MINOR SURGERY

AND

BANDAGING

INCLUDING

THE TREATMENT OF FRACTURES AND DISLOCATIONS, THE LIGATION OF ARTERIES, AMPUTATIONS, EXCISIONS AND RESECTIONS, INTESTINAL ANASTOMOSIS, OPERATIONS UPON NERVES AND TENDONS, TRACHEOTOMY, INTUBATION OF THE LARYNX, ETC.

BY

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FOURTH EDITION, THOROUGHLY REVISED AND ENLARGED, WITH 502 ILLUSTRATIONS.

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PREFACE TO FOURTH EDITION.

THE author has been much gratified by the favorable reception which has been accorded to this work, and has endeavored in the preparation of the present edition to make it worthy of a continuance of that favor. The subject-matter has been carefully revised and much new material has been added, including a chapter upon Surgical Bacteriology. From the fact that great attention is now directed in our medical schools to operative procedures upon the cadaver, it has seemed advisable to the author to add a section upon such operations as can with advantage be practised upon the cadaver. These include Amputations, Ligations, Excisions, the Introduction of Sutures, Intestinal Anastomosis, Tracheotomy and Intubation, and Operations upon the Bones, Tendons, and Nerves.

The descriptions of these operative procedures are brief, and are not intended to take the place of the varied and elaborate ones given in special works upon operative surgery, but they have been introduced to add to the value of the work as a hand-book for the use of students in their practical work.

The author desires to express his thanks to Dr. J. H. Jopson for assistance in revising the proof-sheets.

1725 SPRUCE ST., PHILADELPHIA, July, 1899.

PREFACE TO FIRST EDITION.

THE author has, in this work, endeavored to present, in as concise a manner as possible, a description of the various bandages, surgical dressings, and minor surgical procedures which are employed in the practice of surgery at the present time. The preparation and application of the antiseptic dressings now most commonly used have also received full consideration. The article upon Bandaging is fully illustrated with cuts, mostly new and taken from photographs, which, it is hoped, will prove of value as furnishing an accurate representation of the most important bandages used in surgical practice; the same is in a measure true of the article upon the dressing of Fractures and Dislocations, in which many new cuts of the same kind appear.

The work also contains short articles upon Tracheotomy, Intubation of the Larynx, the Ligation of Arteries, and Amputations, and, although these procedures are scarcely to be included with those of Minor Surgery, it is hoped that their description will increase the value of the work to medical students, for whose use it has been prepared. The author's thanks are due to Dr. Walter D. Green for his kind assistance in revising proof-sheets, and to Mr. James Wood for the skilful photographic work used in illustrating several of the articles.

PHILADELPHIA, August, 1891.

CONTENTS.

PART I.

BANDAGING.

PART II.

MINOR SURGERY.

PART VII.

EXCISIONS AND RESECTIONS, AND SPECIAL OPERATIONS.

PART I.

BANDAGING.

Bandages. These constitute one of the most widely used and important surgical dressings; they are employed to hold dressings in contact with the surface of the body, to make pressure, to hold splints in place in the treatment of fractures and dislocations, and to restore to their natural position parts which may have become displaced.

Bandages may be prepared of various materials, such as linen, crinoline, flannel, cheese-cloth or tobacco-cloth, rubber-sheeting, or muslin, bleached or unbleached; the latter material is the most commonly employed, by reason of its cheapness; flannel, from its elasticity, is sometimes used, but its employment for bandages is now generally limited to its use in dressings for operative work in connection with the eye and abdomen, and for a primary roller in the application of the plaster-of-Paris dressings.

Bandages are either *simple*, when composed of one piece of material, such as the ordinary roller-bandage, or *compound*, when prepared of one or more pieces, adapted by size and shape to peculiar objects.

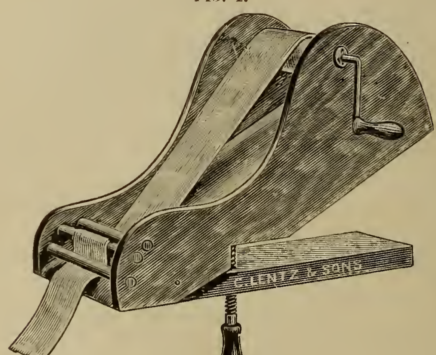
Bandages are also described as uniting, dividing, compressing, expelling, or retaining bandages, according to the purposes they serve by their application.

The importance of being perfectly familiar with the general rules of bandaging and proficient in the application of the roller-bandage cannot be overestimated, and both the student and general practitioner will never have cause to regret the time occupied in learning to apply neatly this form of surgical dressing.

A well-applied bandage adds to the comfort of the patient, and the method of its application often secures for the physician the confidence both of the patient and of his friends, while, on the other hand, a badly applied bandage is apt to be uncomfortable and insecure, and to meet with their adverse criticism.

The Roller-bandage. The roller-bandage consists of a strip of woven material, prepared from some of the materials previously mentioned, of variable length and width according to the portion of the body to which it is to be applied; this, for ease of application, is rolled into a cylindrical form.

Fig. 1.



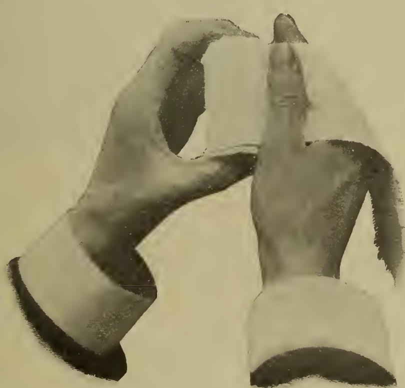
Bandage-winder.

The material commonly employed for the roller-bandage is unbleached muslin, although, for special purposes, linen, flannel, rubber-sheeting, crinoline, or cheese-cloth may be used. It is important that the roller-bandage should consist of one piece, free from seams and selvage, for if made of a number of pieces sewed together, or if it contains creases or selvage, it cannot be so neatly applied, and it is not so comfortable to the patient, as it is apt to leave creases upon the skin.

In preparing the ordinary muslin bandage the material is torn in strips varying in length and width according to the part of the body to which it is to be applied, and it is then rolled into a cylinder, either by the hand or by a machine constructed for the purpose (Fig. 1).

It is important that every student and practitioner should be able to roll a bandage by hand, for in practice the medical attendant may at any moment be called upon to prepare a bandage, in order to apply a dressing, and the art of preparing a bandage is easily acquired by a little practice. To roll a bandage by hand the strip should be

Fig. 2.



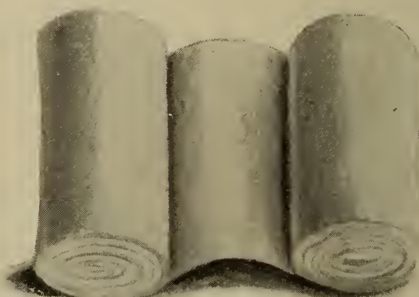
Rolling a bandage by hand.

folded at one extremity several times until a small cylinder is formed; this is then grasped by its extremities by the thumb and index finger of the left hand; the free extremity of the strip is then grasped between the thumb and index finger of the right hand, and by alternate pronation and supination of the right hand the cylinder is revolved and the roller is formed; the firmness of the roller will depend upon the amount of tension which is kept upon the free extremity of the strip during the revolution of the cylinder (Fig. 2). A bandage rolled in the form of a cylinder is called a *single* or *single-headed* roller (Fig. 3); if rolled from each extremity toward the centre so that two cylinders are formed joined by the central portion of the strip, the *double* or *double-headed* roller is formed (Fig. 4).

FIG. 3.

Single roller.

FIG. 4.



Double roller.

Double rollers are not much used, and in practice the single roller will be found to be amply sufficient for the application of almost all the bandages employed in surgical dressings.

The free end of the roller-bandage is called the *initial extremity ;* the end which is enclosed in the centre of the cylinder is its *terminal extremity ;* and the portion between the extremities *the body ;* a roller has also two surfaces, *external* and *internal.*

Dimensions of Bandages. Bandages vary in length and width, according to the purposes for which they are employed, and in practice it will be found that a small variety of bandages will be amply sufficient for the application of the ordinary surgical dressings.

The following list comprises those most frequently used and will show their dimensions :

Bandages *one* inch wide, *three* yards in length, for bandages for the hand, fingers, and toes.

Bandages *two* inches wide, *six* yards in length, for head-bandages and for the extremities in children.

Bandages *two and a half* inches wide, *seven* yards in length, for bandages of the extremities in adults; a roller of this size is the one most generally used.

Bandages *three* inches wide, *nine* yards in length, for bandages of the thigh, groin, and trunk.

Bandages *four* inches wide, *ten* yards in length, for bandages of the trunk.

General Rules for Bandaging. In applying a roller-bandage the operator should place the external surface of the free extremity of the roller upon the part, holding it in position with the fingers of the left hand until fixed by a few turns of the roller, the cylinder being held in the right hand by the thumb and fingers; for thus as the bandage is unwound it rolls into the operator's hand, thereby giving him more control of it; care should also be taken that the turns are applied smoothly to the surface, and that the pressure exerted by each turn is uniform.

When a bandage is applied to a limb the surgeon should see that the part is in the position it is to occupy as regards flexion and extension when the dressing is completed, for a bandage applied when the limb is flexed will exert too much pressure when the limb is extended, and then may, by the pressure it exerts, become a matter of discomfort or even of danger to the patient, or if applied to an extended limb it will become uncomfortable upon flexion.

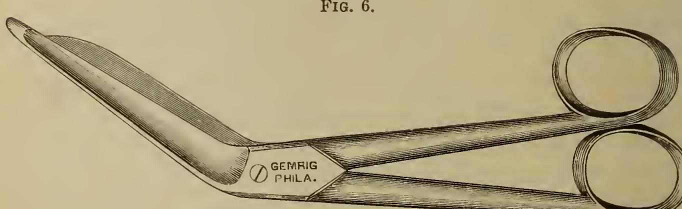
My experience has been that, as a rule, those who have had little experience with the application of the roller-bandage are apt to apply their bandages too tightly, and this may lead to disastrous consequences; gangrene of the extremities having resulted from the too tight application of bandages, especially in the dressing of fractures. Professor Ashhurst, in his clinical teaching, advises students to make use of a larger number of turns of a bandage in securing fracture-dressings rather than to depend upon a few turns too firmly applied—advice which certainly conduces to the safety and comfort of the patient. When the bandage has been completed the terminal extremity should be secured by a pin or safety-pin applied transversely to the bandage, and if a pin be used its point should be buried in the folds of the bandage; if the bandage be a narrow

FIG. 5.

Method of removing a bandage.

one, the end may be split and the two tails resulting may be secured around the part by tying.

FIG. 6.



Bandage-scissors.

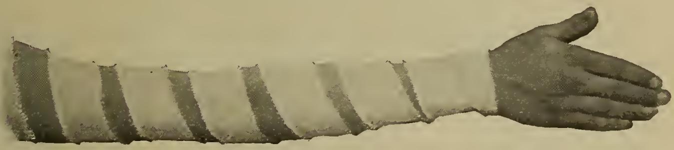
Removal of Bandages. In removing a bandage the folds should be carefully gathered up in a loose mass as the bandage is unwound, the mass being transferred rapidly from one hand to the other, thus facilitating its removal and preventing the part from becoming entangled in its loops (Fig. 5). If it is desirable to cut the bandage to remove it, the use of scissors made for this purpose will be found most satisfactory (Fig. 6).

VARIETIES OF BANDAGES.

Circular Bandage. This bandage consists of a few circular turns around a part, each turn covering accurately the preceding turn. This variety of bandage may be used to retain a dressing to a limited portion of the head, neck, or limbs, to make compression upon the veins of the arm before performing venesection, or to secure a compress to control venous hemorrhage (Fig. 11, *b*).

Oblique Bandage. In this form of bandage the turns are carried obliquely over the part, leaving uncovered spaces between the successive turns (Fig 7). It cannot

Fig. 7.



Oblique bandage.

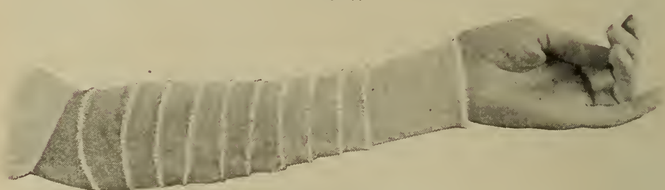
be applied with much firmness on account of the uncovered portions of skin between the turns of the bandage, and its principal use is for the application of temporary dressings, such as wet dressings which may require frequent removal.

Spiral Bandage. In this bandage the turns are carried around the part in a spiral direction, each turn overlapping a portion of the preceding one, usually one-third or one-half; it may be applied as an ascending spiral (Fig. 8) or as a descending spiral (Fig. 9). This bandage may be used to cover a part which does not increase too rapidly in diameter; for instance, the abdomen, chest, or arm.

FIG. 8.

Ascending spiral bandage.

FIG. 9.

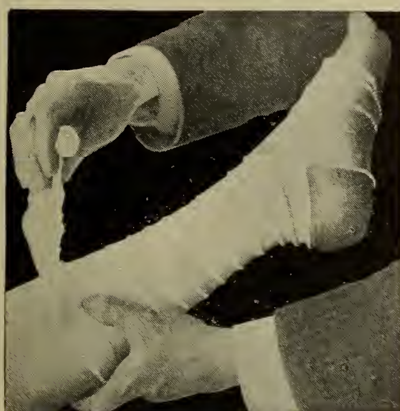


Descending spiral bandage.

Spiral Reversed Bandage. This bandage is a spiral bandage, but differs from the ordinary spiral bandage in having its turns folded back or reversed as it ascends a part the diameter of which gradually increases. By its use it is possible to cover by spiral turns a part conical in shape, so as to make equable pressure upon all parts of the surface. The reverses are made as follows: After fixing the initial extremity of the roller, as the part increases in diameter, the bandage is carried off a little obliquely to the axis of the limb for from four to six inches; the index-finger or thumb of the disengaged hand is placed upon the body of the bandage to keep it securely in place upon the limb, the hand holding the roller is carried a little toward the limb to slacken the unwound portion of the bandage, and by changing the position of the hand holding the bandage from extreme supination to pronation the reverse is made (Fig. 10). Care should be taken not to attempt to make the reverse while the bandage is tense, for by so doing the bandage is twisted into a cord which is unsightly and uncomfortable to the patient, instead of forming a closely fitting reverse.

The reverse should be completed before the bandage is carried around the limb, and when it has been completed the bandage may be slightly tightened so as to conform to the part accurately.

FIG. 10.



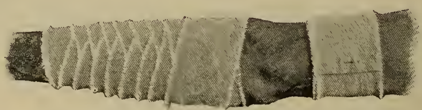
Method of making reverses.

The reverses should be in line to have the bandage present a good appearance, and care should be taken that the reverses should not be made over prominent bony parts of the limb, for if they occupy such positions they cause creases in the skin and become uncomfortable to the patient.

To make reverses neatly and to have them in line require skill and practice; a well-applied spiral reversed bandage is a test of a competent bandager.

Spica-bandage. When the turns of the roller cross each other in the form of the Greek letter *lambda,* leaving the previous turn about one-third uncovered, the bandage is known as a spica-bandage (Fig. 11, *a*). These spica-bandages are especially serviceable as a means of retaining surgical dressings upon particular portions of the surface of the body, such as the shoulder, groin, or foot.

FIG. 11.



a Spica-bandage. b Circular bandage.

Figure-of-eight Bandage. This bandage receives its name from the turns being applied so as to form a figure-of-eight. This method of application is made use of in the Barton's bandage, the bandages of the knee and elbow, and many other bandages.

FIG. 12.

Recurrent bandage

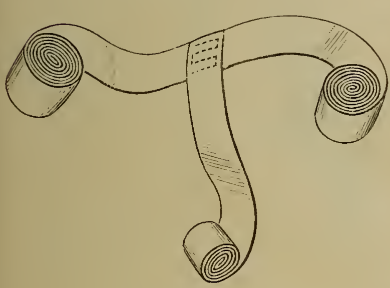
Recurrent Bandage. This bandage derives its name from the fact that the roller after covering a certain part of the surface is reflected and brought back to the point of starting; it is then reversed and carried toward the opposite point, and this manipulation is continued until the part is covered by these recurrent turns, which are then secured by a few circular turns (Fig. 12). This is the bandage usually employed in the dressing of stumps after amputation.

Compound Bandages.

These bandages are usually formed of several pieces of muslin or other material, sewed or pinned together, and are employed to fulfil some special indication in the application of dressings to particular parts of the body. The most useful of the compound bandages are the T-bandages and the many-tailed bandages.

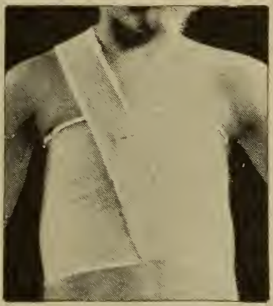
T-bandage. The single T-bandage consists of a horizontal band to which is attached, about its middle, another having a vertical direction; the horizontal piece should be

Fig. 13.



Single T-bandage.

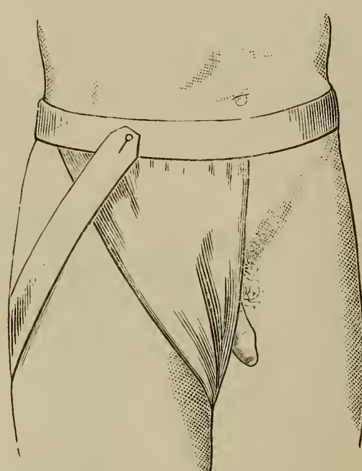
Fig. 14.



