. A similar deviation of the head may be due to a paralytic condition of one of the groups of muscles, and also to cicatricial contraction of the skin and subcutaneous structures after severe burns or other destructive injury. The sterno-mastoid muscle is most frequently the seat of the abnormal contraction, though in many cases the trapezius muscle and the scalene muscles are involved in the affection. In some instances the splenius capitis and deep rotators of the head seem to be the displacing agents. The affection usually involves one side of the neck, but cases are described in which the cervical muscles of both sides have been abnormally contracted. Congenital torticollis is a malformation or is due to injury received at birth; but the acquired form is that which comes most frequently under the surgeon's notice.

FIG. 436.



Torticollis or wry-neck. (TILLMANNS.)

Torticollis results from the head being held for a long time in a strained position, as in inflammation of the cervical glands; to myositis, or inflammation of the muscles, due to rheumatism, gout or other causes; to spasm of the muscle, induced, probably, by lesions of the central nervous system; to muscular spasm the result of injury, and to reflex irritation, such as intestinal worms. A mild form of torticollis occurs after exposure to cold, and is called by the laity stiff-neck.

The distortion caused by caries of the cervical vertebræ is not strictly torticollis.

The pathological changes which occur in long standing cases are alterations of the shape of the bones and ligaments and degeneration of the contracted muscles.

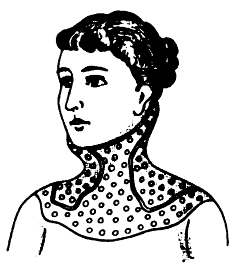
Symptoms.—Wry-neck, due to exposure to cold, occurs as a slight rigidity of the cervical muscles and is attended with pain on attempts at motion. Typical torticollis, due to contraction of the sterno-mastoid muscle of one side, causes the head to rotate, so that the face is turned to the opposite side and the chin slightly elevated. The muscle which is the cause of the deformity is prominent and tense. The shoulder on the side corresponding to the affected muscle is often somewhat elevated and a slight spinal curvature in the dorsal region is not uncommon. The exact character of the displacement varies with the muscle or group of muscles involved.

In the spastic contraction there is little pain, but in the spasmodic form the head, which is ordinarily in the normal position, is persistently and violently jerked to one side, while severe pain is felt in the contracted muscle or muscles on the opposite side of the neck. In some cases this painful spasm and rotary displacement of the head occurs when the least attempt is made to walk or to use the arms. In other cases the spasmodic contraction occurs at frequent intervals without reference to voluntary movements.

Treatment.—Mild rheumatic torticollis is cured in a few days by the application of heat, by means of bags filled with hot water, sand or salt, and rubbing with stimulating liniments, aided perhaps by hypodermic injections of atropia (gr. $\frac{1}{100}$ to gr. $\frac{1}{60}$).

The spastic form may be relieved by general anæsthesia and, if of hysterical origin, will probably not return. In other cases a collar like apparatus may be so adjusted as to prevent a reproduction of the deformity when the patient comes out of the anæsthetic state. Other cases require myotomy, or division of the displacing muscle. If this be the sterno-mastoid the tenotome should be introduced beneath the muscle at its internal edge, just above the clavicle, and as much of the muscle divided as seems necessary. It may require two punctures with the tenotome or an open incision to enable the surgeon to divide both the sternal and clavicular heads of the muscle without running great risk of injuring the deep vessels. After the muscle has been divided, the head should be turned to its normal position and held there by gypsum bandages or some form of retentive apparatus. It is usually wise to over-correct the deformity, as the final result is usually less than that immediately obtained.

FIG. 437.



Apparatus for the after treatment of torticollis. (TILLMANNS.)

It is often difficult, in the more complicated cases, to decide what muscles are responsible for the deformity. A careful study of the character of the rotary displacement is therefore demanded. It is especially important to recollect that in sterno-mastoid contraction the head is turned to the side opposite to that of the affected muscle. Electricity and gymnastics will do a great deal here, as in other muscle deformities. Apparatus, whether consisting of steel springs or rubber bands, may be available as accessory agents, but they can seldom take the place of active and passive muscular movements. The spasmodic form is exceedingly intractable. Myotomy, and excision or stretching of the spinal accessory nerve have been attempted with but moderate success. This nerve is reached by an incision along the anterior border of the sterno-mastoid muscle, after which the muscle is drawn outward and backward, and the nerve found crossing the transverse process of the atlas. Excision of the upper cervical nerves at the base of the occiput has been performed where the deep rotators were supposed to be at fault. The fluid extract of gelsemium in very large doses has given fair results in some cases. Preparations of this drug vary greatly in strength, and minimum doses should be used at the beginning of the treatment.

Spinal Curvatures.

Pathology.—At birth there are no curves in the infant's spine, but as the child assumes the sitting or erect posture, curves which are recognized as the normal vertebral curves, are developed. Weak muscles, careless postures, the prolonged retention of positions causing abnormal curves of the spine and paralysis of special groups of spinal muscles are causes of spinal curvature. Rickets and other agencies tending to interfere with normal development of the growing skeleton are sometimes causes of these distortions in the young.

Angular antero-posterior curvature of the vertebral column, which is due to caries or tuberculosis of the vertebral bodies, is naturally distinct from the spinal deviations now under consideration. The rotary lateral deviation of the spine, to which the name scoliosis is applied, is the most common form of spinal curvature. Kyphosis, the form in which the convexity of the column is increased in a posterior direction, is less common; whereas lordosis, or increased convexity forward, is comparatively frequent.

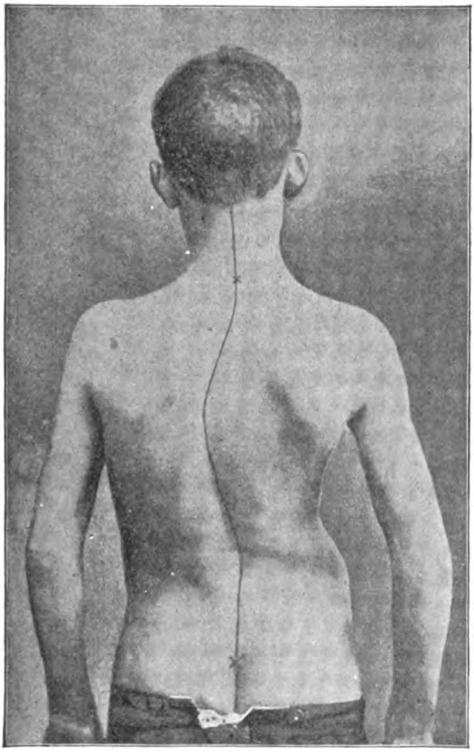
These deviations of the spinal column are due to relaxation and debility of the spinal ligaments and muscles, or to some vicious position assumed while at work or at rest which has a tendency to maintain the spine in an abnormal position for a considerable portion of the day. As a consequence the bones, the inter-vertebral cartilages and the ligaments become more or less misshapen, and the deviation becomes confirmed. Congenital curves of the spine are at times seen.

Varieties.—The varieties of spinal curvature are scoliosis, kyphosis and lordosis.

Scoliosis or rotary lateral curvature, is particularly common in young girls about puberty. There is some rotary twisting of the vertebral bodies as well as a lateral curving. Ordinarily, there is a dorsal curve, with its convexity to the right, and a compensatory curve in the lumbar region with the convexity to the left. Sitting at school desks with one shoulder unnaturally elevated; carrying an infant constantly on one side; and occupying a lolling position during the greater part of the day will tend to lateral curvature in growing girls about the menstrual epoch. Inequality in the length of the legs, due to disease of the joints or to asymmetry in length, will equally lead to lateral curvature. Deformity of the chest from pleuritis, wearing an artificial leg and ankylosis from hip disease may be similar factors in spinal distortion. Rickets is a predisposing cause, as well as of osseous deformities in other parts of the skeleton.

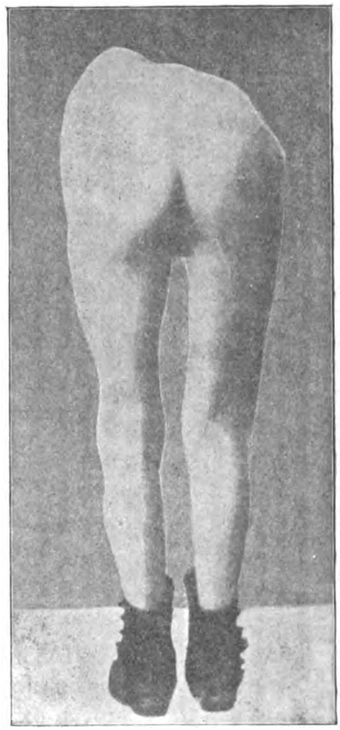
Round shoulders, prominence of one hip, elevation of one shoulder, projection of the posterior border of one scapula and pain in the corresponding shoulder and the back may be the first symptoms to attract attention. The pain may be scarcely noticeable during the day, but is felt at night or when lying down or sitting. It is often unimportant. The winged scapula, as this deformity is termed, becomes

FIG. 438.



Photograph of case of left dorsal scoliosis. (LOVETT.)

FIG. 439.



Characteristic appearance of scoliosis in the stooping posture. (LOVETT.)

more marked; next a deviation of the dorsal spine in the lateral direction is observed, and soon a secondary compensatory curve appears in the lumbar region. Rubbing the skin over the spinous processes of the vertebræ will cause red spots to appear over these bony prominences, so that the surgeon can readily determine the absence or extent of the spinal curvature. The spinous processes, however, are in reality less displaced than the bodies of the vertebræ themselves, which have undergone lateral and rotary displacement. The spinal column loses its flexibility and becomes somewhat stiff. The viscera may be injured and compressed by the deformed skeleton. If the deformity is great, a deep sulcus occurs between the lower ribs and the ilium on the side of the body corresponding with the convexity of the dorsal curve. The ribs and ilium may actually override, and bursæ may be formed from friction. Examination should be made with the patient stripped. The rotary displacement is well shown by having the patient bend over as in bowing. The view from behind makes the displacement clear.

Kyphosis, or round back, is a bending of a part or whole of the spine so that the convexity of the curve is backward, giving the patient the appearance called round shouldered. The term is not used in connection with angular curvature due to tuberculosis of the vertebræ. Kyphosis occurs in children and in old persons, and is commonly in the upper portion of the dorsal region. In long standing cases ossification of the vertebral joints, so that the bodies become ankylosed, may take place. Rickets and faulty positions while at work or at rest may be the cause of the deformity. It is an indication, also, of the increasing debility of the tissues which occurs in the aged. Dyspnœa and other visceral symptoms may be induced in aggravated cases.

Lordosis, or hollow back, is a spinal deviation in which the convexity of the curve is forward; it is usually found in the lumbar region, due to an aggravation of the normal lumbar curve. Congenital dislocation of the hips gives rise to lordosis. Carrying heavy weights on the head is another cause. Pregnancy and abdominal tumors give rise to temporary lordosis, because the patient must bring the center of gravity further back in order to neutralize the weight in front of the median plane. Hollow back, whether occurring in the lumbar region or the cervical region, is characteristic. When the patient lies upon a hard mattress the arching of the spine is conspicuous. There may be compensatory kyphosis, and in kyphosis there is often compensatory lordosis. Uterine and other visceral trouble may occur secondarily.