Single T-bandage for chest.

about twice the length of the vertical piece (Fig. 13). The single T-bandage may be used to retain dressings to the head, the horizontal piece being passed around the head from the occiput to the forehead, the vertical piece being passed over the head and secured to the horizontal piece, the shape and width of the two pieces being varied according to the indications. In applying dressings to the anal region or perineum, or in securing a catheter in a perineal wound, the single T-bandage will be found most useful. In applying a T-bandage for this purpose the body of the bandage is placed over the spine, just above the pelvis, and the horizontal portion is tied around the abdomen. The free extremity is split into two tails for about two-thirds of its length, and is carried over the anal region and brought up between the thighs, the terminal strips passing one on each side of the scrotum and being secured to the horizontal strip in front. The single T-bandage may be

Fig. 15.

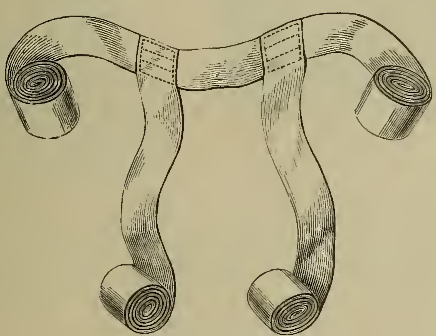


T-bandage of groin.

variously modified according to the indications which are to be met; for instance, in applying a dressing to the breasts the horizontal strip passing around the chest may be made ten or twelve inches in width; the vertical strip, two inches in width, passes from the back over the shoulder and is secured to the horizontal strip in front (Fig. 14). The single T-bandage may be variously modified, according to the ideas of the surgeon, so as to meet the indications presented in special cases. For the groin a piece of muslin six inches wide at its base and thirty inches long is sewed to a horizontal strip of muslin one and a half yards long and two inches in width. It may be applied as in Fig. 15 to hold a dressing to this part.

Double T-bandage. The double T-bandage differs from the single bandage in having two vertical strips attached to the horizontal strip and it may be used for much the same purposes as the single T-bandage (Fig. 16). It may be conveniently used for retaining dressings to the chest, breast, or abdomen; when used for this purpose the

Fig. 16.

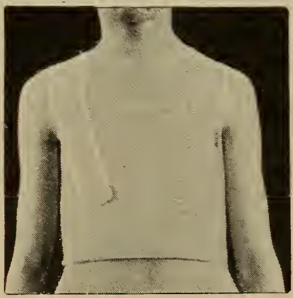


Double T-bandage.

horizontal portion should be from eight to twelve inches wide and long enough to pass one and a quarter times about the chest; two vertical strips, two inches wide and twenty inches long, should be attached to the horizontal strip a short distance apart near its middle. In applying this bandage to the chest, the horizontal strip is placed around the chest so that the vertical strips occupy a position on either side of the spine; the overlapping end of the horizontal portion is secured by pins or safety-pins, and the vertical strips are next carried one over either shoulder and secured to the other portion of the bandage in front of the chest (Fig. 17).

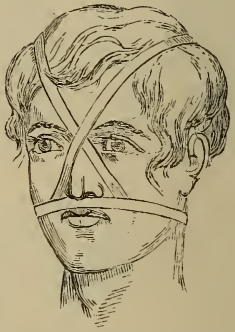
The double T-bandage may also be used to secure dressings to the nose, in which event the strips should be quite narrow, about one inch in width, and should be applied as shown in Fig. 18.

Fig. 17.



Double T-bandage of chest.

Fig. 18.



Double T-bandage of nose.

Many-tailed Bandages or Slings. These bandages are prepared from pieces of muslin of various lengths and breadths, which are split at each extremity into two, three, or more tails up to within a few inches of their centres, their width and length being regulated by the part of the body to which they are to be applied.

The *four-tailed* bandage may be found useful as a temporary dressing in cases of fracture of the jaw, or to hold dressings to the chin. It may be prepared by taking a portion of a roller-bandage three inches wide and one yard in length, and splitting each extremity up to within two inches of the centre; it is then applied as seen in Fig. 19.

The four-tailed bandage may also be used to retain dressings to the scalp, and can be prepared by taking a piece of muslin one yard and a quarter long and six or eight inches in width, splitting it at each extremity into two tails within six inches of the centre; it may then be applied as seen in Fig. 20.

The four-tailed bandage may also be used in the temporary dressing of fractures of the clavicle—the body of the bandage being placed upon the elbow of the injured side, two tails passing around the body, fixing the arm to the side, and two tails passing over the sound shoulder.

Fig. 19.

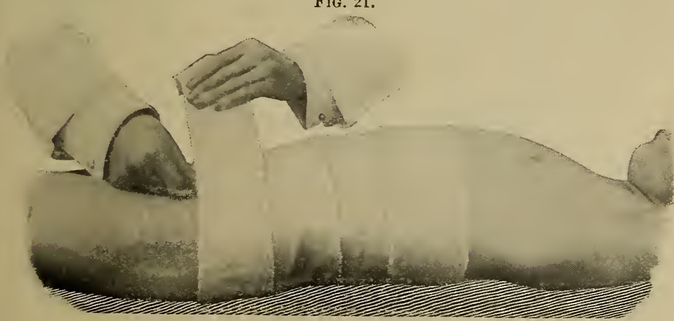
Four-tailed bandage of chin.

Fig 20.

Four-tailed bandage of head.

Many-tailed Bandage of Abdomen. This bandage may also be used for holding dressings in contact with the abdo-

Fig. 21.



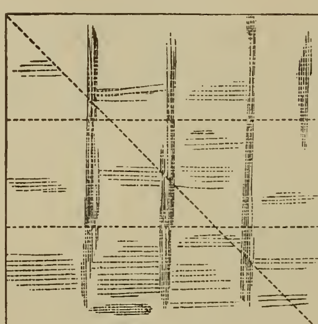
Many-tailed bandage of abdomen.

men or trunk, and is the bandage which most surgeons employ to hold the dressings to a laparotomy-wound, and to give support to the abdominal walls after this operation. In preparing this bandage, a strip of muslin or flannel, one and a half yards in length and eighteen to twenty inches in width, is required; the extremities may be split so as to form a four or six-tailed bandage. In applying this bandage to the abdomen, the body is placed upon the patient's back and the tails are brought around the abdomen and overlap each other, and when sufficiently firmly drawn to make the desired amount of pressure they are secured by means of safety-pins (Fig. 21).

Handkerchief-bandages.

The use of handkerchiefs or square pieces of muslin for the temporary or permanent dressing of wounds, fractures, or dislocations was advocated many years ago by M. Mayor, a Swiss surgeon, who wrote an extensive work

FIG. 22.



The square.

FIG. 23.

The oblong.

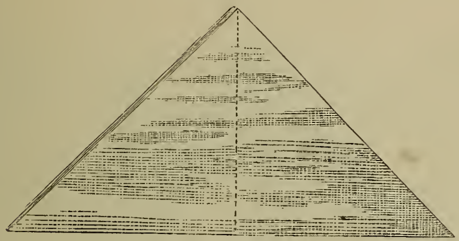
upon this subject, in which he reduced their application to a system. He employed a handkerchief or a square piece of muslin, and by various modifications in the application of these developed a number of very ingenious bandages.

The various forms which the handkerchief or *square* (Fig. 22) is made to assume are as follows: The *oblong*, made by folding the square once or twice on itself (Fig.

23). The *triangle*, made by bringing together the diagonal angles of the square (Fig. 24). The line of folding is known as the base, the angle opposite the base the apex, and the other angles the extremities.

The *cravat* is prepared from the triangle by bringing the apex to its base, and folding it a number of times upon itself until the desired width is obtained (Fig. 25).

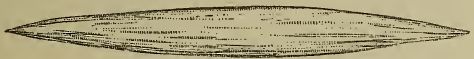
FIG. 24.



The triangle.

The *cord* is formed from the cravat twisted upon itself (Fig. 26). The names of the various handkerchief-bandages are derived from the shape of the handkerchiefs used and the parts to which they are applied; the names serve as guides in their application. It is to be remembered

FIG. 25.



The cravat.

FIG. 26.

The cord.

that the base of the triangle or the body of the cravat is to be placed upon the portion, the designation of which forms the first portion of the name of the bandage; thus, in the *occipito-frontal triangle*, the shape of the handkerchief is given, and we know that the base of the triangle is to be applied to the occiput and then pass to the forehead. In using the cravats the same rule applies; thus, in the *bis-axillary cravat* the body of the cravat is to be placed in the axilla of the affected side, the extremities crossed over the corresponding shoulder and carried over the chest, one before, the other behind, to the axilla of the opposite side, where they are secured.

FIG. 27.

Occipito-frontal triangle.

The Occipito-frontal Triangle. To apply this handkerchief, place the base of the triangle upon or a little below the occiput, and bring the apex forward over the head, allowing it to drop over the forehead; next bring the extremities of the handkerchief forward and tie them in a knot over the forehead; finally turn up the apex over the knotted ends and pin to the body of the handkerchief (Fig. 27).

The Mento-vertico-occipital Cravat. To apply this handkerchief the middle of the base of the cravat is placed under the chin, the extremities are then carried in front of the ear on each side to the vertex of the skull, and are crossed at that point; the ends are then carried downward over the parietal region to the occiput and are secured by a knot at this point (Fig. 28). Another method of applying this handkerchief consists in placing the base of the cravat under the chin and carrying the extremities over the vertex of the skull, crossing them at that point, then carrying them downward to the occiput, and crossing them again here and passing them forward around the chin, and finally securing the ends by a knot (Fig. 29). The turns of the latter handkerchief correspond exactly to the turns of the Barton's bandage of the head.

FIG. 28.

Mento-vertico-occipital cravat.

FIG. 29.

Mento-vertico-occipital cravat (modified).

These handkerchief-bandages may be used to secure dressings to the chin or scalp, or may be employed as temporary dressings to secure fixation of the parts in cases of fracture or dislocation of the jaw.

FIG. 30.

Bis-axillary cravat.

The Bis-axillary Cravat. To apply this handkerchief the body of the cravat is placed in the axilla, and the ends are brought up, one in front of, the other behind, the axilla, and are made to cross over the top of the shoulder; the extremities are then carried across the back and chest respectively to the opposite axilla, when they are secured by tying (Fig. 30). This handkerchief may be employed to secure dressings in the axilla, or to hold dressings in contact with the shoulder.

The Dorso-axillary Cravat. This handkerchief is applied by placing the body of the cravat over the spine between the scapulæ, and then carrying one extremity over the shoulder and through the axilla backward to meet the other extremity, which has been carried through the axilla and over the other shoulder to the back, when the ends are secured by a knot (Fig. 31). This handkerchief may be used to hold dressings to the axilla or upper portion of the back of the chest.

FIG. 31.

Dorso-axillary cravat.

The Compound Dorso-bis-axillary Cravat. To apply this handkerchief two cravats are required. The base of one cravat is placed over the front of one shoulder, and the ends are passed, one over the top of the shoulder, the other through the axilla, and they are then secured by a single knot over the scapula; the ends are next secured by tying them in a loop. The second cravat is next placed in front of the shoulder on the opposite side, and the ends are respectively carried over the shoulder and through the axilla to the back, where they are secured by a single knot the ends of the handkerchief are then passed through the loop of the other handkerchief and secured by a knot (Fig. 32). This handkerchief may be used to draw the shoulders backward in cases of dislocation or fracture of the clavicle.

FIG. 32.

Compound dorso-bis-axillary cravat.

Triangular Cap or Suspensory of the Breast. To apply this handkerchief the base of the triangle is placed under the affected breast, and one extremity is carried beneath the axilla of the same side, and the other extremity is carried around the opposite side of the neck, and they are secured together upon the back by a knot; the apex should then be brought up over the breast and shoulder of the affected side, and pinned to the bandage over the scapula (Fig. 33). This handkerchief may be employed to sling the breast in nursing-women, or to hold a dressing to the breast.

FIG. 33.

Triangular cap or suspensory of the breast.

The Gluteo-femoral Triangle. In applying this handkerchief a cravat is first fastened around the waist, and a second handkerchief folded into a triangle has its base placed in the gluteo-femoral fold, and its extremities are carried around the thigh and secured in front by a knot; the apex of the handkerchief is then carried upward and passed beneath the cravat around the waist, and is turned down and pinned to the body of the triangle (Fig. 34). This handkerchief may be used to retain dressings to the region of the buttock or hip; by unpinning the apex and turning it downward ready access can be had to the parts beneath.

Gluteo-inguinal Cravat. In applying this handkerchief the base of the cravat is placed just over the gluteo-femoral fold, and the extremities are carried forward, one around the inner, the other around the outer portion of the thigh, and they are made to cross in the groin; the ends are next passed around the pelvis and secured together upon the back by a knot (Fig. 35). This handkerchief may be employed to hold dressings to the region of the groin.

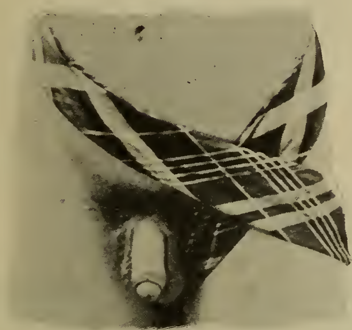
Fig. 34.

Gluteo-femoral triangle.

By employing two cravats a double gluteo-inguinal cravat may be applied, which may be used to hold dressings to both groins. The turns of these cravats correspond to the turns of the single and double spica-bandages of the groin.

I have described a few of the many very ingenious bandages devised by Mayor to substitute the use of the roller-bandage, which will give the student some idea of their design and application. It is well to bear in mind this system of dressing, for the occasion might occur in which the ordinary means of bandaging could not be obtained, and the use of handkerchiefs might answer a useful purpose as temporary dressings. I think their principal use is for temporary dressings, and I do not think they

FIG. 35.



Gluteo-inguinal cravat.

will ever take the place of the roller-bandage, which can be applied with much greater nicety and exactness, and certainly presents a much neater appearance.

BANDAGES FOR THE HEAD AND NECK.

Barton's Bandage. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the roller should be placed on the head just behind the mastoid process, and the bandage should then be carried under the occipital protuberance obliquely upward under and in front of the parietal eminence across the vertex of the skull, then downward over the zygomatic arch, under the chin, thence upward over the opposite zygomatic arch and over the top of the head, crossing the first turn which was made, as nearly as possible in the median line of the skull, and carrying the turns of the roller under the parietal eminence to the point of commencement. The bandage is then passed obliquely around under the occipital protuberance and forward under the ear to the front of the chin, thence back to the point from which the roller started. These figure-of-eight turns over the head and the circular turns from the occiput to the chin should be repeated, each turn exactly overlapping the preceding one until the bandage is exhausted (Fig. 36). The extremity should then be secured by a pin; and pins should be introduced at the points where the turns cross each other to give additional fixation to the bandage. In applying the bandage care

Fig. 36.

Barton's bandage.

Fig. 37.

Barton's bandage, showing crossing of turns at vertex.

should be taken to see that the turns overlap each other exactly, and that the turns passing over the vertex cross as nearly as possible in the median line of the skull (Fig. 37).

Modified Barton's Bandage. To obtain additional security in the application of the Barton's bandage a turn of the bandage passing from the occiput to the forehead may be made, this turn being interposed between the turns of the bandage as ordinarily applied (Fig. 38). In applying this bandage, after the first set of turns has been completed—that is, after the bandage has been brought back to the occiput, the bandage is carried forward upon the head just over the ear, around the forehead and backward above the ear on the opposite side to the occiput; this being done, the ordinary figure-of-eight and circular

FIG. 38.

Modified Barton's bandage.

turns are made, and when these have been completed another occipito-frontal turn may be made as described above, and this may be repeated as often as is desired until the bandage is exhausted, when the extremity is fastened with a pin, and pins are also introduced at all points at which the turns cross.

Use. This bandage is one of the most useful of the bandages of the head, being employed to secure fixation of the jaw in cases of fracture or dislocation, and for the application of dressings to the chin. I have also employed it in place of the head-gear in slinging patients for the application of the plaster-of-Paris bandage in cases of disease of the spine, a stout cord or a piece of bandage about three inches wide and one yard long being passed under the turns crossing over the vertex; this cord is then secured to the cross-bar of the extension apparatus (Fig. 39). This will be found quite as comfortable to the patient as the ordinary head-gear employed and much less likely to slip out of place and interfere with the breathing of the patient.

Fig. 39.

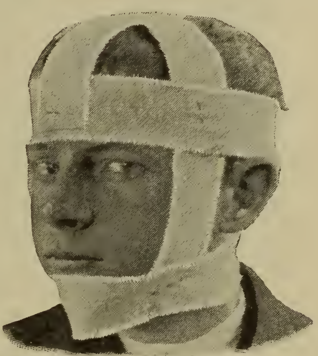
Barton's head bandage, employed for suspension. (Park.)

A firmly applied Barton's bandage holds the jaws so closely together that care should be taken in applying it to patients who are under the influence of an anæsthetic, for if vomiting occurs the material may not be able to escape from the mouth, and suffocation might occur unless the bandage were promptly removed. This accident I once saw occur, and the patient's condition was alarming until the bandage was cut, allowing the jaw to be opened and the contents of the mouth to escape.

Gibson's Bandage. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the roller should be placed upon the vertex of the skull in a line with the anterior portion of the ear; the bandage is then carried downward in front of the ear to the chin, and passed under the chin, and is carried upward on the same line until it reaches the point of starting. The same turns are repeated until three complete turns have been made; the bandage is then continued until it reaches a point just above the ear, when it is reversed and is carried backward around the occiput, and is continued around the head and forehead until it reaches its point of origin;

these circular turns are applied until three have been made. When the bandage reaches the occiput, having completed the third turn, it is allowed to drop down to the base of the skull, and it is then carried forward below the ear and around the chin, being brought back upon the opposite side of the head and neck to the point of origin; these turns are repeated until three complete turns have been made, and upon the completion of the third turn the bandage is reversed and carried forward over the occiput and vertex to the forehead, and its extremity is here secured with a pin. Pins should also be applied at the points where the turns of the bandage cross each other (Fig. 40).

FIG. 40.



Gibson's bandage.

Use. This bandage may be used to fix the lower jaw in cases of fracture or dislocation of the jaw, but is very apt to change its position, and is, therefore, not so satisfactory as the Barton's bandage for this purpose.

Oblique Bandage of the Angle of the Jaw. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the roller is placed just in front of and above the left ear, and if the left angle of the lower jaw is to be covered in, the bandage is to be carried from left to right, making two complete turns around the cranium from the occiput to the forehead. If, however, the right angle of the lower jaw is to be covered in, the turns should be made in the opposite direction.

Having made two turns from the occiput to the forehead, the bandage is allowed to drop down upon the neck, and is carried forward under the ear and under the chin to the angle of the jaw; it is now carried upward close to the edge of the orbit, and obliquely over the vertex of the skull, then down behind the right ear, continuing this oblique turn under the chin to the left angle of the jaw, where it ascends in the same direction as the previous turn. Three or four of these oblique turns are made, each turn overlapping the preceding one and passing from the edge of the orbit toward the ear until the space is covered in; the bandage is then carried to a point just above the ear on the opposite side, is reversed, and finished with one or two circular turns from the occiput to the forehead, the extremity being secured by a pin (Fig. 41).

Fig. 41.

Oblique bandage of the angle of the jaw.

Use. This will be found to be one of the most useful of the bandages; it may be used with a compress in treating fractures of the angle of the lower jaw, for holding dressings to the lower part of the chin and to the vault of the cranium, and is especially useful in retaining dressings to the sides of the face and the parotid region. As before stated, it may be applied to cover either the right or left side of the face, and, by reason of the oblique turns, holds its position most securely, having little tendency to become displaced.

Recurrent Bandage of the Head. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the roller is placed upon the lower part of the forehead and the bandage is carried twice around the head from the forehead to the occiput to secure it. When the bandage is brought back to the median line of the forehead it is reversed and the reversed turn is held by the finger of the left hand while the roller is carried over the top of the head along the sagittal suture to a point just below the occipital protuberance; here it is reversed again and the reverse is held by an assistant while the roller is carried back to the forehead in an elliptical course, each turn covering in two-thirds of the preceding turn. These turns are repeated with successive reverses at the forehead and occiput until one side of the head is completely covered in, and when this is accomplished a circular turn is made from the forehead to the occiput to hold the reverses in place.

The opposite side of the head is next covered in by elliptical reversed turns made in the same manner, and when this has been accomplished two or three circular turns are carried around the head from the forehead to the occiput to fix the previous turns. Pins should be applied at the forehead and occiput at the points where the reversed turns concentrate (Fig. 42).

FIG. 42.

Recurrent bandage of the head.

Use. This bandage when well applied is one of the neatest of the head-bandages, and it will be found useful to retain dressings to the vault of the cranium in the treatment of wounds of the scalp in this region. It will also be found of service in holding dressings to fractures of the cranium and to wounds after the operation of trephining. In restless patients it will sometimes become displaced, and it may be rendered more secure by pinning a strip of bandage to the circular turn in front of the ear and carrying it down under the chin and up to a corresponding point on the opposite side, where it is pinned to the circular turn; or one or two oblique turns passing from the circular turn over the vertex of the skull downward behind the ear, under the chin and up to the circular turn in front of the ear, may be applied. The course of these turns is the same as those employed in the *oblique bandage of the angle of the jaw*, the extremity being secured by a pin.

Transverse Recurrent Bandage of Head. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the roller is placed upon the lower part of the forehead and the bandage is carried twice around the head from the forehead to the occiput to secure it. The head is then covered in by transverse turns of the bandage; the first turn, starting from a point behind the ear on one side, is carried below the occiput to a corresponding point behind the opposite ear, and ascending transverse turns are then made and carried over the head, each turn covering in about two-thirds of the preceding turn, until the forehead is reached, and when this has been reached two or three circular turns are carried around the head from the forehead to the occiput to fix the recurrent turns. Pins should be applied at the points of starting and finishing of the reversed turns behind the ears, and at the occiput and forehead (Fig. 43).

Fig. 43.

Transverse recurrent bandage of the head.

Use. This bandage may be employed to secure dressings to the scalp in cases of wounds, or in injuries to the skull, and is used for the same purposes as the recurrent bandage of the head.

V-bandage of the Head. *Roller Two Inches in Width, Four Yards in Length.* The initial extremity of the roller is secured by two turns of the bandage around the cranium from the forehead to the occiput, and when the roller reaches the occipital protuberance it is allowed to drop a little below this, and is carried forward below the ear around the front of the chin and lower lip, then backward to the point of starting. These turns passing from the occiput to the forehead and from the occiput to the chin are alternately made until a sufficient number have been applied, and the extremity is secured by a pin over the occiput (Fig. 44).

This bandage may be modified by carrying the turns from the occiput forward under the ear and around the upper lip and back to the occiput and alternating these turns with the occipito-frontal turns; if employed in this way, a bandage of one and one-half inches in width should be used.

Use. This bandage may be employed to hold dressings to the front of the chin, to the upper and lower lips in cases of wounds, or to give support to these parts after plastic operations.

Fig. 44.

V-bandage of the head.

Fig. 45.

Head-and-neck bandage.

Head-and-neck Bandage. *Roller Two Inches in Width, Four Yards in Length.* The initial extremity of the roller is placed upon the forehead and carried backward just above the ear to the occiput and is then brought forward around the opposite side of the head to the point of starting. Two of these circular turns are made to fix the bandage, and when it is carried back to the occiput it is allowed to drop down slightly upon the neck, and is then carried around the neck, the turns around the head alternating with the neck-turns until a sufficient number of these have been applied, when the extremity of the bandage is secured by a pin at the point of crossing of the turns at the back of the head (Fig. 45).

Use. This bandage may be found useful in securing dressings to the anterior or posterior portion of the neck or to the region of the occiput.

Care should be taken to apply it in such a manner that too much pressure is not made by the turns around the neck, which would be uncomfortable to the patient, and might seriously interfere with respiration.

Crossed Bandage of One Eye. *Roller Two Inches in Width, Four Yards in Length.* The initial extremity of the bandage is placed upon the forehead and fixed by two circular turns passing around the head from the occiput to the forehead; the roller is then carried back to the occiput and passed around this and brought forward below the ear, and passing over the outer portion of the cheek is carried upward to the junction of the nose with the forehead, and is then conducted over the parietal eminence downward to the occiput; a circular fronto-occipital turn is next made, and when the bandage is brought back to the occiput it is brought forward again to the cheek. It should then ascend to the forehead, covering in two-thirds of the previous turn, and be again conducted back to the occiput; these turns are repeated, the oblique turns covering the eye alternating with circu-

Fig. 46.

Crossed bandage of one eye.

lar turns around the head until the eye is completely enclosed (Fig. 46), and the bandage is finished by making a circular turn about the head and introducing a pin to secure its extremity. It will be found more comfortable to the patient to include the ear on the same side on which the eye is covered in the turns of the bandage.

Use. This bandage will be found useful in retaining dressings to one eye. It will be more comfortable to the patient if a flannel roller be used to apply this bandage, as well as the bandage which includes both eyes.

Crossed Bandage of Both Eyes. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the roller is placed upon the forehead and secured by two circular turns of the bandage, passing around the head from the forehead to the occiput; the roller is then carried downward behind the occiput and brought forward below the ear to the upper portion of the cheek; it is then carried upward to the junction of the nose with the forehead and conducted over the parietal eminence to the occiput; a circular turn is now made around the head from the occiput to the forehead, and the roller is carried from the occiput over the parietal eminence of the opposite side forward to the junction of the nose with the forehead, then downward over the eye and outer portion of the cheek below the ear and back to the occiput; a circular turn around the head is next made, and this is followed by a repetition of the previous turns, ascending over one eye, descending over the other eye, each turn alternating with a circular turn around the head. These turns are repeated until both eyes are covered in, and the bandage is finished by making a circular turn around the head, the extremity being secured by a pin (Fig. 47). In this bandage both ears may be covered in, or left uncovered.

FIG. 47.

Crossed bandage of both eyes.

Use. This bandage may be used to apply dressings to both eyes, and both of these bandages covering the eyes are used where it is desired to make pressure; but, for the simple application of a light dressing or of a bandage for the exclusion of light, the Liebrich's bandage (Fig. 86) will be found more comfortable to the patient.

Occipito-facial Bandage. *Roller Two Inches in Width, Four Yards in Length.* The initial extremity of the roller is placed upon the vertex of the head and the bandage is carried downward in front of the ear, under the jaw, and upward upon the opposite side in the same line to the vertex; two or three of these turns are made, one turn accurately covering in the other. A reverse should be made just above and in front of the ear, and two or three turns are then made around the head from the occiput to the forehead, which completes the bandage (Fig. 48). Pins should be inserted at the points where the turns of the bandage cross each other.

Use. This bandage is employed to secure dressings to the vertex, temporal, occipital, or frontal region.

Fig. 48.

Occipito-facial bandage.

Fig. 49.

Oblique bandage of the head.

Oblique Bandage of the Head. *Roller Two Inches in Width, Six Yards in Length.* The initial extremity of the bandage is placed upon the forehead, and is secured by two circular turns passing around the head from the forehead to the occiput. From the occiput the bandage is carried obliquely over the highest part of the lateral aspect of the head, which is to be covered in, and is passed over the forehead and back to the occiput. It is then carried to the forehead by a circular turn, which is conducted obliquely over the other side of the head and back to the occiput. A circular turn from the occiput to the forehead should be made between the oblique turns. These turns are repeated, so that each succeeding turn covers in three-fourths of the preceding turn until the sides of the head are covered in by descending turns, and the bandage is completed by a circular turn passing around the head from the forehead to the occiput (Fig. 49). This bandage may be applied with descending or ascending turns.

Use. This bandage is employed to make a pressure upon, or to hold dressing to the lateral aspects of the head.

Occipto-frontal Bandage. *Roller Two Inches in Width, Four Yards in Length.* The initial extremity of the roller is placed upon the forehead, and a circular turn is made around the forehead and occiput to fix it. A circular turn is then made, passing around the head from a point below the occiput to a point just above the forehead; the next circular turn is made around the head ascending posteriorly and descending anteriorly, and after a sufficient number of these turns have been made to cover in the front and back of the head, the end of the bandage is secured with a pin (Fig. 50).

Fig. 50.

Occipito-frontal bandage.

Use. This bandage will be found useful in securing dressings to the forehead and anterior and posterior portions of the scalp.

BANDAGES OF THE UPPER EXTREMITY.

Spiral Bandage of the Finger. *Roller One Inch in Width, One and a Half Yards in Length.* The initial extremity of the roller is secured by two or three turns around the wrist; the bandage is then carried obliquely across the back of the hand to the base of the finger to be covered in, then to its tip by oblique turns; a circular turn is next made and the finger is covered by ascending spiral or spiral reversed turns until its base is reached; the bandage is then carried obliquely across the back of the hand and finished by one or two circular turns around the wrist; the extremity may be pinned or may be split into two tails, which are tied around the wrist (Fig. 51).

Fig. 51.

Spiral bandage of the finger.

Use. This bandage is employed to retain dressings to injuries or wounds upon the finger and to secure splints in the treatment of fractures or dislocations of the phalanges.

Gauntlet Bandage. *Roller One Inch in Width, Three Yards in Length.* The initial extremity of the roller is fixed at the wrist by one or two circular turns of the bandage; it is then carried down to the tip of the thumb by an oblique turn of the roller, and this is covered in by spiral or spiral reversed turns to the metacarpo-phalangeal articulations; the roller is then carried back to the wrist and a circular turn is made around it. The bandage is then carried down to the tip of the index finger by an oblique turn, which is covered in the same manner. When all the fingers have been covered in, the bandage is finished by circular turns around the hand and wrist (Fig. 52).

Fig. 52.

Gauntlet bandage.

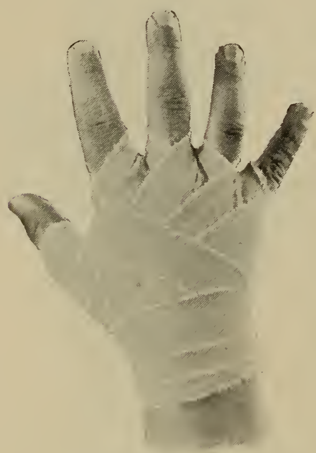
Use. This bandage may be employed to apply dressings to the fingers and hand in cases of wounds or fractures. It was formerly much employed in the treatment of burns of the fingers to prevent the opposed ulcerated surfaces from adhering, but its use for this purpose has been supplanted by wrapping each finger in a separate dressing and applying a dressing over all the fingers and the hand with a few recurrent and spiral turns of a wide roller, the application of this dressing being much less painful to the patient, and being at the same time equally satisfactory in its results.

Demi-gauntlet Bandage. *Roller One Inch in Width, Four Yards in Length.* The initial extremity of the bandage should be placed upon the wrist and fixed by two circular turns passing from the ulnar to the radial side; then carry the roller obliquely across the back of the hand to the base of the thumb, pass the bandage around this and carry the roller back to the wrist, making a circular turn; it should then be carried obliquely across the hand to the base of the index-finger, and so successively until the base of each of the fingers and of the little finger has been included; the bandage is then completed by an oblique turn across the back of the hand passing between the index-finger and the thumb and a circular turn around the wrist (Fig. 53).

The demi-gauntlet bandage may also be applied in such a manner as to cover only the palm and leave the dorsum of the hand uncovered.

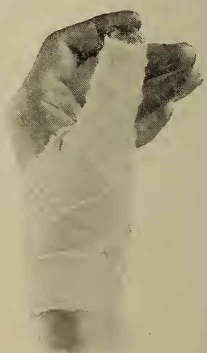
Use. This bandage may be employed to retain light dressings to the dorsal or palmar surface of the hand.

Fig. 53.



Demi-gauntlet bandage.

Fig. 54.



Spica-bandage of the thumb.

Spica-bandage of the Thumb. *Roller One Inch in Width, Three Yards in Length.* The initial extremity of the roller is placed upon the wrist and fixed by two circular turns; then carry the roller obliquely over the dorsal surface of the thumb to its distal extremity; next make a circular or spiral turn around the thumb, and carry the bandage upward over the back of the thumb to the wrist, around which a circular turn should be made. The roller is then carried around the thumb and wrist, making figure-of-eight turns, each turn overlapping the previous one two-thirds as it ascends the thumb, and each figure-of-eight turn alternating with a circular turn around the wrist. These turns are repeated until the thumb is completely covered in with spica-turns, and the bandage is finished by a circular turn around the wrist (Fig. 54).

Use. This bandage is employed to apply dressings to the dorsal surface of the thumb and for the retention of splints in the dressings of fractures or dislocations of the bones of the thumb.

Spiral Reversed Bandage of the Upper Extremity. *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller is placed upon the wrist, and secured by two turns around the wrist; the bandage is then carried obliquely across the back of the hand to the second joint of the fingers, where a circular turn should be made; the hand is covered in by two or

FIG. 55.

Spiral reversed bandage of the upper extremity.

three ascending spiral or spiral reversed turns. When the thumb has been reached, its base and the wrist are covered in by two figure-of-eight turns; the bandage is then carried up the forearm by spiral and spiral reversed turns until the elbow is reached; this may be covered in with spiral reversed turns, and the bandage is next carried up the arm with spiral reversed turns to the axilla (Fig. 55). If, on reaching the elbow, the arm is bent, or is to be flexed in the subsequent dressing, the elbow should be covered in with figure-of-eight turns, and when this has been done the arm may be covered in with spiral reversed turns. When properly applied, the reverses should be in line, and should not be made over the prominent ridge of the ulna.

Use. This is one of the most generally employed of all the roller-bandages; it constitutes the primary roller which is applied in the dressing of fractures of the humerus, and it is also the bandage employed in holding dressings to the arm and forearm and in securing splints to these parts in the treatment of fractures and dislocations.

Figure-of-eight Bandage of the Elbow. *Roller Two Inches in Width, Four Yards in Length.* The initial ex-

FIG. 56.

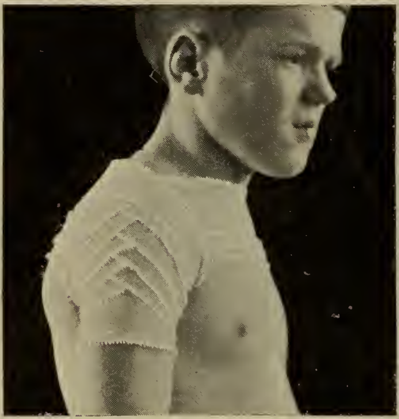
Figure-of-eight bandage of the elbow.

tremity of the bandage is placed upon the forearm a short distance below the elbow-joint, and fixed by one or two circular turns, the arm being flexed. The bandage is then carried by an oblique turn across the flexure of the elbow-joint, and passed around the arm a few inches above the elbow; a circular turn is then made, and the roller is next carried across the flexure of the elbow and passed around the forearm. These turns are repeated, the turns from the forearm ascending and those from the arm descending, each set of turns crossing in the flexure of the elbow until it is covered in, and a final turn is passed circularly around the elbow-joint (Fig. 56). This bandage is sometimes applied by first making one or two circular turns around the elbow and then applying the figure-of-eight turns as previously described.