Treatment.—The prevention of spinal deviation is exceedingly important in young subjects presumably liable to such a deformity. Gymnastic exercises and abstinence from positions, whether at school or at work, that tend to exaggerate the normal curves, should be enforced. Even slight deviations should be subjected to treatment, because they may be entirely cured. Absolute restoration of the outline is impossible, when the bones have been permanently deformed by pressure or when ankylosis between the vertebral bodies has occurred. The general health should be improved by tonics and outdoor exercise, and by abandonment of the injurious habits which tend to confirm the deformity. Gymnastic exercises to develop weak muscles or to draw the bones into proper position should be instituted, but they should not be permitted to be carried far enough to fatigue the patient. Swinging by the hands from a trapeze or from the top of a doorway will straighten out the curves by the traction exerted by the lower limbs. The use of dumb bells and Indian clubs, and massage are valuable in developing the muscles. Propping up certain portions of the trunk while lying down or the use of springs or apparatus to make pressure upon the distorted spine will be found at times efficacious in relieving the deformity. The motions used in swimming are good exercise for a patient with lateral curvature, and they may be performed in the air by having the patient lie upon a proper support. All these mechanical measures must be continued for many months before benefit can be observed.

Mechanical support is valuable as an adjuvant in developing the muscular system, and may, therefore, be useful in the intervals when rest from the more active treatment is required. In rotary lateral curvature a pelvic band with crutch heads extending up into the armpits may be worn. A jacket or cuirass of gypsum bandages fitted to the patient when he is suspended, to straighten out the curves, has advocates. If these means prevent increase of the deformity and augment normal muscular development, the tendency to spinal deviation will disappear as the patient grows older. The flexibility of the spine must be restored, as well as the deviation corrected, if a perfect result is sought.

If the lateral deformity depends upon one leg being shorter than the other, the lower extremities should be made of equal length by increasing the thickness of the sole of the shoe on the short limb. It is possible that making the legs of unequal length by wearing a high sole may be utilized as a treatment for correcting spinal curvature from other causes than asymmetry of limbs.

Kyphosis requires a similar kind of treatment, though the muscular exercise and apparatus should be adapted to the character of the deformity.

If ankylosis of the vertebræ has occurred, cure is not to be expected. Rupture of such osseous or fibrous bands has in some cases been attempted, and has been successful.

Lordosis is managed in a similar manner, but the pressure from the apparatus is so applied as to push forward and compress the dorsal curve. The patient's shoulders and hips may be so elevated when lying in bed as to diminish the lumbar curve, and thus tend to correct the deformity. It must be evident that for the successful management of spinal curvature, some ingenuity on the part of the surgeon will be required. Although the aid of steel springs and rubber bands and other mechanical appliances is often essential, it is upon the muscles that dependence is to be placed in preventing and overcoming the distortion. Much patience is demanded on the part of the patient.

Webbed Fingers.

The term webbed fingers is applied to the congenital deformity in which two or more fingers are fastened together by cellulo-cutaneous bands extending across the inter-digital notch. The band may unite the fingers throughout their entire length or may join only small portions of them. The deformity is only relievable by operation. One of the best plastic operations is to dissect a rectangular flap from the back of one of the fingers extending as far as its middle line, and to raise a similar flap from the palmar surface of the other finger extending as far as its middle line. The base of each of these flaps is of course left attached to the finger from which it is not taken, and extends over the web between the webbed digits. The subcutaneous tissue uniting the fingers is then divided, and the flaps carried around the sides of the two fingers in such a way as to have the two cutaneous surfaces presenting toward each other on the proximal sides of the previously united digits. If some such method is not adopted, the raw surface made by cutting the fingers apart would unite at the base during cicatrization, despite the utmost care and thorough dressing.

Club-Foot.

Pathology.—Talipes, or club-foot, is a deformed position of the foot, or part of the foot, in relation to the leg. It may be congenital or acquired. Usually the muscles, fascias and ligaments are contracted; sometimes the bones and cartilages themselves are misshapen. The deformity may depend upon congenital malformation of the structure of the foot, upon spasm of the contracted muscles, upon paralysis of the muscles which normally should oppose the contracted muscles and upon other displacing agencies. Wasting of the muscles occurs secondarily, atrophy of the foot and leg results and subcutaneous bursæ are developed at points upon which pressure comes during walking.

Congenital cases present a very great amount of distortion when the child is allowed to attain adult age without the adoption of proper means to cure the deformity.

Varieties.—There are six varieties of talipes:

1. Pes varus; in which the inner side of the foot is raised, and the anterior part of the foot and the sole turned inward.
2. Pes valgus. This condition is the opposite of pes varus, and in it the outer side of the foot is raised and the sole turned outward.
3. Pes equinus. Here the heel is raised and the patient walks on the toes.
4. Pes calcaneus is the opposite of pes equinus. The toes are, therefore, raised and the patient walks upon his heel.
5. Pes planus; in which the arch of the foot is sunken and the entire sole rests upon the ground when walking.
6. Pes cavus is the opposite of pes planus. In it the arch of the foot is increased and there is a great hollow in the sole.

These six forms of talipes are the types, but the forms may be variously combined. For example: In equino-varus the heel is raised and the patient has the inner side of the foot elevated and the sole turned inward, while pes calcaneo-valgus is a form in which the patient walks upon the heel with the sole turned outward.

Treatment.—The treatment of club-foot requires many months and a combination of operative, mechanical and physiological measures. Manipulations carried on for months by the patient's nurse, by which the muscles are developed and the foot forced into a normal condition, will frequently cure slight degrees of the deformity. In other cases, tenotomy of the tendons and fascias will be demanded, and will have to be supplemented with manipulations and apparatus in order to maintain the corrected position obtained by operation. The most confirmed and marked cases are found in adults who have gone untreated. In these, and sometimes in severe cases occurring in the young, excision of some of the tarsal bones is the only means by which a fairly good position of the distorted member can be obtained. Cases of unsuccessfully treated club-foot, commonly called relapsed cases, are more difficult to handle than others presenting similar deformity, because after tenotomy has been done the patient's tendons and fascias become more or less matted together by adherent inflammation.

Immediate correction of the deformity by force, applied by the hands, may be possible in moderate deformity in infants. The corrected position so produced is maintained by the application of gypsum bandages. The operation of tenotomy may be done upon infants after two months of life, if by this time efforts to overcome the deformity by manipulation have been unavailing, and in cases where it is evident that these simple measures will not be of service if they are kept up. After tenotomy the foot and leg should be bandaged to a well padded splint of zinc, copper or sheet iron which will maintain the desired position. These flexible splints are cheap and can be altered from time to time as the surgeon desires. They facilitate greatly the change in position of the foot which is the object of treatment. Gypsum splints may be used, if preferred. After six weeks' use of the splint it may be dispensed with in congenital cases, but the little patient should be under the surgeon's eye at intervals until able to walk, and should even be watched by him after that date. The greatest care is necessary to see that excoriations or bed-sores are not produced by the apparatus applied. Massage in its various forms should be continued during treatment. It is essential that the muscles of the leg be subjected to the influence of massage as well as those of the foot.

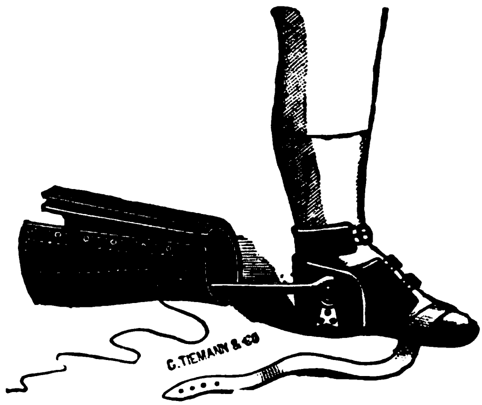
In more marked deformity, portions of the tarsus should be excised. Excision of the astragalus, through an incision on the dorsum of the foot, avoiding injury to the tendons, will often permit immediate correction of deformity. The foot is then maintained in the corrected position with a gypsum splint. Sometimes a more extensive removal of bone is demanded. The cuboid, the cuneiform and a portion of the calcaneum may require removal in bad cases of pes varus. If this open and rapid method of treatment is adopted, sufficient bone should be removed to permit the surgeon to put the foot in a proper position without tension. Any tendons causing a tendency to talipes may be divided subcutaneously or by open incision. Tendons accidentally severed during the tarsectomy should be united by sutures. The bursæ, developed at points of pressure in old cases, should be excised at the time of the tarsectomy. A gypsum splint is used for about six weeks. After this cases may or may not need club-foot shoes for some months.

A tendency to relapse exists in cured club-foot. Efforts at cure of the deformity should, therefore, include prolonged supervision and should at first aim at an over-correction of the deformity.

FIG. 440.

Reeves's universal talipes shoe.

FIG. 441.



Reeves-Scarpa shoe for severe cases.

Pes Varus.

Symptoms.—This is the most frequent form of congenital club-foot. There is inversion of the anterior two thirds of the foot, with turning in of the sole and elevation of the inner part of the foot, so that the patient walks upon the outer part, or, in bad cases, actually upon the dorsum, of the tarsus.

In most cases of pes varus there is elevation of the heel, producing pes equino-varus. The inversion is due to the anterior tibial and posterior tibial muscles and the long flexor muscle of the toes, while the elevation of the heel is produced by the calf muscles acting through the tendon of Achilles. The plantar fascia and other muscles than those mentioned may at times be contracted and increase the deformity.

Treatment.—The inversion of the foot should be treated by tenotomy of the anterior tibial tendon and perhaps of the posterior tibial tendon. Perhaps the plantar fascia and some of the other tendons may require section. The elevation of the heel requires section of the tendon of Achilles. If the case is one of pure pes varus, the last procedure is unnecessary.

After the deformity has been corrected by means of tenotomy and strong manipulation with the hands, the foot, of course, is dressed with the flexible metal splints previously described or possibly with gypsum bandages. The latter, however, is not so desirable in infants as in club-foot of adults, because the skin is tender and more easily irritated. It is, therefore, better, if possible, to use metal splints, which can be removed daily. More radical operations are sometimes demanded. Free tenotomy of all the restricting structures, without reference to their names, accompanied in many cases by the removal of a wedge shape portion of the tarsal bones, is at times the only method which will give a properly shaped foot. Cutting out a wedge of bone is called tarsectomy. It is performed by making a large elliptical flap to expose the bones and removing with a saw, or by disarticulating with a knife, all the bony tissues that prevent the reposition of the foot. After such operations the foot is always shorter than the normal foot would be. This is due partly to the removal of a portion of the tarsus and partly to the fact that the leg and foot are atrophied from imperfect development or from non-use of the muscles. Tarsotomy is the term used when the bones are simply cut through with a saw or chisel and no portion removed. This is seldom effective. Occasionally, reposition of the inverted foot may be accomplished by forcibly bending it into position by means of the hands. Some slight inflammatory reaction is to be expected after this violent treatment. Club-foot shoes or dressings of a retentive kind must be applied after the operation.

FIG. 442.

Diagram of a normal foot and one with pes-equino-varus, to show internal deviation of the anterior part of foot. (SAYRE.)

Pes Valgus.

Pes valgus is the condition opposite to pes varus, and is the turning out of the sole, so that the patient walks upon the inner edge of the foot. It is very frequently associated with flattening of the arch of the foot, becoming then pes plano-varus. It is sometimes combined with pes calcaneus, and is then called pes calcaneo-valgus. Mild cases are managed by bandaging the foot into proper position by splints and pads placed on the inner side of the ankle. In more severe cases tenotomy of the three peroneal muscles and of any other muscles tending to produce displacement, may be required. If the sole is flat, it may be necessary to insert in the shoe worn after the lateral deformity has been corrected, such a metal support or pad as will restore the arch of the foot. Resection of the astragalo-scaphoid joint may be required to restore the arch.

Pes Equinus.

This deformity is not often congenital. It is usually due to infantile paralysis of the muscles of a part of the leg or to abscess or injury causing contraction of the calf muscles. It is to be treated by tenotomy of the tendon of Achilles. Open tenotomy will permit an exact lengthening of the tendons by one of the methods of tenoplasty previously described.

Pes Calcaneus.

Pes calcaneus is another form of club-foot which is not commonly congenital, and, like pes equinus, is quite often due to infantile paralysis of the muscles antagonistic to those producing the deformity. Pes calcaneus is treated by tenotomy of the displacing muscles, shortening of the tendon of Achilles by cutting out a portion, or by apparatus so arranged as to pull up the heel. Rubber bands are utilized in this as in other forms of club-foot.

Pes Planus.

Pes planus, or flat-foot, is a flattened sole, due to obliteration of the normal arch of the instep. This form of club-foot is well demonstrated by covering the sole with shoe blacking and having the patient tread upon a piece of white paper. The imprint of the foot shows the entire foot coming in contact with the floor; this is a good diagnostic symptom of the existence of the deformity. In the normal foot it is simply the heel, outer edge and the toes that touch the ground.

FIG. 443.

Flat-foot. (LOVETT.)

FIG. 444.

Normal foot. (LOVETT.)

The pain produced by this giving way of the plantar arch is often mistaken for rheumatism or neuralgia. This breaking down occurs in persons of weak fiber, in those who are required to stand much upon their feet and in those who are very heavy. An ingrowing toe nail may cause it by reason of the manner of walking adopted to avoid pain from the diseased nail. As previously stated, the condition is often associated with pes valgus. Much comfort is often given by placing in the shoe a metal plate or pad to restore the arch of the foot. Muscular tone can be given the long flexor of the great toe by gymnastic exercises to develop the muscle. This may be done by having the patient raise himself upon his toes a number of times each morning, so as to bring these muscles into action. Strength of this muscle aids in maintaining the tarsal arch. "Weak ankles" is a term often applied to a tendency to pes valgus. The defect is due to the relaxation of the internal lateral ligament of the ankle joint. Massage and support of the ankle by a high laced shoe, or some form of rubber or metal support will, when combined with tonic treatment, usually be sufficient for the correction of this weakness.

Pes Cavus.

Pes cavus, or hollow-foot, is treated by subcutaneous division with a tenotome of the plantar fascia, with or without division of the short flexor muscle of the toes. Improvement in gait and relief from discomfort are sometimes obtained by building up the interior of the shoe so that the sole will come in close contact with the excessive arch of the foot.

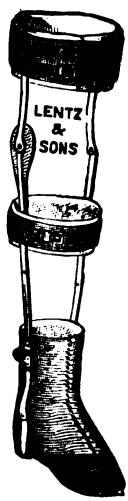
DEFORMITIES OF THE KNEE AND LEG.

Pathology.—Knock-knee, or genu valgum, is a deformity in which, when the patient is standing, the knees are close together or touch, while the internal malleoli are more or less widely separated. The opposite condition, in which, when the internal malleoli touch, the knees are more or less widely separated, is called genu varum, or bow-legs. This latter condition is frequently associated with bowing outward of the tibias. The tibia in rachitic children is sometimes bowed forward instead of outwards.

FIG. 445.

Knock-knees. (Author's case.)

FIG. 446.



Apparatus for treating knock-knee.

FIG. 447.

Apparatus for treating bow-leg.

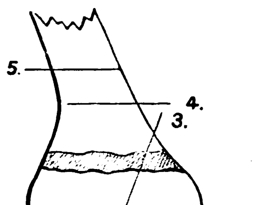
The deformity in knock-knee disappears when the knees are bent so as to bring the legs at right angles to the thighs. In this deformity there is not much pain, but usually a feeling of weakness after prolonged standing or walking, which may be associated with considerable discomfort. The deformity exhibited in the lower extremities and the abnormality in gait of the patient are sufficiently diagnostic. The condition may be due to rickets, but it may also occur from attempts at walking at too early a period while the bones and ligaments are scarcely developed in strength. Local paralysis or a continuation of bad postures in early life may also be factors in the causation of genu valgum. The knee joint shows a tendency to bend backward so that the popliteal space scarcely exists. The inner condyle appears relatively longer when compared with the external condyle, but it is possible that this change of relation is due to improper development of the shaft of the bone.

Treatment.—In the early stages such deformities are often remediable by the use of apparatus which will in case of knock-knee draw the knee outward, and in the case of bow-legs press the tibia or knee inward. In more advanced cases it becomes necessary to use more active measures. This consists in forcibly straightening the deformed limbs by manual power or by performing osteotomy, followed by the application of gypsum bandages to retain the fractured or cut bones in their new position.

FIG. 448.

Osteotome.

FIG. 449.



1. Mayer, Billroth, Schede; 2, Annandale; 3. Ogston, Reeves. Chiene; 4. Macewen; 5. Taylor. (YOUNG.)

Osteotomy is usually performed by means of an osteotome. The latter is an instrument much like a chisel, except that it is bevelled on both sides instead of one. A saw is seldom used at the present time for performing osteotomy.

In knock-knee the femur may be divided by a horizontal cut just above the external or internal condyle or at the junction of the middle and lower thirds; or the relatively large internal condyle may be separated from the rest of the femur by an oblique cut made with the osteotome, so that the condyle will slip upward when the leg is brought inward to a normal position. Some operators prefer condyloid section; others, section above the condyles or in the shaft. In performing osteotomy it is proper that the incision through the skin should be made in the long axis of the bone, in order to divide as few muscular fibers and tendons as possible. The osteotome is introduced with its edge in the direction of the incision, but subsequently it is turned to a right angle before it is struck with the mallet. The bone should be divided for about two thirds of its thickness. The remaining portion of the bone is fractured, as the limb is bent into position. In the condyloid section the instrument should go through the condyle so as to enter, or nearly enter, the joint. Some surgeons prefer to make the section through the shaft of the femur from the internal aspect of the thigh rather than through the external surface.

Osteotomy is frequently required in cases of bow-legs. Sometimes it is necessary to divide both the tibia and the femur. It requires from three to five weeks for the divided bone to unite after osteotomy for genu valgum or genu varum. After this time the gypsum dressing, which is usually applied over the antiseptic dressing immediately after the operation may be removed.

Various irregular deformities of the tibia may occur as a result of rickets. These may demand for their alleviation numerous osteotomies, or in some cases excision of a wedge shaped piece of bone. Some cases of bow-legs too require such a cuneiform resection of bone.

CHAPTER XXVIII.

AMPUTATIONS.

Definition.—An amputation is the removal of the whole or a portion of an extremity. The term is sometimes applied to the accidental or operative removal of any projecting portion of the body, as of the breast, penis, nose or ear. When the removal occurs through a joint and not in the continuity of a bone, the operation is strictly called a disarticulation.

Varieties.—It was formerly the custom to divide amputations into immediate, those done before complete reaction from shock; primary, before inflammation occurred; intermediate, after the beginning of inflammation but before suppuration; and secondary, after the suppurative process had been established. They are now with propriety divided into primary amputations which are done before infection, and secondary amputations which are those performed after infection, has occurred.

Indications.—The removal of a limb may be demanded by extensive injury of soft parts or bones, gangrene, burning, frostbite, inflammatory conditions, malignant tumors and deformities. Modern aseptic methods have greatly diminished the number of amputations for injury; but have increased their frequency in cases of deformity because the risk of operation is now so slight.

Irreparable damage to the bones or soft tissues of a limb requires its removal; so does a traumatic or non-traumatic condition whose attempted cure by conservative methods would cause imminent danger of death.

The decision of the surgeon must rest upon the result of a careful balancing of the chances of benefit with or without amputation. In traumatisms pulpifying muscles and bones, amputation is required; but extensive comminuted fractures with great laceration of the soft parts may often be followed by restoration of functional usefulness of the limb. This result depends upon the immediate adoption of measures to obtain and maintain asepsis and to prevent interstitial pressure upon the blood vessels by extravasated blood and abundant inflammatory exudate. Free incisions through the skin and deep fascia to permit escape of blood and serum are demanded, if coolness of the extremity shows that circulation is impaired by interstitial pressure. Rupture of the main artery of the limb, especially if complicated with laceration of the main vein, makes amputation probably necessary. It is important to insist upon the fact that amputation in traumatic surgery need usually not be hasty. If the hemorrhage is controlled and the parts made aseptic by antiseptic solutions, which may be strong enough to act as caustics if necessary, the operative treatment can be postponed until reaction from shock and hemorrhage has been complete. It matters little if this requires several days. The wise surgeon will wait in doubtful cases, and will seldom, if ever, operate during profound anæmia from hemorrhage or during severe shock.

Location of Amputation.—The point at which an amputation is to take place varies with the nature of the injury or disease and the anatomical peculiarities of the part. The farther from the trunk the less is the danger to life. There are some situations which offer better opportunity for future usefulness than others. These are called points of election. An artificial limb may be more easily adapted or more successively used, if the stump has a certain length or if the attachment of certain muscles is not disturbed. For this reason the point of election in the leg is at the junction of the lower and middle thirds; that of the forearm below the elbow is just below the tubercle of the radius, so as to retain the insertion of the biceps. In amputations of the hand any portion of a finger that can be retained may be found useful, if most of the fingers have to be sacrificed. There is, however, no special advantage in saving at the risk of a protracted convalescence a toe or a small part of the foot.

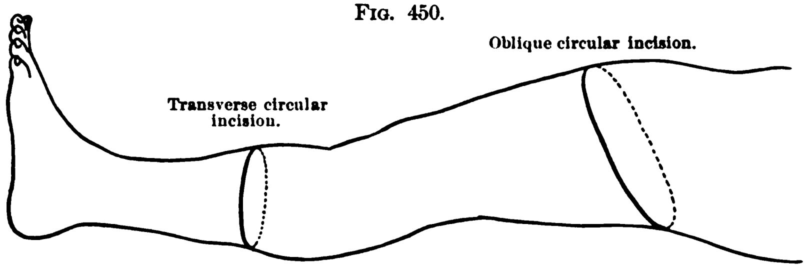
Operative Method.—Ordinary instruments are employed. As transfixion of tissues by long knives is seldom practised at the present time, there is no need of special amputating knives. A saw is used to divide the bone when the amputation is done in continuity and a two tailed or three tailed retractor of gauze or muslin is used to hold the muscles away from the edge of the saw during its use.