Use. This bandage is often employed as a part of the spiral reversed bandage of the upper extremity when the arm is to be flexed, and is also used to hold dressings to the region of the elbow-joint. It was formerly much used to hold the compress upon the wound resulting from venesection at the elbow.

Spica-bandage of the Shoulder (Ascending). *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller is placed obliquely upon the outer surface of the arm opposite the axillary fold, and fixed by one or two circular turns. If the right shoulder is to be covered, the bandage is next carried across the front of the chest to the axilla of the opposite side, then around the back of the chest to the point of starting upon the arm; then the roller should be conducted around the arm of this side up over the shoulder, across the front of the chest, through the opposite axilla and back over the posterior surface of the chest to the point of starting; continue to make these ascending turns, each turn overlapping the preceding one about two-thirds until the shoulder is covered in (Fig. 57), when the extremity of the bandage may be secured by a pin at the point of ending, or the last turn may be carried from the shoulder around the back of the neck and brought forward over the opposite shoulder and pinned to the turns which pass around the axilla. It should be remembered that the turns of the roller overlap each other exactly in the opposite axilla, and it will be found more comfortable to the patient to apply a little cotton-wadding in the axilla to prevent the bandage from excoriating the skin of this part. Care should be taken to see that the turns are made in such a manner that the spica-turns occupy, as nearly as possible, the median line of the shoulder. When this bandage is applied to the left shoul-

Fig. 57.



Spica-bandage of shoulder (ascending).

der, after fixing the initial extremity by circular turns around the arm, the roller should be carried over the back of the chest to the axilla of the opposite side and then brought back to the point of starting; the succeeding turns are then applied in the same manner.

Spica-bandage of the Shoulder (Descending). *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller should be fixed upon the arm as near as possible to the axillary fold by one or two circular turns; and if it is applied to the right shoulder, the bandage should be passed under the axilla and carried obliquely over the shoulder to the base of the neck, then downward across the front of the chest to the axilla of the opposite side; from the axilla the roller is carried over the back of the chest to the base of the neck so as to cross the first turn at this point; it is then carried through the axillary space, then back to the neck, the turns descending toward the shoulder. These turns, taking the same course, are repeated, each turn overlapping two-thirds of the previous one until the shoulder is covered in and the circular turn around the arm is reached, at which point the extremity is secured by a pin (Fig. 58).

Fig. 58.

Spica-bandage of shoulder (descending).

Use. The spica-bandages of the shoulder are employed to hold dressings to the shoulder, to hold compresses over the acromial end of the clavicle in case of dislocation of that portion of the bone, to retain the shoulder-cap used in the treatment of fractures of the upper portion of the humerus, and to retain dressings to the axilla.

Figure-of-eight Bandage of the Neck and Axilla. *Roller Two Inches in Width, Five Yards in Length.* The initial extremity of the roller is fixed upon the side of the neck and secured by one or two loosely applied circular turns; if applied to the right axilla, carry the bandage from left to right over the right shoulder to the anterior part of the axilla under which it passes, to ascend in front over the same shoulder to the back of the neck; these figure-of-eight turns around the neck and axilla, each turn overlapping two-thirds of the previous turn, are repeated until the desired space is covered and the bandage is completed by a circular turn around the neck (Fig. 59).

FIG. 59.

Figure-of-eight bandage of the neck and axilla.

Use. This will be found a useful bandage to secure dressings to the base of the neck, the upper part of the shoulder, and to the axilla, as it does not restrict the motions of the arm unless drawn too tight.

Velpeau's Bandage. *Two Rollers Two and a Half Inches in Width, Seven Yards in Length.* The patient should place the fingers of the hand of the affected side on the opposite shoulder ; the initial end of the roller should be placed on the body of the scapula of the sound side and secured by a turn made by carrying the bandage over the shoulder of the affected side, near its outer portion, then conducting it downward over the outer and posterior surface of the arm of the same side, behind the point of the elbow, and obliquely across the front of the chest to the axilla of the opposite side, thence to the point of starting. This turn should be repeated, to fix the initial extremity of the bandage. Having completed the second turn, carry the roller transversely around the thorax, passing over the flexed elbow of the affected side, from this point to the axilla, and through this to the back. From this point the roller is carried over the shoulder and down the outer and posterior surface of the arm behind the elbow and obliquely across the front of the chest through the axilla to the back, and continuing, passes transversely across the back of the chest to the elbow, which it encircles, then passes to the axilla. These alternating turns are repeated until the arm and forearm are bound firmly to the side and chest. The vertical turns over the shoulder, each turn covering in two-thirds of the previous turn and ascending from the point of the shoulder toward the neck and from the posterior surface of the arm toward the elbow, are applied until the point of the elbow is reached. The transverse turns passing around the chest and arm are so applied that they ascend from the point of the elbow toward the shoulder, each turn covering in one-third of the previous one, and the last turn should pass transversely around the shoulder and chest, covering the wrist (Fig. 60).

Fig. 60.

Velpeau's bandage.

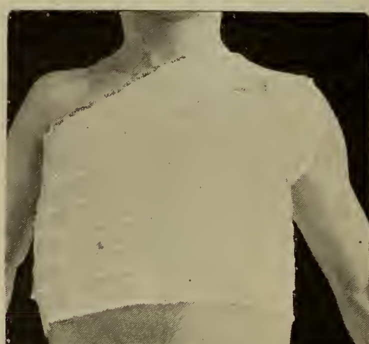
The extremity of the bandage should be secured by a pin where it ends, and additional fixation will be secured by introducing a number of pins at the points where the turns of the bandage cross each other.

Use. This bandage is employed to fix the arm in the treatment of certain fractures of the clavicle and scapula, also to secure fixation of the humerus after the reduction of dislocations of the shoulder-joint.

Desault's Bandage. *Three Rollers Two and a Half Inches in Width, Seven Yards in Length.* A wedge-shaped pad to fit in the axilla is also required. These rollers are known as the *first, second,* and *third* rollers.

First Roller of Desault's Bandage. Before applying the first roller the arm of the patient on the injured side should be elevated and carried off at right angles to the body; the wedge-shaped pad with its base in the axilla should next be applied to the side of the chest, and the initial extremity of the roller should be placed upon the middle of the pad, which may be fixed by two or three circular turns around the chest; the bandage is then carried down the chest by oblique circular turns until the lower extremity of the pad is reached, and it is then carried up the chest

FIG. 61.

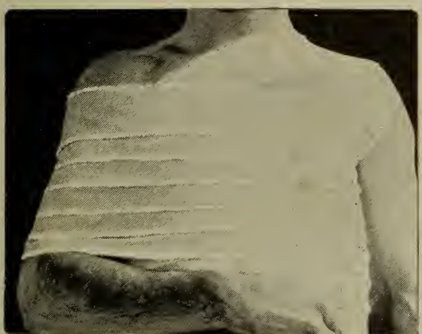


First roller of Desault's bandage.

until the upper extremity of the pad is reached, when it is conducted obliquely across the front of the chest to the sound shoulder and passed under the axilla, brought over the shoulder and conducted around the chest, where it is secured (Fig. 61).

Second Roller of Desault's Bandage. The arm should be brought down against the side so as to press upon the pad previously applied, and the forearm should be flexed upon the arm and brought across the lower portion of the chest. The initial extremity of the roller is placed in the axilla of the sound side, and the bandage is carried around the chest and over the arm of the injured side, making a circular turn around the chest to fix it; then spiral turns are made around the chest from above downward until the elbow is reached, the turns being more firmly applied as they descend, and when this point is reached the end

FIG. 62.



Second roller of Desault's bandage.

of the bandage is secured. Or the initial extremity of the bandage may be placed upon the chest of the sound side and a circular turn may be made to fix it, and then spiral turns, including the chest and arm, may be made from below upward until the axilla is reached (Fig. 62).

Third Roller of Desault's Bandage. The initial extremity of the roller is placed in the axilla of the sound side, and the bandage is carried obliquely over the front of the chest to the shoulder of the injured side, passed over this, and conducted down the back of the arm to the elbow, thence obliquely upward over the upper fifth of the forearm to the axilla of the sound side. From this point it is carried backward obliquely over the back of the chest to the shoulder; crossing the previous shoulder-turn, it is conducted down the front of the arm to the elbow, then around this and backward obliquely over the back of the chest to the axilla of the sound side. These turns are repeated until three sets of turns have been applied, which should overlie each other exactly (Fig. 63). The course of the turns of the third roller is considered the most difficult to remember, and the student may be assisted in its correct application by remembering that all the turns start at the axilla, pass to the shoulder, and then to the elbow, and from the elbow always return to the starting-point—the axilla.

FIG. 63.

Third roller of Desault's bandage.

The turns of the third roller make two triangles, one on the anterior surface of the chest (Fig. 64), the other upon the back(Fig. 65).

After the application of the three rollers the hand and uncovered portion of the forearm should be supported in a sling suspended from the neck.

Use. This bandage, applied completely, or some one of its various rollers, is employed in the treatment of fractures of the clavicle.

Arm-and-chest Bandage. *Roller Two and a Half Inches in Width, Seven Yards in Length.* Before applying this bandage the arm should be placed against the side of the chest and a folded towel or a pad of cotton should be placed in the axilla and allowed to extend from the axilla to the elbow; the latter is used to prevent the opposing surfaces of skin from becoming excoriated by contact.

Fig. 64.

Anterior view of turns of third roller of Desault's bandage.

Fig. 65.

Posterior view of turns of third roller of Desault's bandage.

The initial extremity of the bandage is placed upon the spine at a point opposite the elbow-joint, and it is fixed by a turn or two passing around the arm and chest; the bandage is then continued by making ascending spiral turns, covering in the arm and chest until the axilla is reached; at this point the bandage is carried through the axilla of the sound side and over the back of the chest to the top of the opposite shoulder, and it is then conducted down the front of the arm to the elbow, is passed between the arm and chest and carried up the back of the arm to the shoulder. It is then passed obliquely across the front of the chest and is secured upon the back of the chest. Pins should be introduced at the points of crossing of the bandage (Fig. 66).

Fig. 66.

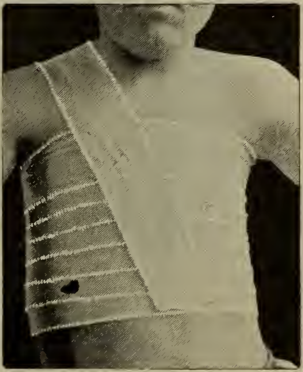
Arm-and-chest bandage.

Use. This bandage will be found useful in fixing the arm to the body and in fixing the shoulder-joint where it is desirable to allow the forearm to be free. It is employed in the treatment of fractures of the shaft and neck of the humerus to fix the arm and hold splints in position.

BANDAGES OF THE TRUNK.

Spiral Bandage of the Chest. *Roller Three Inches in Width, Nine Yards in Length.* The initial extremity of the roller is applied to the anterior portion of the waist, and fixed by one or two circular turns; the bandage is then carried upward, encircling the chest by ascending spiral turns, each turn covering in one-half of the previous turn until the axillary fold is reached; the roller is next carried around the axilla to the back, and obliquely over this to the base of the neck of the opposite side, and then it may be passed down over the chest and pinned to the spiral turns at several points; a pin should also be inserted at the point where the last turn of the roller leaves the spiral turn upon the back of the chest (Fig. 67).

Fig. 67.

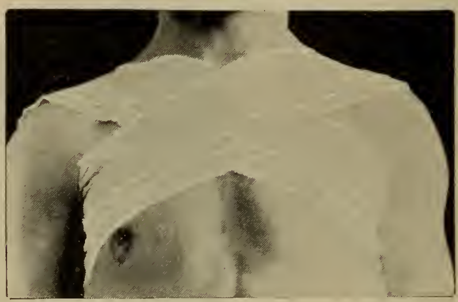


Spiral bandage of the chest.

Use. This bandage is employed to hold dressings to the chest, and may be used as a temporary dressing in fractures of the ribs or sternum. Care should be taken that the bandage be not so tightly applied as to interfere with respiration.

Anterior Figure-of-eight Bandage of the Chest. *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller should be placed in the axilla of one side, and the bandage is then carried obliquely across the anterior portion of the chest to the shoulder of the opposite side; it is then carried backward around the shoulder and through the axilla, and is next conducted obliquely over the anterior portion of the chest to the opposite shoulder, through the axilla and again back to the anterior portion of the chest, the turns crossing in the median line over the sternum. These turns should be repeated, ascending from the shoulder toward the neck, each turn overlapping three-fourths of the preceding one, until five or six turns have been applied, the end of the bandage being secured by a pin (Fig. 68), or it may be completed by a circular turn around the chest.

FIG. 68.



Anterior figure-of-eight bandage of the chest.

Use. This bandage may be employed to bring the shoulders forward, and to hold dressings to the anterior portion of the chest.

Posterior Figure-of-eight Bandage of the Chest. *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller should be placed in the axilla of the left side, and the bandage should then be carried obliquely across the back of the chest to the tip of the opposite shoulder; it is next carried through the axilla and conducted across the posterior portion of the chest to the tip of the opposite shoulder, and passed through the axilla to the point of starting. These turns are repeated, descending from the neck toward the shoulder, until five or six have been applied, the end of the bandage being secured by a pin (Fig. 69). In applying both of these bandages the crosses of the bandage, either anterior or posterior, should be made in the median line of the chest.

FIG. 69.

Posterior figure-of-eight bandage of the chest.

Use. This bandage may be employed to hold dressings to the posterior portion of the chest and to draw the shoulders backward.

FIG. 70.

Suspensory and compressor bandage of the breast.

Suspensory and Compressor Bandage of the Breast. *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller should be placed upon the scapula of the affected side, and secured by two oblique turns carried over the opposite shoulder and conducted downward under the breast to be covered in, and then carried to the axilla of the same side. Next carry the roller transversely around the chest, covering in the lowest portion of the affected breast. These turns should be repeated, the oblique turns from the axilla over the shoulder alternating with the transverse turns around the chest, until the breast is covered in, each series of turns ascending, and covering two-thirds of the preceding turns (Fig. 70).

FIG. 71.

Suspensory and compressor bandage of both breasts.

Use. This bandage is employed to support the breast and to make compression at the same time; it may also be employed to hold dressings to the breast.

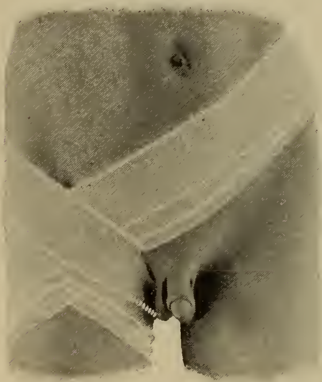
Suspensory and Compressor Bandage of Both Breasts. *Two Rollers Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the bandage should be secured by oblique turns of the axilla and shoulder, passing under one breast, as in the preceding bandage; the roller should next be carried transversely around the back to the other breast, then under the breast and upward over the opposite shoulder, then obliquely downward around the chest to the other side, being carried transversely over the lower portion of both breasts to the point of starting upon the back. Repeat these oblique turns from the shoulder to the breast and from the breast to the shoulder, and alternate them with a transverse turn around the chest and over both breasts. Both series of turns should ascend, and each turn should overlap two-thirds of the preceding one (Fig. 71).

Use. This bandage is employed to support and compress both breasts and to retain dressings to them.

BANDAGES OF THE LOWER EXTREMITY.

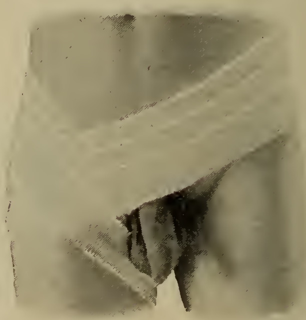
Single Spica-bandage of the Groin (Ascending). *Roller Two and a Half Inches in Width, Seven Yards in Length.* Place the initial extremity of the bandage upon the anterior portion of the right thigh just below the groin, and secure it by one or two circular turns around the thigh, or place the initial extremity of the roller obliquely upon the upper part of the thigh and carry it behind the limb and upward around the outer side of the thigh to the abdomen, omitting the circular turns; then carry the bandage obliquely across the lower part of the abdomen to a point just below the crest of the left ilium and conduct it transversely around the back of the pelvis to a corresponding point on the opposite side; then bring it obliquely downward to the groin and over to the inner portion of the thigh, carrying it around the limb, crossing the starting-turn in the middle line of the thigh. These turns are repeated, each turn ascending and covering in two-thirds of the previous turn, until six or eight complete turns have been made, and the bandage is then secured at any point where it ends (Fig. 72).

FIG. 72.



Ascending spica-bandage of the groin.

FIG. 73.

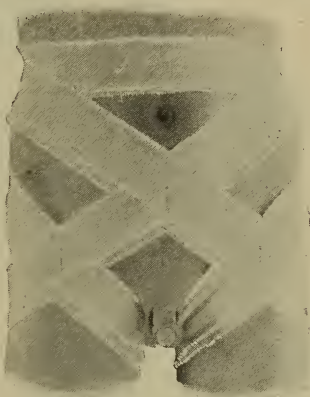


Descending spica-bandage of the groin.

Single Spica bandage of the Groin (Descending). *Roller Two and a Half Inches in Width, Seven Yards in Length.* Place the initial extremity of the roller obliquely upon the anterior surface of the right thigh and secure it by one or two circular turns around the limb, or start the bandage with an oblique turn, as previously described; then carry the bandage obliquely across the abdomen to a point just below the crest of the ilium, and conduct it transversely around the back of the pelvis to a corresponding point on the opposite side; then bring it obliquely down over the lower portion of the abdomen, crossing the first turn, to the junction of the thigh with the scrotum, pass it under the thigh and bring it up over the lower part of the abdomen, and let it follow the course of the first turn. These turns are repeated, each turn descending and overlapping two-thirds of the previous turn until the groin is covered (Fig. 73). When either of these bandages is applied to the left groin, after the initial extremity of the roller is fixed, it is carried first to the crest of the ilium of the same side, then around the back of the pelvis to a corresponding point on the opposite side, then obliquely across the lower part of the abdomen to the outer aspect of the thigh, being conveyed around this and brought up between the thigh and the scrotum, passing obliquely over the groin to follow the course of the original turn.

Double Spica-bandage of the Groins. *Roller Three Inches in Width, Nine Yards in Length.* The initial extremity of the roller is placed upon the abdomen just above the the iliac crests and secured by one or two circular turns; the bandage is then carried from a point just below the crest of the right ilium obliquely across the lower portion of the abdomen to the outer portion of the left thigh, is carried around this and brought up between the scrotum and the thigh, and is passed obliquely over the groin, crossing the previous turn in the median line, and is conducted to a point just below the crest of the ilium on the same side. The bandage is then continued around the pelvis to the same point on the opposite side, and from this point is made to pass obliquely over the groin to the inner side of the right thigh, passing around this and coming up on its outer side, crossing the previous turn at the middle line of the groin, to be carried obliquely across the groin and lower part of the abdomen to the crest of the ilium on the opposite side. These turns are repeated, each turn covering in two-thirds of the pre-

FIG. 74.



Double spica-bandage of the groins.

vious turn, until both groins have been covered (Fig. 74). The turns may be so applied as to ascend or descend, forming the ascending or descending double spica-bandage of the groins. When properly applied, this bandage presents three sets of crossing-turns, one in each groin and one in the median line of the abdomen.

Use. The spica-bandages of the groin, either single or double, are employed to hold dressings to wounds in the inguinal region—for instance, those resulting from herniotomy, or from operations upon the glands of the groin. They are also employed to make pressure upon this region, and will often prove of use in the securing of compresses applied for the temporary retention of herniæ.

Spica-bandage of Buttock. *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the bandage is placed upon the back of the thigh just below the gluteal fold, and is carried around the thigh and brought back to the posterior aspect of the limb so as to fix and cross the starting turn near the middle of the thigh. It is next conducted obliquely across the thigh and buttocks and carried to the brim of the pelvis of the opposite side, when it is brought obliquely over the abdomen and back to the posterior surface of the thigh. These ascending turns are applied, each turn covering in about three-fourths of the preceding one, until the buttock is covered, and the bandage is then finished by one or two circular turns around the pelvis and abdomen (Fig. 75).

FIG. 75.

Spica-bandage of buttock.

Use. This bandage is employed to hold dressings to the upper posterior portion of the thigh, or the buttock.

Figure-of-eight Bandage of the Knee. *Roller Two and a Half Inches in Width, Five Yards in Length.* The initial extremity of the roller is placed upon the right thigh three inches above the patella and secured by two or three circular turns; then conduct the bandage over the outer condyle of the femur across the popliteal space to the inner border of the tibia and around the anterior surface below the tubercle and head of the fibula, and make one circular turn; the roller should then be carried obliquely across the popliteal space to the inner condyle of the femur, crossing the previous turn; then carry it around the front of the

Fig. 76.

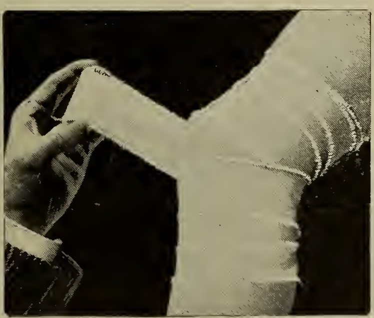


Figure-of-eight bandage of the knee.

thigh to the outer condyle; repeat these turns, ascending toward the knee from the leg and descending from the thigh toward the knee, and finish the bandage by a circular turn over the patella (Fig. 76).

This bandage may also be applied by making two circular turns around the patella and popliteal space, and then carrying the bandage to the thigh three inches above the patella, and then finishing it with descending turns from the thigh and ascending turns from the tibia, making all turns cross in the popliteal space.

Use. This bandage is employed to hold dressings to the knee-joint either anteriorly or posteriorly. These figure-of-eight turns are often employed in covering the knee in applying the spiral reversed bandage of the lower extremity when it is desired that the patient be allowed to bend the knee.

Figure-of-eight Bandage of Both Knees. *Roller Two and a Half Inches in Width, Seven Yards in Length.* Place the knees of the patient together with a compress between them; then place the initial extremity of the roller upon one thigh, about three inches above the patella, and secure it by one or two circular turns around both thighs; then conduct the roller from the outer condyle of the left femur obliquely across the popliteal spaces of both legs to the head of the fibula on the opposite side, making a circular turn around both legs; pass the roller from the head of the fibula on the opposite side across the popliteal space to the external condyle opposite the point of starting.

Fig. 77.

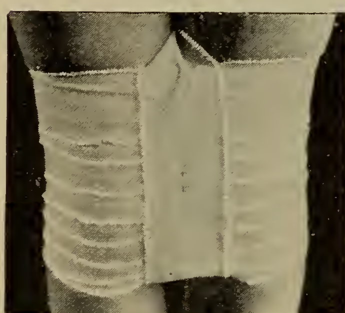


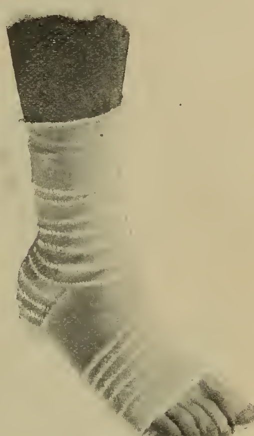
Figure-of-eight bandage of both knees.

Repeat these turns, descending from the thighs and ascending from the legs, until the knees are covered, and finish the bandage by carrying a turn of the bandage at right angles to the previous turns between the thighs and the legs (Fig. 77).

Use. This bandage is employed to secure fixation of the limbs after operations upon the perineum, and may also be employed to obtain temporary fixation of the limbs in transporting cases of fracture of the femur, and after the reduction of dislocations of the head of that bone.

Spica-bandage of the Foot. *Roller Two and a Half Inches in Width, Five Yards in Length.* Fix the initial extremity of the roller upon the ankle and secure it by two circular turns; then carry the bandage obliquely over the dorsum of the foot to the metatarso-phalangeal articulation, and make a circular turn around the foot at this point; then continue it upward over the metatarsus by making two or three spiral reversed turns; next carry the bandage parallel with the inner or outer margin of the sole of the foot, according to whether it is applied to the right or left foot, directly across the posterior surface of the heel; thence along the opposite border of the foot and over the dorsum, crossing the original turn in the median line of the foot. This completes the first spica turn. These spica turns are repeated, gradually ascending by allowing each turn to cover in three-fourths of the preceding turn, until the foot is covered in with the exception of the posterior portion of the sole of the heel (Fig. 78). Care should be taken to see that the turns cross each other in the median line and that they are kept parallel to each other throughout their course.

FIG. 78.



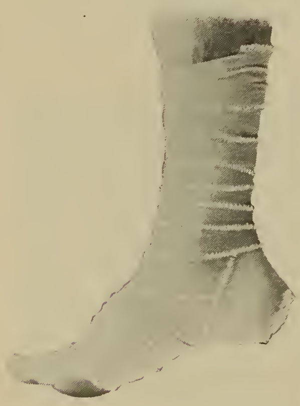
Spica-bandage of the foot.

Use. This bandage will be found very useful when it is desired to make firm compression upon the foot or to retain dressings to it; it is especially useful in the treatment of sprains of the ankle or the anterior tarsus.

Bandage of Foot Covering the Heel (American). *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller is placed upon the leg just above the malleoli and fixed by two circular turns around the leg; the bandage is then carried obliquely across the dorsum of the foot to the metatarso-phalangeal articulation, at which point a circular turn is made; two or three spiral or spiral reversed turns are then made, ascending the foot; the roller is next carried directly over the point of the heel and continued back to the dorsum of the foot; thence beneath the instep around one side of the heel and up over the instep; from this point it is carried beneath the instep around the other side of the heel and up in front of the ankle, from which point it may be continued up the leg (Fig. 79).

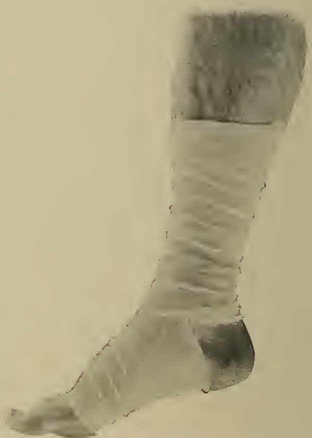
Use. This bandage is employed to cover in the foot, and retain dressings to the foot and heel.

FIG. 79.



Bandage of foot covering the heel.

FIG. 80.



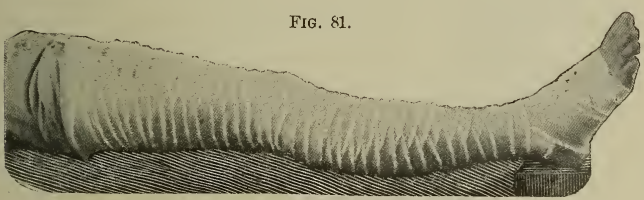
Bandage of foot not covering the heel.

Bandage of Foot Not Covering the Heel (French). *Roller Two and a Half Inches in Width, Seven Yards in Length.* Fix the initial extremity of the roller upon the leg just above the malleoli and secure it by two circular turns around the leg; the bandage is then carried obliquely across the dorsum of the foot to the metatarso-phalangeal articulation, and at this point a circular turn should be made. The roller is now carried up the foot, covering it in with two or three spiral reversed turns, and at this point a figure-of-eight turn is made around the ankle and instep; this should be repeated once, which will cover in the foot with the exception of the heel; the bandage may then be continued up the leg with spiral reversed turns (Fig. 80).

Use. This bandage may be employed to secure dressings to the foot, and is the one generally used to cover this part in applying the spiral reversed bandage of the lower extremity.

Spiral Reversed Bandage of the Lower Extremity. *Roller Two and a Half Inches in Width, Seven Yards in Length.* The initial extremity of the roller is placed upon the leg just above the malleoli and secured by two circular turns. It is then carried obliquely over the foot to the metatarso-phalangeal articulation, where a circular turn is made around the foot. Two or three spiral reversed and two figure-of-eight turns of the ankle and instep should be made, while just above the ankle one or two circular or spiral turns are made around

FIG. 81.



Spiral reversed bandage of the lower extremity.

the leg, and as the bandage is carried up the leg, as it increases in diameter, spiral reversed turns are made until it approaches the knee; at this point, if the limb is to be kept straight, the spiral reversed turns may be continued over this region and up upon the thigh. If the knee is to be bent, figure-of-eight turns may be applied until the knee is covered, and then the thigh may be covered with spiral reversed turns (Fig. 81). To cover in the thigh as well as the leg, two bandages of the dimensions before given will be required. Care should be taken to keep the reverses in a line and not to make them over the spine of the tibia, as they may thus become painful to the patient.

Use. This is one of the most frequently employed of the roller bandages; it is used to apply pressure to the lower extremity, to retain dressings, and to secure splints in the treatment of fractures and dislocations.

Figure-of-eight Bandage of the Leg. *Roller Two and a Half Inches in Width, Seven Yards in Length.* This bandage differs from the spiral reversed bandage of the lower extremity only in the fact that when the swell of the calf is reached figure-of-eight turns are made around the leg instead of spiral reversed turns. In applying the roller, when the calf of the leg is reached, the bandage is carried obliquely around the leg to the crest of the tibia and then made to cross the starting-turn in the median line; these descending and ascending turns are repeated until the calf of the leg has been covered in, and the bandage is finished with one or two circular turns just below the knee (Fig. 82).

Fig. 82.

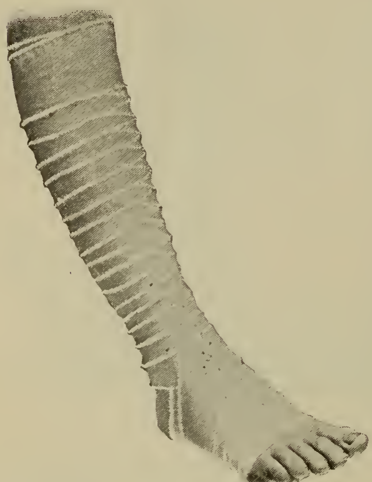


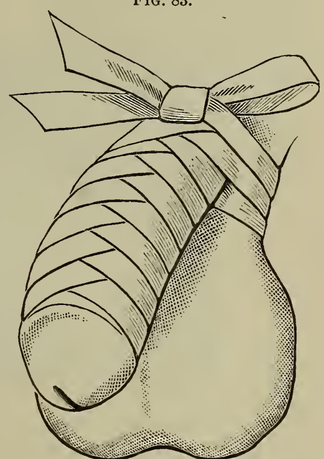
Figure-of-eight bandage of the leg.

Use. This bandage holds its place more firmly than the ordinary spiral reversed bandage of the leg, and may be employed in the treatment of ulcers of the leg in conjunction with strapping, where it is desirable to change the dressings at infrequent intervals and to allow the patient to walk about during the course of treatment.

SPECIAL BANDAGES.

Spiral Reversed Bandage of the Penis. *Roller Three-quarters of an Inch in Width, Thirty Inches in Length.* Fix the initial extremity of the roller by two circular turns around the penis close to the pubis; then carry the bandage obliquely down to the corona glandis; from this point ascend the body of the penis by spiral reversed turns to the pubis, and finish the bandage by two figure-of-eight turns around the neck of the scrotum and root of the penis, or split the end of the bandage so as to form two tails and secure it by tying these around the root of the penis (Fig. 83).

Fig. 83.

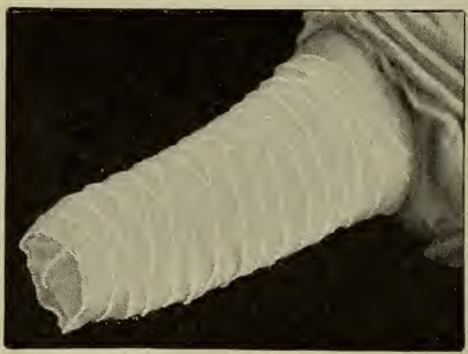


Spiral reversed bandage of the penis.

Recurrent Bandage of Stump. *Roller Two and a Half Inches in Width, Five to Seven Yards in Length.* Place the initial extremity of the roller upon the anterior or posterior surface of the limb a few inches above the extremity of the stump, and carry the bandage to the end of the stump, and then conduct it upward or downward on the limb, as the case may be, to a point directly opposite the point of starting; then bring the bandage back over the face of the stump to the point of starting, and continue these recurrent turns, each turn overlapping two-thirds of the previous one until the face of the stump is covered; then reverse the bandage and secure the recurrent turns at their points of origin by two or three circular turns. The roller should next be carried obliquely down to the end of the stump, and a circular turn should be made around this. The bandage should then be carried up the limb by spiral or spiral reversed turns beyond the point at which the recurrent turns terminated, and secured by one or two circular turns (Fig. 84).

In applying this bandage in very short stumps resulting from amputations at or near the shoulder or hip-joints, after making the recurrent and spiral turns, it will be

Fig. 84.

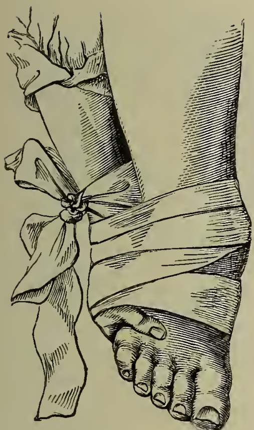


Recurrent bandage of stump.

found necessary to carry the bandage, in the case of the shoulder, across the chest to the opposite axilla and back, and apply several of these turns; so in case of the hip amputations it will be found best to finish the bandage with a few turns about the pelvis.

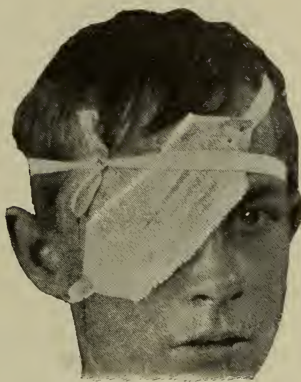
Bandage for Securing the Hands and Feet in the Lithotomy Position. The hand of the patient should be brought down and made to grasp the outer side of the foot; the initial extremity of the roller is fixed by two circular turns around the wrist and ankle, and the bandage is then passed around the foot and hand, and these turns are alternated with turns around the wrist and ankle, until the hand and foot are firmly secured. The same procedure is adopted with the hand and foot of the opposite side (Fig. 85).