The Esmarch apparatus is generally employed to prevent bleeding. If the tissues below the line of proposed amputation are the seat of malignant disease or infiltrated with pus, the thick rubber band should be used above the point of operation without the previous use of the bandage to force the blood upwards.

The conditions of success are that the end of the bone be covered without tension by integument, which will not become adherent to the bone or exert traction on the scar; that injury to the skin at the time of operation should not be such as to imperil its nutritive blood supply, that the nerves should be divided at a point high enough to prevent compression in the scar, that angles of bone should be rounded, and that the scar should be placed where it will escape friction and pressure when the limb is used or artificial substitutes fitted to the stump.

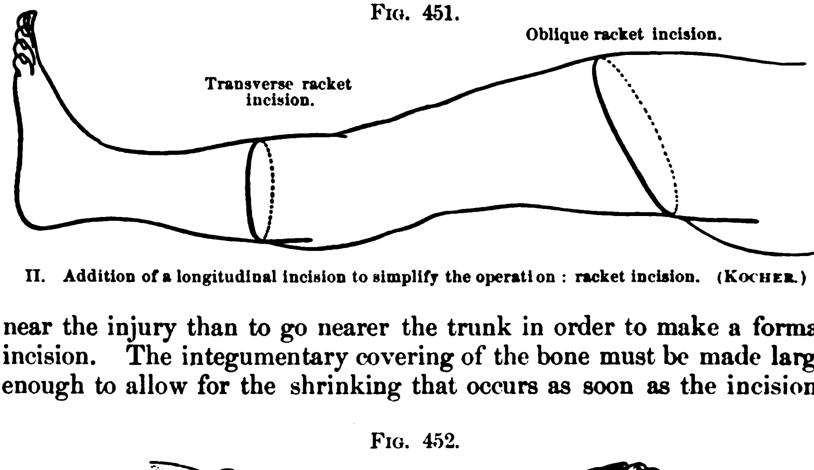
The methods of dividing the soft parts may be divided into 1, the circular; 2, the flap; and 3, the mixed, in which flaps are made of the integument and the muscles are cut in a circular manner. All methods may be considered as derivatives of the circular, for by splitting the cellulo-cutaneous circular cuff on both sides flaps are obtained, which may be square or rounded at the corners; by making the circular incision oblique, as preferred by Kocher, an oval wound is obtained, which, by splitting the integument on one or both sides, is converted into flaps of unequal length or into the racket shaped wound often used in disarticulations. In amputations for injury it may be wiser to use the irregular shaped portions of integument obtainable

FIG. 450.



I. Fundamental type: circular incision. (KOCHER.)

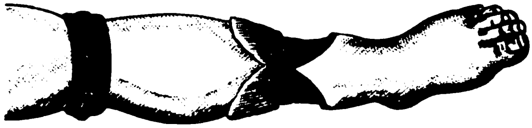
FIG. 451.



II. Addition of a longitudinal incision to simplify the operation: racket incision. (KOCHER.)

near the injury than to go nearer the trunk in order to make a formal incision. The integumentary covering of the bone must be made large enough to allow for the shrinking that occurs as soon as the incisions

FIG. 452.

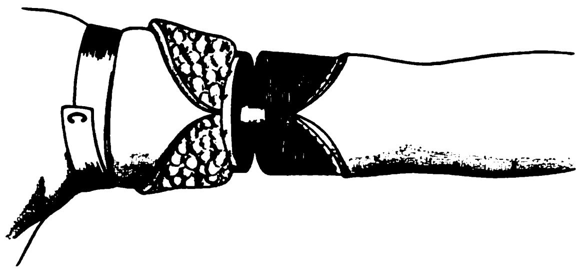


Formation of two semilunar skin flaps. (TILLMANNS.)

are made. Too much skin can easily be retrenched, but short or narrow flaps cannot be stretched to cover the bone without danger of sloughing. No muscle is needed in the flap but the superficial fascia and skin must be preserved without having their blood supply interfered with by the knife edge. A good rule is to make flaps whose combined length will be at least two thirds the girth of the limb at the point where the bone is to be sawed. Their combined width should equal the circumference of the limb. A common error is to make flaps too narrow at the end.

The transverse circular method is begun by dividing the skin and superficial fascia at a right angle to the axis of the limb. The skin and fascia are then drawn upwards, and the deep fascia and superficial muscles divided by a similar circular cut at the point where the skin edge stops. The deep muscles are then cut down to the bone at the

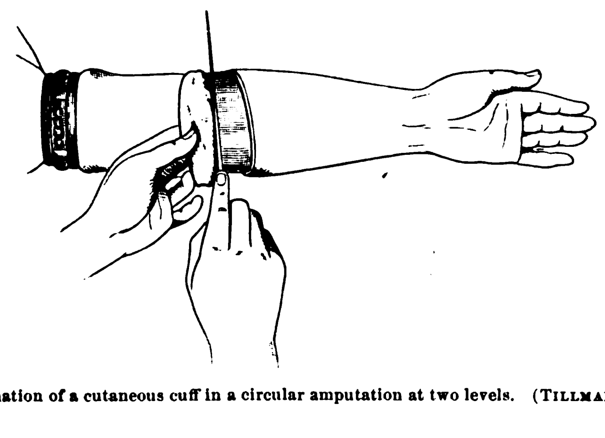
FIG. 453.



Modified circular amputation: skin flaps and circular through muscles. (ESMARCH.)

level of the edge of the retracted superficial muscles. Next the periosteum is divided by a circular incision and detached from the bone to a sufficient extent to make a covering for the end of the bone when it is sawn. The bone is sawed at a point as high above the skin incision as one half the diameter of the limb. Instead of this method which leaves a conical hollow in the muscles at the end of the stump, a cuff

FIG. 454.



Formation of a cutaneous cuff in a circular amputation at two levels. (TILLMANNS.)

of skin and superficial fascia may be turned up; and the whole muscular mass then divided by a single circular cut, down to the bone. A short incision perpendicular to the circular incision may be made to aid in turning up the cuff of skin.

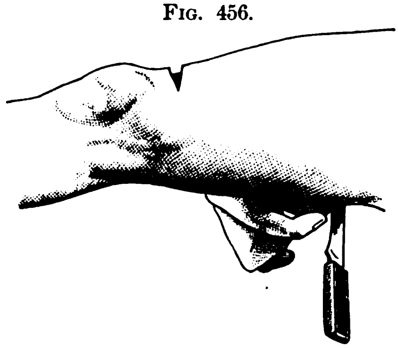
The periosteal cuff described in the first method is not essential in amputation by any of the methods. After hemorrhage has been arrested, the edge of the circular wound is sutured, in a vertical or horizontal line, with or without drainage.

The oblique circular incision, with which the so-called elliptical incision is almost identical, is carried around the limb in a plane not at a right angle to the axis of the limb, but oblique to that axis. This cut makes what is practically a single flap; and the muscles are divided in such a manner that the single flap increases in thickness as it nears the bone. Kocher, who advocates this method, advises the incision to be made thus: Mark the lower end of the cut by raising a fold of skin in the fingers and making a short incision in it at a right angle to the surface; mark the upper limit by pinching up a similar fold and making a short incision in it parallel to the surface. The upper cut should be situated at the level at which it is proposed to divide the periosteum; the distance between the two points should equal the diameter of the limb. Seize the skin at the lower incision and draw it upwards, while the knife divides the muscles obliquely down to the bone. When the bone is reached divide the periosteum transversely and dissect it from the bone sufficiently to form a covering for the bone when sawed. Saw the bone and bend the flap of integument, muscle and periosteum over it, and suture the edges of the skin. If the surgeon prefer, the muscles may be divided by a transverse circular cut at the base of the skin flap. The periosteal cuff may be omitted.

FIG. 455.

Oblique incision: the lower end made by cutting across a fold of skin raised up between the finger and thumb. (KOCHER.)

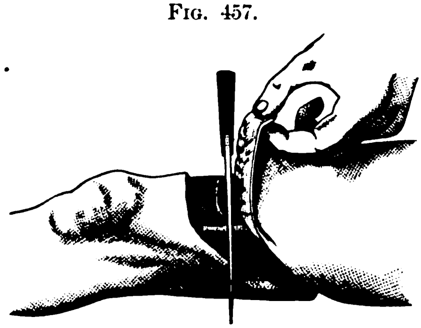
FIG. 456.



Oblique incision: the upper end made by cutting across a fold of skin raised up between the finger and thumb. (KOCHER.)

The so-called racket incision and the so-called lanceolate incision are obtained by making a longitudinal incision upwards from a transverse circular and an oblique circular incision, respectively. The additional cut makes it more easy to lift up the flap. Two longitudinal incisions added to a transverse circular incision make two equal, rectangular flaps; if added to the oblique circular cut, they make unequal rectangular flaps. If the angles

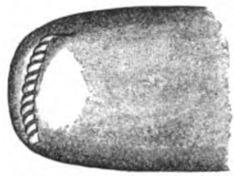
FIG. 457.



Oblique incision: position of knife in order gradually to carry the incision deeper through the soft parts of the flap. (KOCHER.)

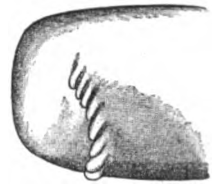
of the flaps are removed by curved incisions, the ordinary semilunar flaps are obtained. The racket or lanceolate incisions are particularly valuable in disarticulations where the whole mass of muscles is to be retained in order to obtain a movable stump over the end of the bone.

FIG. 458.



Position of line of suture in the transverse circular incision. (KOCHER.)

FIG. 459.



Position of the line of suture in the oblique incision. (KOCHER.)

Affections of Stumps.

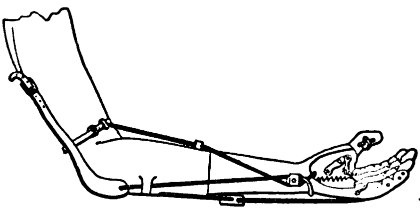
Secondary hemorrhage, septic infection, abscesses, and gangrene of the tissues forming the stump of the limb should be treated as in other operations. Neuromatous tumors occurring on the ends of nerve trunks, making them bulbous, and the entanglement of nerves in the contracting scar following extensive suppuration may cause severe neuralgia of a stump. The treatment is excision of the scar and removal of the bulbous ends of the nerves. This complication may usually be avoided by cutting the nerves off high up in amputation wounds and keeping these wounds aseptic. No nerves should be included in the ligatures used to stop bleeding. Shortly after the amputation, violent muscular spasms may occur in the stump. These twitchings are to be controlled by firm bandaging, fixation of the stump by splints or sand bags, and the use of anodynes hypodermically. Conical stump is a protrusion of the bone through the soft tissues, which are the seat of a granulating sore or a cone shape sensitive stump due to a tense and adherent cicatrix. Conical stump was not uncommon in preantiseptic days when sloughing of flaps and suppuration were not infrequent occurrences. It may arise from insufficient tissue in the flaps. Patients often feel pain and other sensory phenomena in the limb which are referred to the parts which have been lost by the amputation. These symptoms gradually disappear and are due to nerve irritation. Local remedies such as are employed in neuritis and neuralgia may be used on the stump and internally.

Artificial Limbs.

The improvement in artificial limbs has been very great in recent years. These prosthetic appliances are more complicated and less useful in the case of loss of portions of the upper than of the lower extremity. By the use of springs to act in place of the muscles and the transmission of motion by leverage of the stump and by bands extending from the opposite shoulder, a considerable degree of usefulness can be given to artificial hands and arms.

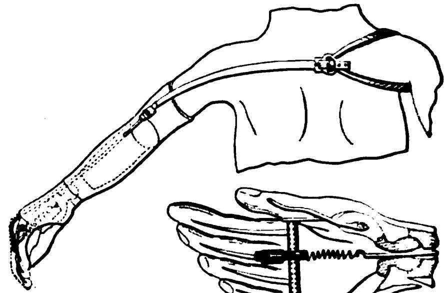
The desiderata in artificial legs are strength to bear the weight of the body, motion of the knee and ankle and elasticity in the gait. This is accomplished by springs within the limb, rubber feet and similar mechanical devices. The stump fits into a hollow conical cylinder so that the weight will be borne against the sides of the stump;

FIG. 460.



Apparatus for hand. (DENNIS.)

FIG. 461.



Apparatus for hand and arm. (DENNIS.)

and the limb is attached to the trunk by straps and bands. The latter may be carried over the shoulder.

SPECIAL AMPUTATIONS.

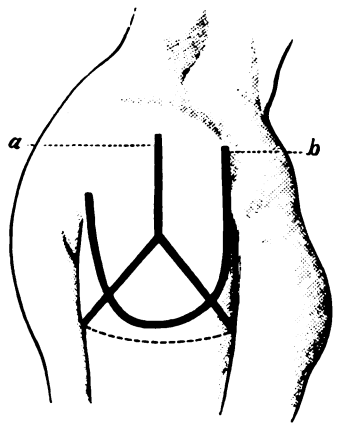
Removal of Arm and Shoulder Girdle.

This operation may be required for the extirpation of malignant tumors. Bleeding is best controlled by an early ligation of the large vessels. The lanceolate incision gives a satisfactory result. The cut begins at the sternal end of the clavicle and runs along that bone to the acromion. The clavicle is then divided in its inner third, and the subclavian artery and vein exposed, tied in two places and cut. The nerves of the brachial plexus are divided, and the large branches of the subclavian artery tied. Then the incision is continued downwards in front, from the point where the clavicle has been divided, so as to cut the anterior muscles and enter the hollow of the axilla. Finally the posterior part of the incision is made by carrying the knife from the acromion down the back of the shoulder and into the axilla to join the anterior incision.

Disarticulation of the Shoulder.

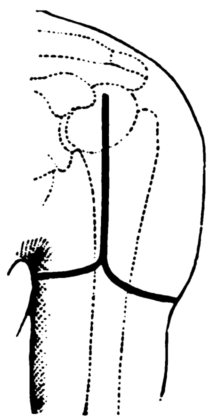
It is desirable here to leave a stump of muscle and periosteum, to give support to an artificial arm. The vessels may be controlled by a rubber band running across the axilla and over the shoulder, and held there either by bandages running across the chest and back or by two long pins, as in Wyeth's method at the hip, thrust through the anterior and posterior axillary folds respectively. The lanceolate or oval cut is probably as good as any. In the single flap method, a flap is made of the deltoid muscle and the tissues on the inside of the bone are divided transversely near the top of the axilla. Another method is practically a circular incision at the level of the axillary folds with a longitudinal cut running upward to the vicinity of the acromion.

FIG. 462.



Disarticulation at the shoulder: *a*, oval method; *b*, method by deltoid flap. (STIMSON.)

FIG. 463.

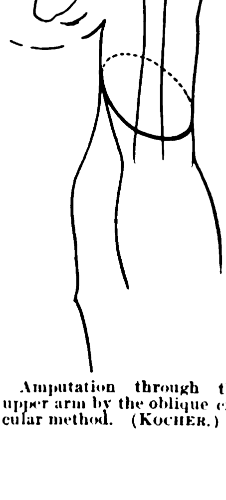


Amputation through shoulder joint. Lines of incision for modified oval method. (SMITH.)

Amputation of the Arm.

The insertions of the deltoid, great pectoral and broad dorsal muscles should be retained if possible, so as to preserve adduction and abduction of the stump. If the amputation is high, the operation may be similar to that chosen for disarticulation at the shoulder joint. As the arm is flattened laterally, the broadest flaps are attainable from the lateral aspects. The oblique circular, the transverse circular and the flap methods yield perhaps equally good results.

FIG. 464.



Amputation through the upper arm by the oblique circular method. (KOCHER.)

Disarticulation at the Elbow Joint.

This operation gives a much less useful stump than amputation through the forearm; even if the latter be at the upper part of the radius and ulna. The attachments of the triceps and biceps to the upper ends of these bones give extension and flexion to the stump, and therefore give the patient a movable hook-like end to the upper limb. This hook is very useful with or without the adaptation of an artificial forearm and hand. If the upper part of the forearm can be saved, disarticulation at the elbow should not be done. The distance of the joint below the internal epicondyle is nearly twice as great as the distance from the external epicondyle to the joint. This must be recollected. The joint is best opened, after the flaps have been made, by thrusting the knife through the capsule just above the head of the radius. An oblique circular or a transverse circular operation is satisfactory. In the former case the single flap may be made from either the anterior or posterior part of the limb. The olecranon may be removed entirely, or the part to which the triceps is attached may be sawed off from the shaft of the ulna and retained.

Amputation of the Forearm.

No special points need mention. The oblique circular is a good method, but so is the double flap method. The transverse circular incision is often used in the lower third where the muscles have become so largely tendinous. The two bones should be sawed simultaneously.

Disarticulation at the Wrist Joint.

This operation should not be done if it is possible to save a portion of the hand or a part of a finger. It is desirable to have the flap, if the oblique circular or any single flap method is selected, made from the palmar tissue. This tissue is accustomed to pressure and has a highly developed tactile sense.

Amputations and Disarticulations of the Hand.

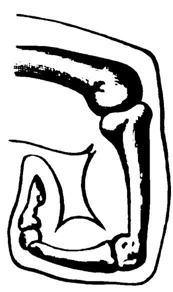
Disarticulations of the inter-carpal and carpo-metacarpal joints are seldom undertaken, but are done on general principles. The metacarpal bone of the thumb or the little finger is usually removed by a racket incision.

Many operations have been devised to save portions of the hand;

FIG. 465.

Illustrating various finger amputations. (FARABEUF.)

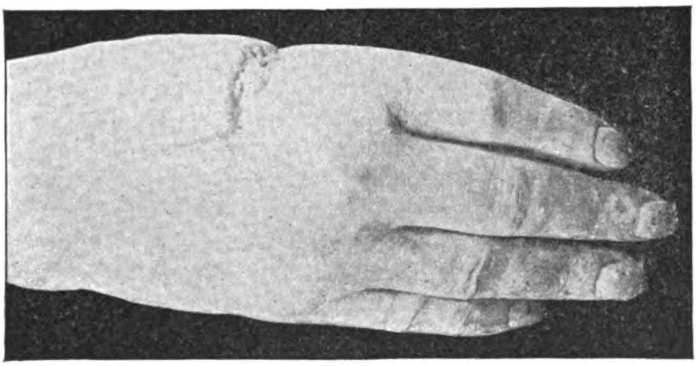
FIG. 466.



Phalanges flexed to show situation of joints. (DENNIS.)

for no mechanical device is equal to even a defective finger. If a portion of the thumb and a part of another finger can be saved to oppose it, the patient is given a member which can grasp objects. The muscles soon become accustomed to their new functions and give serviceable results, even in very distorted hands. It is, however, justifiable to remove a stiff finger, which obstructs the movements of the others. To amputate the head of a metacarpal bone, which has lost the phalanges attached to it, may lessen the noticeable deformity by allowing the adjacent fingers to fall together and close the gap. If, however, most of the hand is destroyed by injury, a small part of a finger or of a metacarpal bone saved may be very useful. Sometimes the skin of a badly damaged finger may be preserved to cover another finger. Amputation through the middle of the metacarpal bones leaves quite a useful member. Antero-posterior flaps are satisfactory.

FIG. 467.



Amputation of first and second phalanges of the thumb, and excision of the metacarpal bone of index finger; transplantation of metacarpal bone of the thumb to the index finger. (DENNIS.)

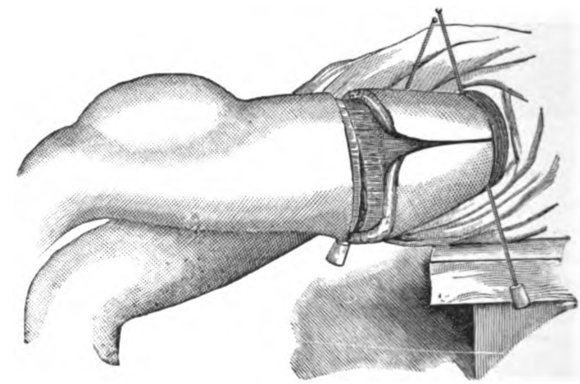
Disarticulation at the phalangeal joints is well performed by a short dorsal and a long palmar flap or by the oblique circular method so arranged as to make a palmar flap. The metacarpo-phalangeal disarticulations are often accomplished by racket incisions, though any of the other methods may be used. The head of the metacarpal bone may be removed or allowed to remain. In disarticulating the phalangeal or the metacarpo-phalangeal joints it must be recollected that the joint is entered by drawing the edge of the knife transversely across the finger just below the head of the bone above, when the joint is flexed. In operating for injury formal amputations are often impossible. The flaps may be made from irregular portions of integument and it is wise to sacrifice as little bone and skin as possible. In burns and frostbites it often happens that portions seemingly destroyed subsequently regain vitality; hence haste in amputation may lead to unnecessary sacrifices. Sometimes the bones of one finger may be utilized to do service for another.

Disarticulation at the Hip Joint.

This was formerly a very dangerous operation, but improvements in hemostasis and the methods of aseptic surgery have robbed it of most of its danger. It is desirable, when possible, to retain the muscles in the stump, which then remains movable. The operation may then give almost as good a support for an artificial limb as amputation below the trochanters.