FIG. 85.



Bandage for securing the hands and feet for lithotomy.

FIG. 86.



Liebreich's eye-bandage.

Liebreich's Eye-bandage. This bandage consists of a strip of flannel two and a half inches in width and from six to ten inches in length, to the extremities of which tapes are sewed. It may be applied transversely so as to cover both eyes, or obliquely so as to cover one eye only, and it is secured by the tapes carried around the head and tied over the forehead (Fig. 86).

Use. This bandage is used to hold compresses or dressings to the eye or eyes, and the elasticity of the flannel permits of its being applied so as to make a variable amount of pressure.

Borsch's Eye-Bandage. This bandage is employed for holding a dressing to one eye, and consists in a strip of flannel, two or two and a half inches in width, which is passed around the head from the occiput and covers both eyes (Fig. 87). A narrow strip of flannel is attached to the posterior portion, which is carried over the head and passed under the horizontal strip in front of the eye which is to be left uncovered, and is then folded back so as to raise the horizontal strip from the eye, and secured (Fig. 88).

FIG. 87.

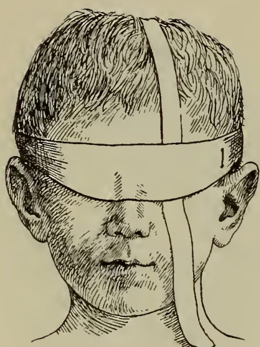
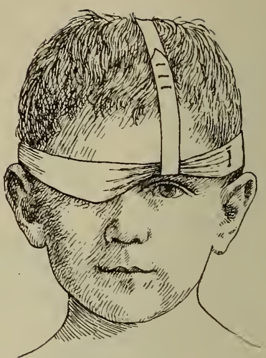


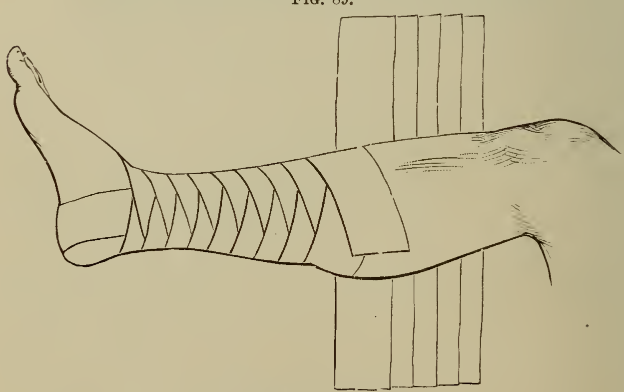
FIG. 88.



Application of Borsch's eye-bandage.

Bandage of Scultetus. This is a compound bandage, consisting of a number of pieces of muslin, and may be prepared from a two and a half or three inch roller by cutting off strips long enough to encircle the part about

FIG. 89.



Bandage of Scultetus.

one and one-third times. The strips are placed under the part in such a manner that the first piece shall be overlapped by the second, the second by the third, and so on from below upward; the pieces are then brought around the limb, and the extremities of the last piece are secured by pins (Fig. 89). This bandage was formerly much employed in the treatment of compound fractures to secure dressings to the wound, and possessed the advantage that when a single strip became soiled it could be removed without disturbing the whole dressing, the new strip to be introduced being pinned to the extremity of the soiled piece to be removed, and then being drawn through by its removal. This bandage will often be found convenient in applying dressing to cases of excision of the joints, where as little disturbance of the parts as possible is important in dressing the wound. When the strips are attached to each other by a thread passed through the centre of each strip, the bandage is known as *Pott's bandage.* This bandage is applied and secured in the same manner, but it possesses no advantages over the bandage of Scultetus.

Gauze Bandages. Bandages may be prepared from gauze, the same material that is used for gauze dressings, and are now very extensively used in surgical practice. The gauze bandages are prepared by cutting or tearing the material into strips varying in width from two inches to three inches, and in length from five yards to eight yards; these strips are then wound so as to form roller-bandages. Gauze bandages are sometimes employed in the dressing of fractures, but do not furnish as substantial a dressing as the ordinary muslin bandages. They, however, constitute a soft and comfortable material for holding dressings to wounds. They are applied in the same manner as the ordinary muslin roller, with the exception that in their application reverses are seldom required, as the open mesh of the bandage gives it considerable elasticity, so that the bandage can be made to adapt itself to the part without making reverses. Any of the ordinary bandages which have been previously described may be applied by means of the gauze bandages, such as those of the head, extremities, and trunk.

In applying dressings to wounds of the head and neck it is often used to cover in both the head and neck, and also to make a few turns over the upper part of the chest and around each shoulder, which prevents the turns of the bandage from slipping, and holds the dressing in place, so that it cannot be disarranged by movements of the patient (Fig. 90).

FIG. 90.

Gauze bandage of head and neck.

Flannel Bandage. These bandages are prepared from flannel which is cut into strips from two to four inches in width and from five to seven yards in length. These strips are formed into rollers either by hand or by means of the bandage-winder. Flannel bandages, by reason of the elasticity which they possess, can be applied without reverses and are used to make a moderate amount of elastic pressure. They are often employed in applying dressings to the head, especially after operations upon the eyes, and are generally applied as a primary roller before the application of the plaster-of-Paris dressings, and may also be used in subacute joint-affections, both to protect the parts and make a moderate amount of elastic pressure.

The Rubber Bandage. This bandage is made from a strip of rubber-sheeting, from one inch to four inches in width and from three to five yards in length, which, for convenience of application, is rolled into a cylinder.

Its use was introduced to the profession by Dr. Martin, of Boston, and it will be found a useful form of dressing where it is considered desirable to apply elastic pressure to a part (Fig. 91).

It may be employed in the treatment of varicose veins of the legs, in chronic ulcers of those parts where pressure is an important element in the treatment, and may be used as a substitute for strapping to secure this object. Its application has also been recommended in the treatment of swelled testicle in that stage of the affection in which pressure is indicated.

FIG. 91.

Martin's rubber bandage.

For application to the leg a rubber bandage two and a half inches in width and three yards in length is required.

The initial extremity of the roller is fixed upon the foot near the toes and secured by a circular turn; the foot is then covered in by spiral turns overlapping each other about two-thirds, and a figure-of-eight turn is made from the ankle to the instep. The bandage is then carried up the limb to the knee with spiral turns, where it is secured by two tapes sewed to the terminal extremity of the bandage, which are passed around the leg and tied. The bandage need not be reversed, as its elasticity allows it to conform to the shape of the limb. Care should be taken not to apply the turns with too much firmness; the bandage should be stretched very slightly; if this precaution is not taken, it soon becomes uncomfortable to the patient. A patient using one of these bandages will soon learn to apply it himself, making just the requisite amount of tension to secure its holding its place, and to insure a comfortable amount of pressure upon the part. A well-fitting stocking may be placed upon the limb before the bandage is applied, or it may be applied directly to the skin.

The bandage should be removed at night when the patient goes to bed and hung up to dry, as its inner surface becomes moist from the secretions from the skin; it should be reapplied as soon as the patient rises in the morning.

In using it in the treatment of ulcers of the leg no ointment should be applied to the ulcer, as oily dressings soon destroy the rubber; applications may be made to the ulcer by means of dry powders, such as oxide of zinc, iodoform, or aristol, before the bandage is applied.

In the treatment of swelled testicle the bandage is applied to the testicle by means of recurrent turns not too firmly made, and secured in place by spiral turns, until the whole surface of the organ is covered in; the end of the bandage is secured with tapes tied around the root of the scrotum. The same precaution to apply the bandage so as to make only moderate pressure should also be observed here.

Elastic-webbing Bandage. This bandage, which is woven from threads of rubber covered with cotton or silk, has recently been introduced, and possesses all the advantages of the rubber bandage as regards elasticity, and has the additional advantage that the air can circulate through the meshes of the bandage and moisture can evaporate from the surface covered by the bandage, so that the skin covered by it does not become bathed in perspiration, as is the case with the rubber bandage. It is applied in the same manner and for the same purposes as the rubber bandage. In the treatment of varicose veins we have found it a most satisfactory dressing, as the patient soon learns to apply it himself, so as to make the requisite amount of pressure

FIXED DRESSINGS, OR HARDENING BANDAGES.

For the application of these dressings a variety of substances are used which are incorported in the meshes of some fabric, such as crinoline or cheese-cloth, or painted over its surface to give fixity or solidity to the bandage.

The materials most commonly used in the preparation of fixed dressings are plaster-of-Paris, starch, silicate of sodium or potassium, and paraffin.

Plaster-of Paris Dressings.

The plaster-of-Paris used for the application of surgical dressings should be of the same quality as that which the dental surgeons employ in taking casts for teeth—that is, the *extra calcined* variety. If moist or of inferior quality, it will not set rapidly or firmly, and will fail to give sufficient fixation to the dressing.

Methods of Applying the Plaster-of-Paris Dressings. The plaster-of-Paris dressing may be applied in several ways, either by covering the part to be enclosed with some loose fabric, and rubbing the moist plaster into it, alternating the layers of the fabric with layers of moist plaster, or it may be applied by means of a roller which has been prepared by incorporating plaster-of-Paris in its meshes.

It may also be applied in the form of the Bavarian dressing (page 99), or in the form of moulded plaster-of-Paris splints (page 100).

To apply a plaster-of-Paris dressing according to the first method, the part to be enclosed—the leg, for instance—should first be covered by a neatly applied flannel bandage, or a muslin bandage which has been shrunken by being washed; new muslin is not satisfactory as a primary application to a limb in applying a plaster-of-Paris dressing, as the moisture from the plaster wets it and causes it to shrink, so that it may exert injurious pressure after the bandage becomes dry.

The limb having been covered by the bandage, and any bony prominences, such as the malleoli, having been padded with small wads of cotton to prevent undue pressure upon them, the part is next covered by a layer of turns of a crinoline bandage or by strips of cheese-cloth or any other loose material. A small quantity of plaster-of-Paris is next mixed with water until it has the consistence of thick cream, when it is smeared evenly over the whole surface of the previously-applied bandage. Another layer of the bandage or of strips is next applied, and the plaster is smeared over this in the same manner, and so alternate layers of plaster-of-Paris and bandage are applied until a casing of the desired thickness is obtained. If the plaster-of-Paris of the quality previously described be used, it will set or become hard in a few minutes.

The most convenient method of applying the plaster-of-Paris dressing is that introduced by Prof. Sayre, which consists in the use of bandages which have been previously prepared with plaster-of-Paris; these are moistened and applied while moist to the part to be encased.

Preparation of the Plaster-of-Paris Bandage. These bandages are prepared by taking cheese-cloth, mosquito-netting, or crinoline, which latter is by far the best fabric, and cutting or tearing it into strips two and a half to three inches in width and five yards in length. These are laid on a table, and plaster-of-Paris of the quality before mentioned is dusted over them and rubbed into the meshes of the fabric; the material when impregnated with plaster is loosely rolled into a cylinder, and these bandages when prepared should be placed in air-tight jars or tin cans until required.

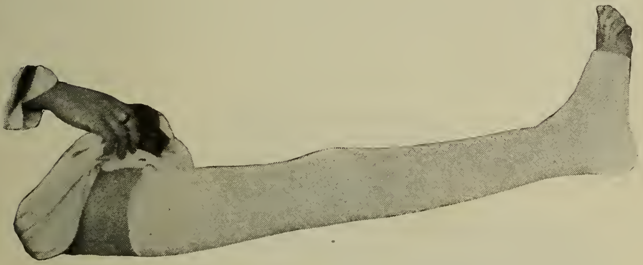
Bandages thus prepared, which have been exposed to the air or have been kept for a long time, are not apt to set well when applied; but if such bandages are placed in a hot oven and baked for half an hour before being used, they will be found to set as satisfactorily as those freshly prepared.

These bandages may be prepared by a machine made for this purpose, but I do not think that they are apt to have the plaster as evenly distributed through them, and, therefore, are not as satisfactory as those prepared by hand.

Application of the Plaster-of-Paris Bandage. Before applying this dressing, the part to be encased—the leg, for instance—should be covered by a flannel roller, the bony prominences being protected by pads of cotton, or a closely fitting stocking may be applied to the part.

The bandage should be dipped in warm water and kept covered for a few minutes; it may be squeezed with the hand, and as soon as bubbles of air cease to escape it is a sign that it is thoroughly soaked and is ready for application.

FIG. 92.



Leg encased in plaster-of-Paris dressing.

On removing it from the water the excess of water should be squeezed out by the hand, and the bandage should then be evenly applied to the limb with just enough firmness to make it fit the part nicely, and as few reverses as possible should be made. A sufficient number of bandages are applied to make a dressing as firm as may be required; three rollers of the above dimensions are usually quite ample for a dressing for the leg, and when the last roller has been applied some dry plaster should be moistened with water until it has the consistency of thick cream, and rubbed evenly over the surface of the bandage to give it a finish (Fig. 92). If a good quality of plaster has been used the bandage should be quite firm in from ten to fifteen minutes, but the patient should not for a few hours be allowed to put any weight upon the bandage.

An equally firm bandage may be applied with the use of a less number of bandages, if the surgeon rubs over the surface of each layer of bandage applied a little moist plaster, then applying another layer and repeating the same procedure; finishing the dressing by an external coating of moist plaster, as above described.

In applying these dressings a fewer number of bandages will be required if narrow strips of tin, zinc, or binder's board are incorporated in the layers of the bandage, which also increase the strength of the dressing.

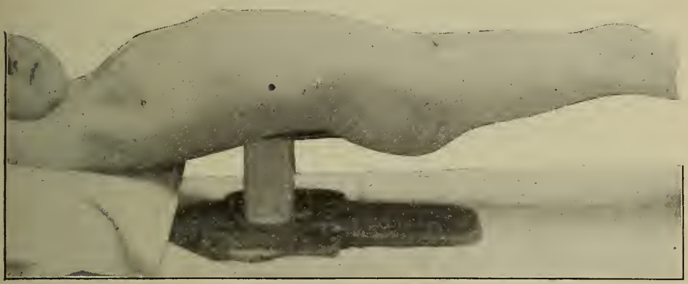
Application of the Plaster-of-Paris Bandage to the Thigh and Pelvis. Where it is desirable to apply a plaster-of-Paris bandage to the thigh, and at the same time

FIG. 93.

Pelvic supporter.

fix the hip-joint by including the pelvis in the bandage, the use of a pelvic supporter (Fig. 93) is most satisfactory. The patient is placed upon the supporter so that the lumbar spine rests upon the body of the supporter, while the pelvis rests upon the metal shelf which extends from it, as seen in Fig. 94. The limb is extended and held in the required position, and the plaster bandage is applied to the thigh and is also carried around the pelvis, and passed over the metal shelf upon which the pelvis rests. When the bandage has become firm, the supporter is removed by slipping it upward.

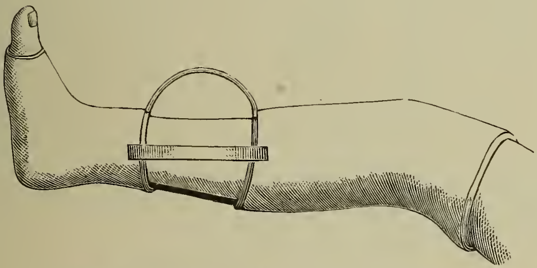
FIG. 94.



Position of patient upon pelvic supporter.

Interrupted Plaster-of-Paris Dressing. This form of plaster-of-Paris dressing is applied by first placing a short iron rod under the extremity, opposite to and extending some distance above and below the point at which the

FIG. 95.



Interrupted plaster-of-Paris dressing. (STIMSON.)

dressing is to be interrupted ; this is fixed by a few turns of the plaster bandage above and below the portion of the limb which is to be left exposed; stout wire is next bent into loops, the extremities of which are incorporated in the subsequent turns of the plaster bandage ; three loops thus placed in addition to the posterior iron bar will usually make the dressing sufficiently firm (Fig. 95). A number of turns of the bandage are applied to firmly fix the loops, and the limb is held in the desired position until the plaster has set.

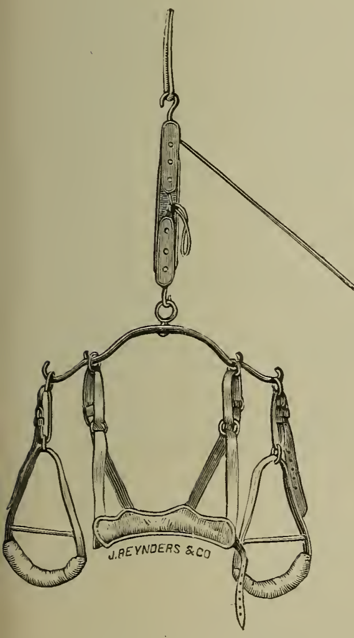
Application of the Plaster-of-Paris Jacket. The patient's body should be covered with a soft, closely fitting woven shirt without arms, but with shoulder-straps to hold it in position, or an ordinary woven undershirt may be employed; one or two folded towels, or a pad of cotton wrapped in a towel, are next placed over the abdomen between the shirt and the skin—this is called, by Prof. Sayre, the *dinner pad*, and is intended to leave space for the distention of the abdomen after eating. Small pads of raw cotton may also be placed over the anterior iliac spines, and, in the case of females, a pad of cotton wrapped in a handkerchief may be placed over each mammary gland.