Wyeth's method is probably the best of the numerous suggestions for disarticulation at the ilio-femoral joint. The buttocks of the patient are placed at the edge of the table with the shoulders and trunk lower than the hips and the limb is raised to drain out the venous blood, or the Esmarch apparatus is applied. Then a large mattress needle or skewer, about a quarter of an inch thick and ten inches long, is thrust through the thigh from a point one inch below and a little inside of the anterior superior spine of the ilium to a point on the outside of the hip on the same level as the point of entrance but three inches from it. A second skewer is thrust deeply through the muscles at the inner side of the thigh, entering at a point inside of the saphenous opening and one inch below the perineum and emerging one inch below the tuberosity of the ischium. The points of the needles are sheathed by thrusting them into sterile corks. A piece of rubber tubing half an inch in diameter is then carried tightly around the hip,

FIG. 468.

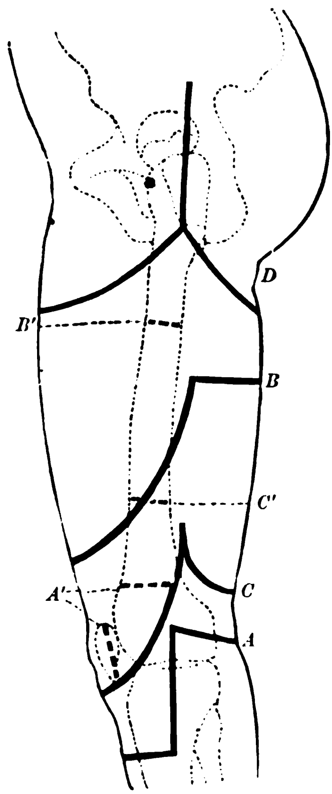


The needles and constrictor applied : circular and longitudinal incisions for skin flap. (WYETH.)

above the needles, five or six times and tied. This method of preventing the rubber constrictor slipping off during the operation is superior to other devices.

After provision has thus been made to prevent bleeding the limb may be removed by any method that is allowed by the condition of the soft parts. A circular incision, about six inches below the rubber constrictor and a longitudinal cut over the greater trochanter, from the constrictor down to the first incision, make a satisfactory method of getting a cellulo-cutaneous cuff. This cuff is raised and the muscles divided by a circular cut down to the bone at about the level of the lesser trochanter. The soft tissues below are pushed downward from their bony attachments, so that the collapsed vessels in the flaps may be tied and then the capsule of the joint is opened and the head of the bone forced out of the socket by using the whole length of the femur as a lever. After the chief vessels have been tied, the constrictor is removed and the smaller arteries ligated. If much oozing occurs, pressure will stop it or the use of catgut stitches carried through the muscular masses will occlude the bleeding vessels. Provision may be made for intravenous injection of saline solution before the operation is begun. Bleeding may be arrested also by compressing the abdominal aorta just to the left of the middle line above the navel. This is best done by standing on a stool at the left of the patient, and placing the closed fist at the point indicated and throwing the weight of the body upon it with the elbow extended.

FIG. 469.



A, Gritti's amputation at the knee: *A'*, lines of division of bone; *B*, long anterior flap (Sédillot); *B'*, division of bone; *C*, amputation at lower third (J. Spence); *C'*, division of bone; *D*, disarticulation of hip. (STIMSON.)

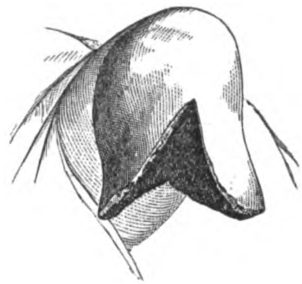
Amputation of the Thigh.

Any method may be adopted that seems best suited to the particular injury under treatment. The oblique circular, with a liberating longitudinal incision on one or both sides is good, and so are the various flap methods. It is perhaps well to have the scar placed posteriorly, by making the longer flap in front; and thus prevent the flexor muscles drawing an anterior scar to the end of the stump.

Disarticulation at the Knee Joint.

This operation gives a good stump and is followed by little retraction of the muscles. It is preferable to amputation through the lower portion of the shaft of the femur. Some operators remove the patella; some saw off the condyles; some saw off the articular surface of the patella and the condyles, and place the two sawn surfaces in contact. It is probable that a long anterior flap, extending an inch below the tubercle of the tibia, with the patella retained in it makes as good a stump as any. Two lateral flaps which cause the scar to sink into the intercondyloid fossa are also said to be very satisfactory. The method of Gritti, which is an osteoplastic operation and unites the freshened surface of the patella to the cancellated tissues of the denuded condyles, has some possible advantages. The makers of artificial limbs are apt, perhaps, to prefer an amputation two or three inches above

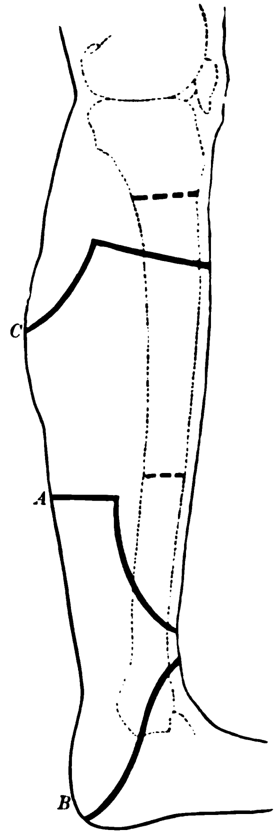
FIG. 470.



Stephen Smith's amputation at the knee joint.

the joint or the osteoplastic disarticulation to a pure disarticulation, as it gives a better chance for a satisfactorily movable joint at the knee in the prosthetic appliance.

FIG. 471.



Amputation of leg. *A*, long anterior flap; *B*, supra-malleolar amputation by long posterior flap; *C*, at the upper third. (STIMSON.)

Amputation of the Leg.

The best point of division of the bone as far as wearing an artificial leg is concerned is probably the junction of the lower and middle thirds. The chief pressure comes, in wearing an artificial leg, at the anterior inferior corner of the stump. The scar, therefore, should not be placed on the front of the shin ; and the crest of the tibia should be sawed off, at the point where the bone is divided, so as to make the corner less angular. If the amputation is made within two or three inches of the knee, it is likely that the strong flexors will cause permanent flexion of the stump at the knee. This is undesirable. It would perhaps be better to disarticulate at the knee by Gritti's method.

A long anterior flap operation or an oblique or a transverse circular method will probably be found most useful. The tissues of the heel may be used for the posterior flap, when the amputation is just above the malleoli, and make a firm covering to the bone, which will bear pressure well during walking.

Disarticulation at the Ankle Joint and Amputations of the Foot.

Artificial feet are made which are almost perfect in their function as supporting and locomotive agents ; but painful cicatrices on the feet or irregularities, which create a tendency to corns or bunions, render the patient much more uncomfortable than would the wearing of the substitute foot. The conditions are so different from those which obtain in the case of the hand that portions of the foot are with justice removed, though the corresponding parts of the hand would be preserved with great diligence.

Scars should, as a rule, be placed on the dorsum, in operations upon the foot; and the plantar tissue which is accustomed to bearing pressure and is not easily irritated should cover the end of the stump. By filling a part of his shoe with cotton a man with a walking stump, which is long enough, can often walk so well that his deformity escapes detection. It is desirable to save if possible the metatarsal bone and phalanges of the great toe, for it bears much of the weight of the body.

Toes are usually removed by disarticulation, as it is not worth while to save a portion of their short phalanges. The methods are similar to those used in operations on the hand.

The variety of partial amputations of the foot, through the tarsus and metatarsus, is great; but it should be remembered that most of these formal operations are practically unimportant. The use of the saw is better than the endeavor to disarticulate the irregularly shaped bones with anatomical accuracy. A good rule is to save as much of the foot as possible, provided that good plantar tissue or tissue from the heel can be obtained for the inferior surface of the stump and that the scar can be put on the dorsum, where it will not receive pressure in walking. It is easier to adapt a good artificial foot, if the amputation is at the junction of the lower and middle thirds of the leg, than if it is in the metatarsal or tarsal bones. On the other hand, these amputations give very good results with no expense for prosthetic apparatus; and to many persons a slight limp is of less importance than the expense of a perfect artificial foot.

Disarticulation between the metatarsus and tarsus, often called Lisfranc's method, and disarticulation in the middle of the tarsus, the medio-tarsal method of Chopart, give useful feet. The osteoplastic operation of Pirogoff, at the ankle, saws the calcaneum obliquely and turns it and the heel tissues up against the lower portion of the tibia and fibula, after the lower ends of these bones have been sawed off. This gives a longer stump than the disarticulation at the ankle, after the manner of Syme. Syme removed the heel bone and covered the ends of the tibia and fibula, from which the malleoli were cut, with the cushion made by the thick structures at the heel.

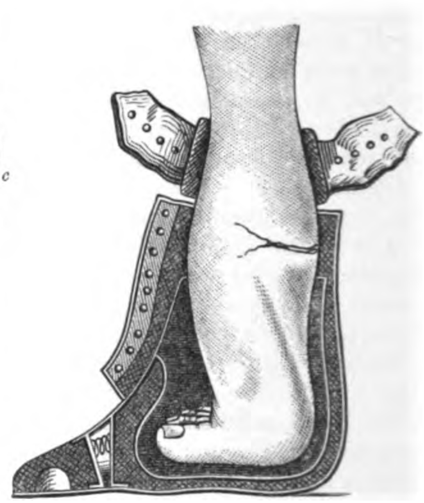
The tarso-metatarsal disarticulation (Lisfranc's) is performed by making a transverse dorsal incision with its convexity forward from a point behind the tuberosity of the fifth metatarsal bone to a point behind the base of the metatarsal bone of the great toe. The plantar flap extends to the middle of the balls of the toes. It must be cut with care and should contain the muscles, so that the vessels may not suffer injury. The medio-tarsal disarticulation (Chopart's) takes away all of the bones of the foot except the astragalus and calcaneum. In it a transverse dorsal cut, convex forwards, is made from a point midway between the external malleolus and the tuberosity of the fifth metatarsal bone to a point just behind the tuberosity of the scaphoid; and then a plantar flap is made similar to that in the tarso-metatarsal operation, but not so long. It may be well in both of these operations to divide the tendon of Achilles to preclude retraction of the heel.

In the tibio-tarsal disarticulation the foot is placed at a right angle with the leg and a cut down to the bone is made from the tip of one malleolus, around the sole of the foot to the tip of the other malleolus. The foot is then extended on the leg and a transverse cut made across its dorsum from one end of the first incision to the other. This second incision is convex forwards. The ankle joint is then opened, the astragalus detached from the tibia, the calcaneum removed from the heel, and the malleoli and part of the lower end of the tibia sawed off. The cup-like heel flap is then turned up over the end of the tibia. Care must be observed not to injure the posterior tibial

FIG. 472.

Mikulicz-Wladimirow's osteoplastic resection of the tarsus: 1, incision through the soft parts (*a b*) and division of the bone; 2, position of the foot after the operation. (TILLMANNS.)

FIG. 473.



Final result after osteoplastic resection of the tarsus. (TILLMANNS.)

vessels at the inner side of the ankle, or the heel flap may slough. In the osteoplastic operation of Pirogoff and its modifications the incisions are similar to those in disarticulation at the ankle; but the plantar incision is carried obliquely farther forwards, and the calcaneum after being sawed obliquely upwards and backwards is turned up against the sawn end of the tibia. This method makes a longer stump than the tibio-tarsal disarticulation and may therefore be less suitable for the adaptation of an artificial foot, but it enables the patient to walk well with little limp.

Numerous osteoplastic operations have been suggested to render the limb long enough to be useful without artificial substitutes. The metatarsus and part of the tarsus has been saved, for example, and united to the end of the tibia, after removal of the calcaneum, astragalus and most of the other tarsal bones.

CHAPTER XXIX.

SURGICAL DISEASES OF THE BREAST.

Mammary Neuralgia.

NEURALGIA of the mammary glands is found especially in young women and is often associated with some ovarian or uterine difficulty. Hyperæsthesia is often excessive, so that the mere contact of the clothing gives rise to great pain. A similar neuralgic condition is at times found as an accompaniment of small benign tumors of the breast or of chronic mammary inflammation. The fear felt by the patient that the condition is one of malignant disease must be dispelled, as it has a tendency to increase the pain. It should be recollected also that this affection, which is one of no vital importance, is more painful than are malignant growths in their early stages. At times there is a slight serous or blood-stained discharge from the nipple when the mastodynia, or neuralgia of the breast, accompanies a localized chronic inflammation.

Treatment.—The treatment consists in assuring the patient of the innocent character of the disease; in distracting attention from the mammary region; in relieving the source of the nervous wear and tear; and in giving mental occupation of an agreeable nature. Valerianate of zinc, iron preparations, and other tonics are the remedies indicated; in fact, the line of treatment is that to be followed in cases of hysteria. If there be any small inflammatory nodules within the breast, it is proper to remove them if the patient's anxiety is great enough to warrant such a slight operative procedure. If the surgeon is in doubt as to the character of these hardened tissues, operation is valuable by enabling him to clear up the diagnosis. The question of malignancy can then be definitely settled by the microscope.

INFLAMMATION OF THE BREAST.

Pathology.—Inflammation of the mammary glands, called mastitis or mammitis, may be acute or chronic. In the former condition, suppuration, causing what is termed mammary abscess, may occur. This is very unusual, however, excepting during lactation. The so-called cold abscess, due to the tubercle bacillus, is rare, but may occur. Acute mastitis arises occasionally as a complication of mumps, just as in the male we find orchitis arising secondary to that inflammation of the parotid gland. The breasts of newborn children, male and female, sometimes secrete a milky looking fluid and may become inflamed. Puerperal mastitis occurs more commonly in primiparæ; and during the first three or four weeks of nursing, although it may occur at the end of many months of suckling. It is not usual in mothers who bring up their children by artificial feeding. The cause is microbic infection through fissures or ulcers of the nipple or by the route of the milk ducts. In instances of fissured or otherwise irritated nipples, the child is unable freely to empty the breast and by its efforts causes still further irritation of the inflamed tissue. The infective inflammation so caused at the nipple travels along the lymphatics into the interior of the breast, and adds, therefore, its irritative influence to that due to distention of the milk ducts from retained lacteal secretion. Freely washing the surface of the nipple after nursing with some form of non-poisonous antiseptic would prevent many cases of mastitis. Tuberculosis and syphilis occur in the breast.

Acute Mastitis. Symptoms.—Acute mastitis begins, as a rule, with a chilly sensation, fever, headache and local soreness of the breast, followed by a sensation of weight, aching pain and throbbing. Upon manipulation, the organ feels hard and knotty in spots, because inflammation usually affects a few, not all, of the lobules of the gland. As the disease progresses the whole breast becomes swollen and hard, and the skin tense, shining and livid. If suppuration occurs, it is usually preceded by a chill, after which the skin becomes œdematous. Soon there is evidence of pointing, and the pus is finally evacuated spontaneously if the abscess is not opened by the surgeon's knife.

Treatment.—The treatment should begin with physical and functional rest. The former is obtained by keeping the patient quiet, with the arm supported in a sling and the breast held up against the thorax by a closely fitting bandage. Functional rest is obtained, if the case is a puerperal one, by preventing the child nursing. It is important that neither breast be used for suckling. If the secretion of milk continues and causes pain by distention, it is necessary to empty both glands by means of a breast pump or suction with the lips. Leeches may be used in persons of vigorous health and should be applied below the breast rather than above it. Purgatives and antiphlogistic remedies are indicated in cases of sthenic type; but if the patient is debilitated, tonic rather than depressing remedies should be prescribed. Hot water fomentations, applied by means of a conical sponge laid over the breast several times a day, will often be a great comfort to the patient. An antiseptic dressing covered with rubber tissue to prevent evaporation makes a good emollient dressing. The ointment of belladonna or extract of belladonna made into a paste with a little water, spread upon the surface of the breast, lessens the pain and may aid in diminishing the secretion of milk. Ichthyol or mercurial ointment are good applications. Lotions of lead water and laudanum are at times serviceable. Some surgeons believe that the application of ice bags is good practice. In some cases inflammation subsides by resolution, and after two weeks' time the patient may resume nursing. If suppuration occurs, free incision and curetting must be adopted at a very early period. This will be discussed under abscesses of the breast. Acute mastitis may run on to a stage of chronic inflammation, which must be managed in the same manner as cases which assume a chronic type from the beginning.

Chronic Mastitis. Symptoms.—Chronic inflammation of the breast usually attacks only one, two or three lobules of the gland and exhibits itself as a hard, irregular mass accompanied by a moderate degree of pain. The process is a sort of cirrhosis. The inflammatory process involves the connective tissue, which becomes increased in amount and compresses the glandular structure of the breast until it becomes more or less atrophied. Since the whole gland is not affected, there is a certain resemblance between this lobular mastitis and carcinoma, because in each case there is no sharp outline felt between the growth and the normal gland and because the two conditions are most common about the menopause. The points of diagnosis are that the inflammatory induration is not as hard as carcinoma; the integument is not adherent to the mass nor dimpled by it. Moreover, carcinoma is apt to attack single portions of the breast, whereas inflammatory involvement of two or three lobules is not uncommon. Again, the inflammatory condition may be found in both breasts at the same time; this condition is exceedingly rare in carcinoma. Retraction of the nipple, which occurs in carcinoma situated directly below the nipple, does not occur in inflammation. There is slight probability of inflammation being followed by involvement of the axillary lymphatic glands, but such involvement is common late in carcinoma. Chronic mastitis is also differentiated from carcinoma by the fact that it improves under treatment. Laying the hand flat on the breast is sometimes a good test. The nodules of chronic inflammation may scarcely be felt by this manipulation, but tumors will be quite perceptible. Non-malignant tumors of the breast are diagnosticated from chronic mastitis by being more defined in outline.

Treatment.—The treatment of chronic mastitis is carried out by hot water applications made by means of a conical sponge laid upon the breast two or three times a day; by anointing the skin with oleate of mercury ointment (about 10 per cent.); or by using some form of counter-irritation, such as is obtained by painting the parts with tincture of iodine or by the application of a blister. Pressure should be made upon the diseased gland by covering it with cotton wadding and carrying a bandage of elastic webbing around the chest, so as to support and press the gland against the ribs. The turns of the bandage should be started below the breast and carried upward. Friction or pressure by corsets or other articles of clothing should be prevented. The arm should be kept quiet as much as possible or carried in a sling. The support of the breast, associated with equable pressure, is probably the most important part of the treatment. Potassium iodide may be given internally as a sorbefacient. This line of treatment should be continued for months, since improvement is usually slow.

Suppurative Mastitis. Pathology.—Suppuration may occur between the breast and the skin, within the gland itself or between the gland and the pectoral muscle. The first condition is called supramammary abscess; the second mammary abscess; the third, sub-mammary abscess. It is possible also to have tubercular disease of the breast causing the so-called "cold abscess." Acute abscess of the breast is due here, as in other places, to the entrance of pyogenic bacteria, which gain admission through the ducts of the nipple or through fissures of the nipple or integument.

Supra-mammary abscess presents no special symptoms needing description. Abscesses behind the breast push the breast forward, giving it a very conical appearance. The pus may, after protracted suffering, burrow beneath the breast and finally cause a spontaneous opening at the circumference of the gland or even near the axilla. Occasionally, evacuation occurs through the substance of the gland. Mammary abscess may occur at several points and riddle the breast with pus pockets and sinuses. If operative evacuation is to be done, it should be undertaken at an early period. Suppurative mastitis is an affection causing great pain and exhaustion, and is usually found during lactation. Abscesses in connection with the mammary glands may also be the result of necrosis of the underlying rib, or may be due to spontaneous opening through the chest wall of a pulmonary abscess or suppurative pleurisy.

Treatment.—The measures to be employed in acute, non-suppurative mastitis have been discussed under the treatment of that affection. When pus has evidently formed, it should be evacuated by one or more free incisions. The line of incision should be in a radiating direction from the areola, so as to be parallel to the milk ducts. The incision should be made in the areola alone or entirely outside of it, because an incision extending from the areola into the encircling skin beyond is apt to be followed by unsightly pigmentation at the circumference of the areola. The abscess cavity should be curetted and disinfected, and provision made for drainage. If the abscess has many pockets or if there are multiple abscesses, thorough evacuation of all pus accumulations must be made. Thorough cleansing after each nursing, bathing the breast at such times with some non-poisonous, antiseptic lotion, and giving support to large pendulous breasts are methods to be employed to prevent mammary abscess. After spontaneous opening of a mammary abscess, the sinuses remaining must be laid open and scraped out under antiseptic precautions. Moderately firm compression, with bandages cut to fit the chest or composed of elastic webbing, and applied over an ordinary gauze dressing, is an efficient adjuvant. It is astonishing to see how a breast freely incised becomes, under such conditions, an efficient organ for nursing after subsequent pregnancies.

Paget's Disease of the Breast.

This affection is a peculiar granular inflammation of the nipple and the areola resembling eczema. It occurs in women from forty to sixty years of age and is apt to be followed by malignant disease. If the condition occurs, the diseased structures should be excised to prevent the occurrence of any further malignant involvement.

Tumors of the Breast.

Pathology and Symptoms.—Tumors of the male breast are rare. The female breast is the seat of all forms of tumor, some of which are more common than others. Carcinomas, sarcomas and adenomas are the most common growths found in the breast. In not a few cases the tumor is a mixed one; but these mixed tumors usually contain adenoid tissue as one of the elements and are, therefore, adeno-fibromas, adeno-cystomas and adeno-sarcomas. It is said that about three fourths of the tumors found in the breast are carcinomas. The commonest benign growth in this situation is an adeno-fibroma, which is usually called a fibroma or an adenoma. It is, as a rule, however, a mixed tumor, and not a pure fibroma or a pure adenoma.

These adeno-fibromas are very slow in their growth and occur in young women. They are movable, hard and encapsulated and are easily enucleated when removal is attempted. The growth is well defined in outline, which is quite different from chronic lobular inflammation, with which it might be confounded. It produces no pulling in of the skin and no involvement of the lymphatic nodes. It is painless, except in persons of a nervous temperament, when neuralgic pain is often present. A tensely filled mammary cyst may very much resemble an adeno-fibroma. The diagnosis is accurately determined by puncturing the obscure tumor with a hypodermic needle, through which fluid will escape if it is a cyst or an adeno-cystoma.