The patient should next be suspended by the apparatus consisting of a collar and arm-pieces attached to a cross-bar (Fig. 96), which is attached by a cord and pulley to a tripod. If this apparatus is not at hand, a very satisfactory substitute may be made by folding two towels into cravats and tying together the ends, so as to make two loops, one of which is placed in each axilla; a bar of wood two and a half feet in length is next taken and the loops are secured to the ends of this by stout cords or handkerchiefs; a Barton's bandage is next applied to the head, and a strip of bandage is passed under the turns which cross the vertex and is secured to the middle of the cross-bar. The bar is next suspended by a cord passed through a pulley or ring, which may be attached to the sill of a door if the ordinary tripod cannot be obtained.

The patient should be slowly raised by the apparatus until the toes only are in contact with the floor, and the extension should not be carried to the point which makes it uncomfortable to the patient (Fig. 97). The shirt should be drawn downward over the hips by an assistant and held in place until a few turns of the bandage have been applied.

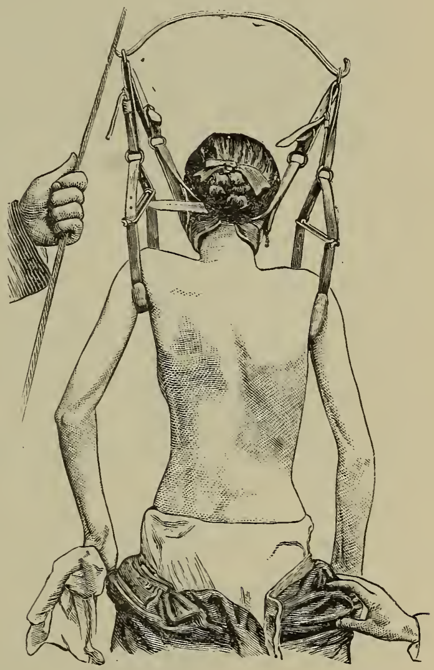
The plaster bandage having been soaked and squeezed, a turn should be made around the body above the pelvis, and it should then be carried downward below the iliac spines, and from this point made to ascend gradually by spiral turns until it reaches the axillary line. The turns should be applied smoothly and not too tightly. After two or three layers of turns have been applied, the

FIG. 96.



Suspensory apparatus.

FIG. 97.



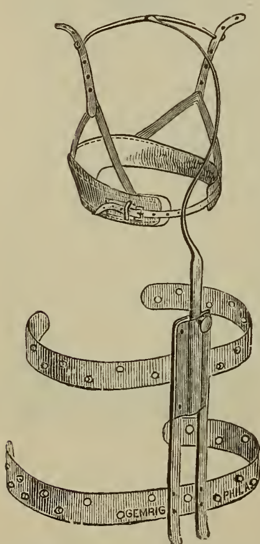
Patient suspended for application of plaster jacket.

surgeon may rub some moist plaster upon their surface if he desires to use fewer bandages. These turns are repeated until a bandage of the desired thickness is applied, and the surface of the dressing may be finished by rubbing it over with moistened plaster. This jacket for a child will generally require the use of three or four bandages of the dimensions given; for an adult, from six to eight bandages.

The patient should be kept suspended until the bandage has set, usually from ten to fifteen minutes, and then should be carefully lifted so as not to bend the spine, and placed on his back upon a mattress, until the dressing becomes perfectly hardened. The dinner pad and mammary pads, if they have been used, should next be removed. In applying this dressing, strips of zinc or tin may be placed between the layers of bandage if it is desired to give more strength to the jacket.

Application of the Jury-mast by Means of Plaster-of-Paris. In disease of the spine involving the cervical or upper dorsal region the ordinary plaster-of-Paris jacket is not satisfactory, and in such cases the "jury-mast" is employed in connection with the plaster jacket. In applying the "jury-mast" the same steps are taken in the preparation of the patient as in applying the plaster-of-Paris jacket, with the exception of extension, which need not be used.

Fig. 98.



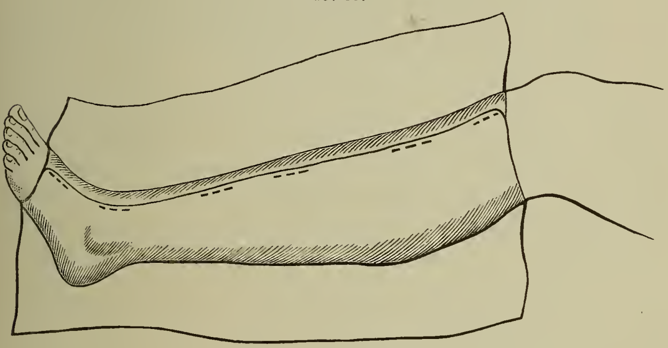
Head-support and jury-mast.

After three or four layers of the plaster bandage have been applied to the body, an apparatus made of two bars of metal having two perforated strips of zinc attached to them a few inches apart, which partly encircle the body, is applied and held in position by turns of the plaster bandage. The perpendicular bars have at their upper part a slot, into which the lower end of the "jury-mast" fits, and is secured by a screw; to the upper part of this is attached a movable cross-bar, to which are fastened the straps of the collar from which the head is suspended (Fig. 98).

The Bavarian Dressing. To apply this dressing, which is sometimes employed in the treatment of fractures of the extremities, take two pieces of Canton flannel the length of the part to be enclosed, and more than wide enough to envelope its circumference. In applying it to the leg these pieces should be cut so as to correspond to the outline of the leg and posterior portion of the foot.

These pieces should be placed one over the other and sewed together in the middle line, the seam corresponding to the back of the leg. The leg and foot are then placed upon this, and the inner layer of flannel is brought up in front of the leg and over the dorsum of the foot and made fast with pins or a few stitches (Fig. 99). Plaster-of-Paris

FIG. 99.



Bavarian dressing.

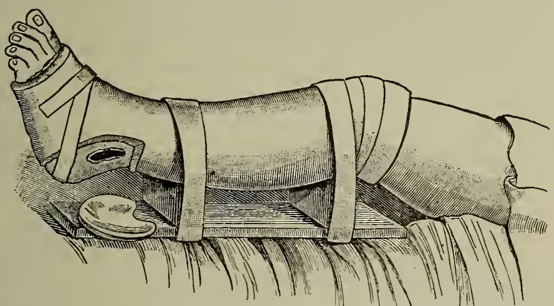
is next mixed with water to form a paste, which is rubbed thickly and evenly over the flannel next to the limb until a sufficient thickness is obtained; the outer layer of flannel is then brought up about the leg and moulded to its surface by the hands. A loosely applied roller may now be used to hold the dressing in place until the plaster has set.

When it is necessary to inspect the parts, the turns of the bandage are cut, and upon separating the layers of flannel the two halves can be turned aside, the seam at the back acting as a hinge. Upon reapplying the splints to the leg they may be retained in position by a roller or by one or two strips of bandage.

Moulded Plaster Splints. It is sometimes found difficult to apply the ordinary plaster dressings to parts irregular in their shape, and at the same time to have a splint which can be removed with ease. To accomplish this purpose moulded splints of plaster may be made by cutting a paper pattern of the part to be covered in, and then cutting pieces of crinoline to conform to this pattern; eight or ten pieces will usually form a splint of sufficient thickness. One of these pieces of crinoline is laid upon a table and dry plaster is rubbed into its meshes; another is laid upon this and plaster is applied to it in the same way, and so on until all the pieces have been placed in position, one over the other, with plaster rubbed well into the meshes. The dressing is then folded up and dipped into water, squeezed out, and moulded to the part and held in position, until it sets, by the turns of a bandage. The edges should overlap slightly, and in applying it a strip of waxed paper may be placed under the overlapping edge to prevent its adhesion to the dressing below, and thus facilitate its removal. Splints prepared in this way can be removed with ease, and are often of service in cases where it is desirable to inspect the parts frequently; I have employed with advantage such splints in making fixation of the hip-joint in cases of coxalgia, and also for the same purpose in affections of other joints. The splints upon being reapplied are secured by a few strips of bandage, or by a roller bandage.

Trapping Plaster-of-Paris Bandages. In applying the plaster-of-Paris dressing to a part where there is a wound which is covered by the plaster bandage, it is well to make some provision whereby the plaster dressing over the site of the wound may be cut away, making a trap or window through which the wound may be inspected or dressed, if necessary (Fig. 100). To accomplish this, before applying the plaster bandage, a compress of lint or gauze or a small pasteboard box should be placed over the wound, which, when the dressing is completed, forms a projection on its surface, indicating the position of the wound, and also allows the surgeon to cut away the dressing without injuring the skin below. These traps may be cut out after the bandage has partially set, or after it has become hard. In applying the plaster-of-Paris dressing

Fig. 100.



Plaster-of-Paris bandage trapped. (Esmarch.)

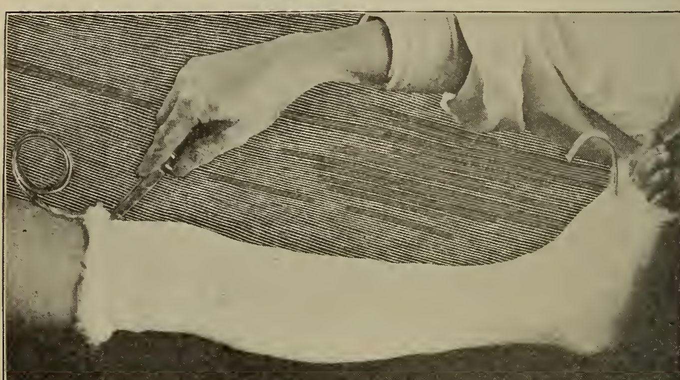
in cases of compound fracture and after osteotomy, I always make provision for trapping of the bandage if it should become necessary, although in the vast majority of cases if the wound remain aseptic it does not have to be done.

Removing Plaster-of-Paris from the Hands. One objection to the use of plaster-of-Paris dressings is the difficulty of removing it from the hands of the surgeon, and the harsh condition in which the skin is left after its removal. If, however, the hands are washed in a solution of carbonate of sodium—a tablespoonful to a basin of water—the plaster will be readily removed and the skin will be left in a soft and comfortable condition. Rubbing the hands with moist brown sugar or cornmeal accomplishes the same object.

Removal of the Plaster-of-Paris Bandage. The removal of the plaster-bandage is sometimes a matter of difficulty, particularly if it has to be removed before the parts below it are consolidated, as it may disarrange them and cause the patient pain if it is not accomplished without much force.

When the bandage is applied to get a cast of a part, or in the treatment of fractures where it may be necessary to remove the bandage in a few days to inspect the parts, a strip of sheet-lead one-half of an inch in width is first placed over the flannel bandage and is allowed to project at each end beyond the dressing; the plaster can then be readily cut through upon the strip with a knife without injury to the parts below (Fig. 101). As soon as the bandage has become firm the lead strip is removed by traction upon one end of it, and if the bandage has been entirely divided it can be removed at any time without difficulty.

FIG. 101.



Cutting plaster bandage upon lead strip.

In applying plaster dressings to the extremities, even if their removal is not likely to be immediately required, I usually employ the lead strip, cutting the bandage upon it, but leaving three or four bridges of undivided bandage, which can be easily divided when the removal of the bandage is finally required.

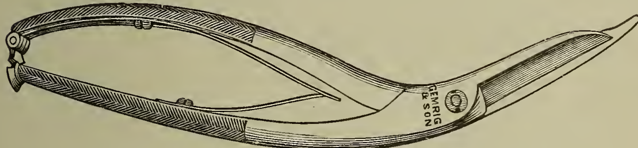
They may also be removed by means of a saw devised for this purpose (Fig. 102), or by strong cutting-shears of various kinds (Fig. 103); or a line may be painted over the

Fig. 102.

Hunter's saw for removing plaster-bandages.

dressing with hydrochloric acid or vinegar, which softens the plaster so that it can readily be cut through with a knife. The incision of the bandage upon the lead strip or

Fig. 103.



Shears for cutting plaster bandages.

the use of the saw or shears is, I think, most satisfactory in removing these dressings. They should be used carefully, as the final layers of the bandage are divided, to avoid wounding the skin.

Uses of Plaster-of-Paris Dressings. These dressings are employed to secure fixation as primary or secondary dressings in the treatment of fractures, and in the ambulant treatment of fractures, and for a like purpose in injuries and diseases of the joints. They are also largely used in the treatment of diseases and deformities of the spinal column, and will be found most satisfactory applications after osteotomy and tenotomy, to secure immobility and hold parts in their corrected positions; when employed in the dressing of cases after tenotomy, they are generally used for a few weeks until the proper mechanical apparatus is applied.

The Starched Bandage. To apply this bandage starch is first mixed with cold water until a thin, creamy mixture results, and this is heated until a clear mucilaginous liquid is produced. The part to be dressed is first covered with a flannel-roller, and over this a few layers of a cheese-cloth or crinoline bandage, which has been shrunken, are applied; the starch is then smeared or rubbed with the hand evenly into the meshes of the material, and the part is again covered with a layer of turns of the bandage, and the starch is again applied; this manipulation is continued until a dressing of the desired thickness is produced. Strips of pasteboard may be applied between the layers of the bandage to give additional strength to the dressing, if desired.

It requires from twenty-four to thirty-six hours for the starched bandage to become dry and thoroughly set. It may be removed in the same way in which the plaster-of-Paris dressing is removed.

Use. Before the introduction of the plaster-of-Paris dressing it was frequently employed in the treatment of fractures, and in injuries and diseases of the joints. It may be used in such cases, but possesses no advantage over the former dressing, and has the disadvantage of setting much less promptly.

Silicate of Potassium or Sodium Bandage. In applying this bandage, after a flannel-roller and several layers of a cheese-cloth or crinoline bandage have been applied to the part, the surface of the latter is coated with silicate of sodium or potassium applied by means of a brush, then a second layer of bandage is applied and treated in the same manner, and this manipulation is continued until a bandage of the desired thickness is produced. This dressing may also be applied by soaking loosely wound rollers of crinoline in silicate of potassium or sodium and applying them to the part as the plaster-of-Paris bandage is applied. It requires twenty-four hours for this dressing to become firm. As it is irksome for a patient to keep a part quiet while the silicate bandage is becoming firm, I often cover it as soon as applied with a layer of tissue-paper, and apply over it a light plaster-of-Paris bandage, which sets in a few minutes; this is removed at the end of twenty-four hours, when the silicate bandage is usually firm. In removing the silicate bandage it may be first softened by soaking it in warm water, and then it can be readily cut with scissors, or it may be cut with bandage shears.

In applying either the starched bandage or the silicate of potassium bandage care should be taken to use cheese-cloth or crinoline which has been shrunken by being moistened and allowed to dry before being employed; otherwise dangerous compression of the part may occur if the bandage has been firmly applied and shrinks after its application.

The Paraffin Bandage. Paraffin, which melts at from 105° to 120° F., is used in the application of this bandage. The limb being covered by a flannel roller, a vessel containing paraffin is placed in a basin of boiling water. As the roller, which may be either of flannel, cheese-cloth, or crinoline, is unwound it is passed through the melted paraffin and applied to the part, and the turns are repeated until a dressing of sufficient thickness results, when the surface may be brushed over with melted paraffin. This dressing sets very rapidly, being quite firm in from five to ten minutes.

Moulded Splints.

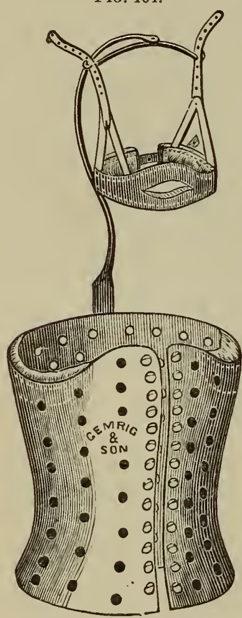
Raw-hide or Leather Splints. In moulding raw-hide or leather splints it is necessary, first, to apply a plaster-of-Paris bandage to the part to which the raw-hide splint is to be fitted; and as soon as the plaster has set it is removed, and a solid plaster cast is next made by pouring liquid plaster-of-Paris into this mould. When this has become dry a piece of raw-hide, which has been soaked for a time in warm water, is moulded to the cast and held firmly in contact with it by tacks or a bandage until it has become perfectly dry. It is then removed, and its surface is covered with several coats of shellac, to prevent its absorbing moisture from the skin when applied, and changing its shape. Eyelets or hooks are fastened to the edges of the splint, through which tapes are passed to secure the splint in place.

Made in this manner raw-hide splints fit the part very accurately, and constitute a very satisfactory dressing for cases of joint-disease, and in the form of leather jackets are often employed in the treatment of disease of the spine in place of the plaster-of-Paris jacket (Fig. 104).

In the treatment of high dorsal or cervical caries a leather splint in two sections, which rests upon the shoulders and supports the head, is often used with good results (Fig. 105).

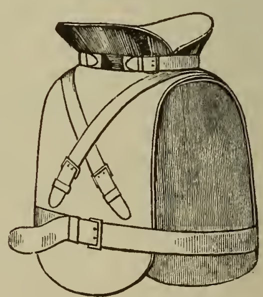
Binder's Board or Pasteboard Splints. This material, which can be obtained in sheets of different thickness, is frequently employed for the manufacture of splints. In moulding these splints a portion of the board of the requisite size and thickness is dipped in boiling water for a short time, and when it has become softened it is removed and allowed to cool; a thick layer of cotton batting is next applied over it, and it is then moulded to the part and held firmly in

FIG. 104.



Leather jacket with jury-mast.

FIG. 105.