The adeno-cystomas are formed by occlusion and dilatation of the irregularly developed acini and ducts, which occur in the adenomatous structure. They may consist of one or more large cysts, containing often a great many smaller cysts growing inward from the outer wall of the original tumor. The solidity of the mass depends upon the relative quantity of cyst wall and brownish fluid. These tumors do not infiltrate the surrounding tissues; they are encapsulated and do not cause lymphatic involvement; they may, however, develop fungous masses, the surface of which may bleed. Such fungating tumors present to the naked eye the appearance of malignant disease; but such is not their character. After removal they show no tendency to return.

Mammary sarcomas vary very much in their degree of malignancy, and are at times combined with adenoid structures. The round cell sarcomas, with little intercellular substance, are probably the most malignant of all tumors occurring in the breast. Sarcomas are found, as a rule, in early life; from twenty to thirty five years being the average age at which this disease is found. Such tumors have a smooth surface, are elastic, mobile, isolated, and rapid in growth; and the cutaneous vessels are often enlarged. The skin finally gives away and a fungous protrusion occurs; but the lymphatic glands are not involved until the disease has made great progress. Recurrence after removal is very apt to take place about the line of incision. Secondary growths in other parts of the body are very usual in the late stages of the disease.

Carcinomas are frequently found in this region, and are believed to sometimes follow prolonged irritation, such as Paget's disease of the nipple or chronic lobular inflammation of the gland. Traumatism has been assigned as a cause of carcinomatous disease, and from thirty five to fifty years is the period of life in which its occurrence is most frequent. Scirrhus or hard carcinoma is a very hard tumor without definite outline. It is at first movable, but it soon becomes adherent to the skin and to the pectoral muscle; and the gland is thereby finally fastened to the chest wall. The skin over the growth is pulled in and, on account of this retracting influence exerted upon the hair follicles, a characteristic dimpled appearance, often called "pig skin," is produced. If the tumor is directly below the nipple, the nipple is slowly pulled in by the retraction until its appearance is somewhat like that of the navel. This retraction of the nipple occurs only when the tumor is situated directly beneath the nipple; hence its absence does not indicate that the mammary growth is not a carcinoma, unless the tumor is subjacent to the nipple. In some cases of mammary carcinomas there is a slight discharge of the fluid from the nipple.

The absence of pain or tenderness in the early stages of the disease often misleads the patient as to its dangerous character, and this error is enforced by the comparatively slow increase in size of the lump found in the breast. In the later stages of the disease, the pain may become great, and seriously so when the axillary glands become the seat of secondary infiltration and produce pressure upon the nerve trunks in the arm-pit. Instead of scirrhous carcinomas being nodular, they may at times occur as a rapid infiltration of the breast.

Gradually the skin overlying the tumor becomes ulcerated, and from the surface of this foul sore escapes a thin, and often bloody, discharge. Severe hemorrhage may supervene from such an ulcer, but it is readily stopped, as a rule, by slight pressure. The carcinomatous ulceration may slowly spread over the whole front of the chest. The lymphatic nodes of the axilla are usually quite early involved, though the enlargement may not be perceptible through the skin until they have attained quite a large size. The cervical glands are not usually involved until some time after the axillary glands have become the seat of carcinomatous infiltration. Pain and swelling of the arm from pressure upon the nerves, veins and lymphatics is one of the late symptoms. Secondary growths occur in the liver, lungs and bones, and finally death supervenes.

In cases where there is great increase in the fibrous tissue of the tumor, the pathological condition is called atrophic scirrhus. This form of the disease may exist with very little or no progress for months or years. This quiescent form of carcinoma is simply one of very slow growth, and its final result differs in no way from that of other cases. Hard carcinoma is a disease most common in women about forty to fifty years of age. Soft carcinoma, or encephaloid, occurs at an earlier period of life.

Soft carcinomas are much more rapid in their growth and much more malignant, than hard carcinomas; and appear as round movable tumors, situated deeper in the breast than scirrhus. On examination, such growths feel knobby, but are not exceedingly hard; they are elastic and at some places feel almost as fluctuating as cystic tumors. The integument overlying them becomes red and œdematous, and suggests the occurrence of suppuration. Ulceration soon supervenes and portions of the tissue become detached, though there is not the same tendency to fungous protrusion as is found in some other tumors. The disease is accompanied with comparatively little pain, but the lymphatic nodes and viscera are affected quite early. In the space of eight or ten weeks these growths may assume the size of a cocoanut.

The clinical difference between hard and soft carcinoma resides in the comparative hardness and the chronicity of progress of the former. The round cell sarcoma resembles clinically the soft carcinoma, but is circumscribed and encapsulated, while the latter is an infiltrated growth. The average duration of soft sarcoma is from six to twelve months, while that of a hard carcinoma is about two and a half years.

Cystic or colloid degeneration may occur in both forms of carcinoma, and small abscesses may occasionally develop in connection with them.

Cystic tumors of the breast are not infrequently found. They may occur during lactation, and then often contain milk. Glandular cysts of various kinds occur in the organ and contain fluid varying in color from a light straw to a red. These benign tumors are smooth in outline and do not involve the lymphatic glands or ulcerate. These are sometimes so hard as to give the surgeon's fingers the impression of a solid growth. At other times they may be distinctly fluctuating. It is at times good policy to puncture the tumor before attempting to remove it with the knife, for the whole breast has been excised for malignant disease which subsequent examination showed to be an innocent cyst. The surgeon must carefully distinguish a benign cyst from a malignant tumor which has undergone cystic degeneration.

Treatment.—Simple cysts may be treated by evacuation of the fluid with an aspirator, and then setting up an irritation by scraping the interior of the wall with the point of a needle or by introducing some counter-irritant, such as the tincture of iodine or a five per cent. solution of carbolic acid. Prompt cure will often be better obtained by excising the cystic tumor. The breast itself should not be removed unless its structure is practically riddled with cysts. Excision of the breast is then justifiable because a return of the enlargement would seem to indicate a malignant tumor, and would, therefore, give great anxiety to the patient.

Clinically, it is frequently impossible to diagnose with certainty sarcoma from carcinoma or either of these from mixed adenoid growths.

A hard, lobulated slow growth, which does not draw in the skin, is probably innocent. An elastic, rapid growth is almost certainly malignant. Experience has taught that any growths in the breast, which do not after a few weeks' treatment show evidence of diminishing in size, had better be removed by operation. If the tumor is a small one, a single incision will enable the operator to enucleate it from the gland tissue without mutilation of the organ. If it is innocent, the patient's mind will be relieved and the slight operation will be fully justified by the mental relief given to the patient. If these small growths thus early removed prove to be malignant, both the surgeon and the patient are put upon their guard and warned of the absolute necessity for instant removal of the entire breast and all the neighboring lymph nodes.

Sarcomas may be as malignant as, or more malignant than, carcinomas. It is of little interest to the patient to know from which she suffers, hence these two forms of tumor must be treated alike. Pure fibromas are not apt to recur, if all the tumor structure is removed ; but this form of tumor is rare. The removal of adeno-fibromas and adeno-cystomas may be advisable, since the difficulty in diagnosing them, before microscopical examination is made, is great. Pregnancy hastens the development of tumors in the breast; undoubtedly because of the increased blood supply to the organ.

Excision of the Breast.

When there is the slightest reason to believe that the tumor is a malignant one, it is proper to perform excision of the mammary gland. It is only in benign growths or in those which are expected to prove themselves benign, when subsequent histological study is made, that partial removal of the gland is justifiable. The accepted belief that malignant growths are originally local and not the result of constitutional change is a strong argument in favor of early and radical operation. Operation should not be performed when the disease has become so extensive that it is evidently impossible to remove all the tissue visibly infiltrated; nor in patients who presumably cannot stand the shock of the operation. Under our present methods of operation, however, excision of the breast is almost devoid of danger. It is justifiable to attack these growths under nearly all circumstances, and to follow the first operation by other operations when recurrence takes place, until it is manifestly impossible for the knife to get beyond the limits of infiltration as discernible by the naked eye. It is the tendency to postponement on the part of the patient and the encouragement which such delay receives at the hands of some physicians that often prevent surgical aid being given until the gland is considerably involved in the disease. Patients in whom secondary visceral lesions have occurred, are not proper subjects for operation.

In proceeding to attack the growth, the surgeon must recollect that any small portion of the infiltrated tissue left behind is a source of imminent risk, and his incisions must, therefore, be made so far beyond the limit of the growth as to avoid, as far as possible, such contingency. It is an imperative rule that the axilla be opened freely and all the lymphatic nodes of that region enucleated in every case. It is wise to also remove the lymph nodes above and below the clavicle and the greater and less pectoral muscles.

The operation of excision of the breast is performed by carrying an elliptical incision around the gland, about three quarters of an inch from its circumference; and then removing it with the two pectoral muscles from their origins to a point near their insertions. The lymph nodes and fat below the clavicle should also be removed. This is done through the wound made by the excision of the breast gland. The lymph nodes and fat in the axilla should also be extirpated by means of an incision carried outwards. The mass can be removed in one large piece or in two sections. Some operators object to the tumor or the implicated tissue being incised, lest the disease be spread by infection of the knife so used if it be employed for other steps of the operation. It is wise when operating in the axilla to clear away the tissue around the axillary vein freely first, in order that its location may be clearly appreciated. Laceration of the vein gives rise to copious hemorrhage. It is easily arrested, however, by lateral ligature, by suturing the opening in the vessel with fine catgut or by grasping the margin of the tear with hemostatic forceps, which should be allowed to remain in the wound for forty eight hours. The skin covering the posterior portion of the axilla should be perforated for the admission of a rubber drainage tube, which will permit the exit of wound fluids while the patient lies upon her back. A triangular flap of skin raised from the neck will uncover the space between the outer edge of the sterno-mastoid muscle and the clavicle and permit removal of the supra-clavicular nodes. This step should not be omitted. Mammary carcinoma or sarcoma should be attacked early and radically.

The axillary wound is then closed by sutures, and the raw surface left by the removal of the breast somewhat contracted by strong sutures carried across it. A considerable degree of approximation can be obtained if the skin and subcutaneous tissue are separated from the chest wall by dissecting up the edges a short distance. It is well to place over the open surface a piece of perforated rubber tissue or Lister protective before applying the gauze dressing, because the gauze placed directly over the raw surface becomes adherent from the drying of the secretions, and gives pain when the dressing is removed. Skin grafts or skin shavings to hasten healing may be applied at once or after granulation has been established—say at the end of ten days.

If the disease returns, secondary operations should be done promptly. In order to get access to the tissues high up in the axilla, around the axillary artery and vein, it will probably often be wise to amputate the arm. This will give better opportunity to thoroughly extirpate infiltrated tissue and excise the involved artery and vein, the coats of which may be the seat of malignant disease.

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