Leather splint for cervical caries. (OWEN.)

place by the turns of a roller bandage; in a few hours it becomes dry and hard.

This material from its cheapness and the ease with which it is obtained, is frequently employed to mould splints for the treatment of fractures, especially in children, and for the fixation of joints in the treatment of acute and chronic joint affections. A moulded pasteboard splint may also be employed to fix the ends of the bones after the excision of a joint.

Porous Felt Splints. This material is also employed for the manufacture of splints, and is applied by dipping the material in hot water and then moulding it to the part and securing it by a bandage; as it dries it becomes hard.

Hatters'-felt Splints. Hatters'-felt may also be employed for the manufacture of splints or dressings. It is softened by dipping it in boiling water or heating it in the flame of an alcohol lamp, and when soft and pliable it is moulded to the part, and as it cools it again becomes hard. These splints are employed for the same purpose as those made of plaster-of-Paris, leather, or pasteboard.

PART II.

MINOR SURGERY.

SURGICAL BACTERIOLOGY.

Bacteria (*Schizomycetes*). These are minute cellular organisms of microscopic size, classified as belonging to the vegetable kingdom, among the fungi. They play an active part in the causation of the processes of fermentation and putrefaction, and are the causal agents of many varieties of diseases. The word *germ* is often used as synonymous with *bacterium* in speaking of the organisms that cause disease, but we must remember that certain pathogenic germs, as the *hœmatozoön malariœ*, the *amœba coli*, and the *coccidœa*, are members of the animal kingdom and are not bacteria.

Bacteria may be divided into the *lower* and the *higher* bacteria. The lower forms are always unicellular, although in the process of growth cells may remain attached to each other; while the higher forms are filamentous, often branched, are made up of numbers of simple cells joined together, and the cells sometimes show a tendency to specialization. To this class belongs the organism which causes actinomycosis, the *Actinomyces bovis seu hominis*, and also the *streptothrix madurœ*, the organism of *Madura foot* or *mycetoma*. The lower bacteria, with which we are mainly concerned, are unicellular, exceedingly minute, the round forms measuring not more than 1 micromillimetre ($\frac{1}{25000}$ inch) in diameter, and, therefore, only capable of investigation under the highest powers of the microscope. When unstained they appear to be homogeneous, but by staining can be seen to possess a cell-wall or limiting membrane, not always well defined, called the *ectoderm,* enclosing the protoplasmic contents or *endoderm,* which contains no nucleus. The cell-wall is probably of a gelatinous nature, and when it is well defined the bacteria are said to be *capsulated.* In the protoplasm of the cell body certain bodies, *metachromic granules,* are sometimes seen by staining, as well as other round or oval unstained spaces, which, when situated at the ends of a bacillus, are known as *polar granules.* Both of these are probably either the results of degenerative changes, or are artificially produced in drying.

Certain bacteria produce coloring matters—red, yellow, and blue—many of which are allied to the lipochromes, a class of coloring matters found in certain animal and vegetable organisms.

Unicellular bacteria are classified according to their shape into *cocci,* or round cells, *bacilli,* or rod-shaped cells, and *spirilla,* which are cylindrical cells of curved or spiral outline. Motility in those bacteria which possess it is due to the presence of *cilia* or *flagella.* The ordinary mode of growth of bacteria is by division or splitting. Under circumstances unfavorable to growth they may also produce *spores,* but not as a means of multiplication, as one bacterium usually produces but one spore.

Spores. These may be of endogenous or arthrogenous origin. *Endogenous* spores arise especially in the bacilli. They appear in the protoplasm of the cell as granules, which develop into round, oval, or short rod-shaped bodies; the remaining portion of the bacterium either persisting for a time or disappearing very soon. *Arthrogenous* spores appear to be cocci which have swollen, become more refractive, and are more resistant to unfavorable surroundings than the original coccus. Spores are highly refractive, and consist of a protoplasmic body with a dense surrounding membrane. They are very resistant to unfavorable surroundings, and are much more difficult to destroy by heat, chemical reagents, or drying than are adult bacteria. When placed under circumstances favorable to their growth, the capsule splits, a little bud appears and develops into an adult bacterium.

The ordinary method of multiplication of bacteria is by division or fission, one individual dividing into two, and these again into two more, the process sometimes taking place with great rapidity. The new cells may remain attached or separate, according to the nature of their limiting membrane. In the case of cocci, when forming pairs, they are called *diplococci.* They may also be tetragenous, or form chains, as in the *streptococci* and *streptobacilli*, or bunches, as in the case of the *staphylococci.* A *zoöglea mass* is formed by the cohesion of a large number of bacteria, where, owing to the gelatinous nature of their envelopes, they adhere to each other and appear to be embedded in jelly.

Bacteria are found widely distributed in the air, the water, the earth, and wherever there is organic substance from which they can obtain their nutrition. They live by breaking up into simpler forms the complex organic compounds on which they are dependent for their carbon and nitrogen, being unable to extract the same from inorganic material. They also require moisture, being destroyed in time by drying. Those which require oxygen are called *aërobic*, while those which only grow when it is excluded are called *anaërobic. Facultative aërobic* and *facultative anaërobic* are terms used to designate those bacteria which can grow in its presence or absence; the first, however, growing best with and the latter best without it. Another division of bacteria is into *saphrophytic*, or those living on dead organic matter, and *parasitic*, or those depending on living organisms, the latter embracing the pathogenic bacteria. The boundary line between these two classes is not well defined, however. A certain amount of heat is necessary to bacterial existence, the pathogenic germs growing best at the body temperature; they are destroyed by high temperatures, most of the pathogenic bacteria being killed between 122° and 140° F. (50° and 60° C.). The spores are, as a rule, much more resistant to heat. Low temperatures tend to inhibit the growth of bacteria rather than to destroy their life. Direct sunlight also has an injurious action upon them.

Cultivation. Bacteria are studied outside of the body by growing them on culture-media, which may be liquid or solid, proteid or carbohydrate-containing material. The media are sterilized and kept in tubes or dishes (Petri's dishes). A little of the culture or material to be studied is transferred to the culture medium by a sterilized platinum wire called an *öse*, and spread on the surface of the solid medium (*stroke-culture*), or plunged into it (*stab-culture*), or mixed with the fluid medium. The tubes or plates are then placed in an oven heated to the required temperature. The germs form colonies of characteristic size, shape, and coloring, and the different species may thus be isolated and studied. The liquid media include bouillon, peptone solution, and extracts of vegetable substances, as potato. Solid media include mixtures of beef extracts with gelatin or agar-agar, coagulated blood-serum, and slices of potato or other vegetables.

Inoculation. The action of bacteria and their toxins is studied experimentally by the injection of cultures, or of the body fluids or the juice of bacterially infected tissues into some of the lower animals. The animals usually employed are the guinea-pig, rabbit, mouse, rat, and pigeon. Injections are made with a sterile hypodermic syringe under the skin, into the peritoneal cavity, intravenously, and into the anterior chamber of the eye, or the skin may be merely scarified. The animal is carefully watched afterward, its symptoms noted, and when dead of the disease, or killed, cultures are made from the organs, and the tissue-changes studied.

Staining. In order to detect bacteria in the tissues, or to study and differentiate them from each other, it is necessary to stain them, and this is accomplished by the use of dilute aqueous or alcoholic solutions of the aniline dyes, counter-staining the tissues to make their detection easier. Bacteria differ widely in the facility with which they take the stains, some staining readily, while others require the action of heat or of a mordant; and they differ also in the tenacity with which they retain the stains in the presence of various reagents, as alcohol and the mineral acids. We are thus able to separate different bacteria by the use of special methods of staining and decolorizing. For example, the gonococcus, the bacillus coli communis, and the typhoid bacillus, are decolorized by the use of Gram's method; while the bacilli of anthrax, tuberculosis, diphtheria, and tetanus are stained by it. The aniline stains most frequently employed are methylene-blue, gentian-violet, thionin, fuchsin, dahlia, and vesuvin.

Koch's Law. To prove that a certain bacterium is the cause of a disease, the following rules have been laid down by Koch: The bacterium must first be found in the diseased person or animal. It must be cultivated outside of the body. When inoculated in pure culture in a healthy animal, it must produce the original disease. From the body of the animal the original microbe must again be isolated.

Intoxication and Infection. Bacteria usually gain an entrance into the body through some break in the continuity of the skin or mucous membrane, especially the latter, owing to its being easier of penetration. They often enter through an open wound. Favoring elements are a weakened or diseased state of health of the individual, or an unusual virulence of the germ. If the germs remain localized, and only their products are absorbed, the process is spoken of as *intoxication.* If the germs themselves enter the circulation, we have *infection,* although the term infection is also used by surgeons to denote the presence of bacteria in a wound, without necessarily or even usually implying their presence in the circulation. If the germ be pyogenic—that is, one that excites suppuration, the symptoms produced by the absorption of its products constitute *sapræmia.* If the germ enters the circulation we have *septicæmia,* and if it finds lodgement in the tissues or organs and gives rise to secondary abscesses, we have *pyæmia.*

Elimination. Bacteria are eliminated by the kidneys, the intestine, the salivary glands, in the bile and milk, and probably also by the sweat-glands. They frequently cause lesions in the eliminating organ.

Pathogenic Action. The pathogenic action of bacteria is due to the formation of certain poisonous products secreted by them, or produced by their action upon the tissues. From the bacteria themselves, by their degeneration, we have also formed the *proteins.* The bacteria by their secretion produce the *ferments,* and, perhaps, the *toxins;* and by their action upon the tissues we have produced the *ptomaïnes, amines, peptones, albumoses, fatty acids, etc.*

Toxins. The toxins are produced by the pathogenic bacteria. They are poisonous when injected, even in very minute doses, acting after a period of incubation, and are looked upon by many observers as being of the nature of ferments. Others have classified them as *toxalbumins* or *toxalbumoses.* The different pathogenic bacteria elaborate their own specific toxins. Some of them have a local as well as a general action, producing inflammation, necrosis, etc., when injected into living animals.

Resistance of the Tissues to Bacteria. That the introduction of bacteria into the body is not always followed by the development of disease is due to a number of circumstances, one of the most important being the resistance offered by the tissues. Certain of the leucocytes have what is known as a *phagocytic* action—that is, the power to take into themselves and destroy by intracellular action the invading germs. The leucocytes appear to be attracted to the germs by a power residing in the bacteria, known as *positive chemotaxis,* their migration being accompanied by the nutritive changes constituting the process of inflammation, and in the case of pyogenic germs of suppuration. Inflammation seems to be a limiting and protecting process. The bacteria if very virulent may overcome the leucocytes, or repel them by the production of toxins, which are *negatively chemotactic* —that is, they repel the leucocytes and interfere with their phagocytic action, and we have in consequence a general invasion of the organism by the bacteria, often without any local inflammation. In addition to the phagocytic action of the leucocytes, the blood and fluids of the body have a certain germicidal power, said to be due to the presence of albuminous bodies—*alexins*. The presence in a wound of a foreign body favors the growth of bacteria, as does, to a certain extent, the presence of blood-clot or other material which can act as a culture medium for the germs.

Immunity. This consists in the freedom from liability to a disease, and may be natural or acquired. In *natural immunity* the person or animal is immune from birth; while *acquired immunity* may be the result of a previous attack of the disease, or may be produced artificially. As examples of natural immunity we have that shown by the lower animals to syphilis and leprosy, and of man to certain diseases of the lower animals. One attack of small-pox, scarlet fever, or typhoid fever confers an acquired immunity on the patient which is usually permanent; while an attack of pneumonia, influenza, or diphtheria is followed by a period of temporary immunity. Immunity may also be absolute or relative; the first being rare, the latter common, being overcome by unusual conditions. Artificial immunity is active or passive. *Active immunity* is obtained by the injection into animals of increasing doses of a pathogenic organism, or of its toxins, the dose being gradually increased until a high degree of immunity is obtained. This method is preventive of future attacks, but owing to its slowness is not useful against an existing disease. *Passive immunity*, which is less lasting than active immunity, is conferred by the injection into an animal of the serum of an animal that has been highly immunized by the previous method. The serum will destroy existing toxins and organisms, and confer temporary immunity against further infection.

Antitoxin. The mechanism of the production of immunity is largely, if not altogether, dependent upon the formation by the reaction of the tissues to the toxins of an albuminous body known as antitoxin. To the presence of this substance in the serum of an actively immunized animal is due its curative power when injected into an animal suffering from the same disease. The antitoxin of diphtheria has been widely employed of late years with beneficial results, and the investigations now being carried on in tetanus, hydrophobia, anthrax, and other diseases, afford foundation for the hope that similar good results may be obtained with them. A distinction is made between antitoxic serum and antimicrobic serum; the first being produced by the injection of toxins, and the latter by the injection of living bacteria. The antimicrobic serums tend to the destruction or paralysis of the microorganisms, but not necessarily of the toxins.

Varieties of Bacteria.

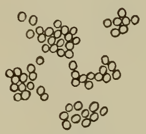
The bacteria of importance surgically are those giving rise to ordinary suppuration, the gonococcus, the tubercle bacillus, the bacillus of malignant œdema, the bacillus of glanders, of anthrax, of tetanus, the bacillus of infectious emphysema, and the organisms causing actinomycosis and mycetoma.

Bacteria of Suppuration. A large number of bacteria are capable of giving rise to suppurative inflammation, but the most important are the staphylococci, especially the staphylococcus pyogenes aureus, and the streptococcus pyogenes or streptococcus erysipelatis, they being identical. Beside these, as rarer causes, we have the bacillus pyocyaneus, the bacillus coli communis, the typhoid bacillus, the gonococcus, the diplococcus pneumoniæ and the bacillus pneumoniæ (Friedlander).

The Staphylococcus Pyogenes Aureus. This bacillus, which causes 80 per cent. of suppurative inflammations, and is almost always the cause of osteomyelitis, grows in clusters (Fig. 106), can be cultivated on ordinary media, but best on agar, and forms small, round colonies, at first whitish, later of an orange-yellow color. It is found in health on the skin, in the pharynx, and in the external secretions.

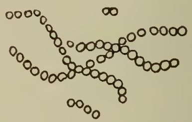
The *staphylococcus pyogenes albus*, or *epidermis albus*, as it is called, from being found in the epiderm, is less virulent than the preceding, and forms white colonies. It not infrequently is the cause of stitch abscesses.

FIG. 106.



Staphylococcus pyogenes aureus. (ABBOTT.)

FIG. 107.

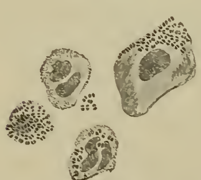


Streptococcus pyogenes. (ABBOTT.)

Streptococcus Pyogenes. This is a small, round organism which forms chains (Fig. 107). It is found occasionally on mucous surfaces in health, and causes dangerous phlegmonous inflammations. It also causes erysipelas, being identical with the streptococcus erysipelatis.

Bacillus Coli Communis. This is a rod-shaped bacillus, and may be long and slender, or short and rounded. It strongly resembles the typhoid bacillus. It is provided with flagella. It is found in the intestines in health, and seems to acquire virulent properties from inflammation or strangulation of the bowel, giving rise to appendicitis and peritonitis by migration through the diseased wall of the bowel, or by escape through a rupture. It may also be the cause of cystitis, pyelitis, pyelonephritis, and occasionally of localized abscesses.

FIG. 108.



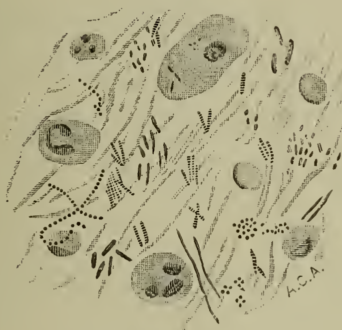
Gonococcus. (After BUMM.)

Gonococcus. This is the germ of gonorrhœa, is a kidney-shaped coccus, arranged in pairs, with the concave edges toward each other; the diplococci usually inhabit the pus-cells, but are occasionally free (Fig. 108). Beside specific urethritis, it causes salpingitis, oöphoritis, arthritis, endocarditis, conjunctivitis, proctitis, and other lesions.

Tubercle Bacillus. This is the cause of tuberculosis, is a rod-shaped bacillus, sometimes slightly curved, 1.5 to 3.5

micromillimetres in length and 0.2 to 0.5 micromillimetres thick. It is not motile, and occurs singly, in pairs, and in groups; spore production has not as yet been demonstrated (Fig. 109). Inoculation may be directly through a wound, or by inhalation, ingestion, or placental transmission, the last being rare. It may affect any organ of the body. It causes tuberculosis in many of the lower animals, cattle being especially liable to it.

FIG. 109.



Tubercle bacilli. (ABBOTT.)

Bacillus Mallei. Glanders is caused by this bacillus, which resembles the tubercle bacillus, but is shorter and thicker (Fig. 110). Infection of the mucous membranes of the respiratory tract and through the skin is not uncommon in men who are exposed to infection from horses.

FIG. 110.

Bacillus mallei. (ABBOTT.)

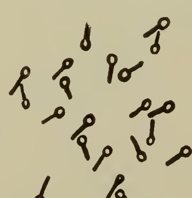
FIG. 111.

Threads of bacillus anthracis containing spores. (ABBOTT.)

Bacillus Anthracis. This, the cause of anthrax, is a very large, straight bacillus, usually from 5 to 20 micromillimetres in length, sometimes, however, attaining a length of 50 micromillimetres. It forms long chains and produces spores, which are very resistant (Fig. 111). Infection in man usually arises from handling infected skins and hides, and causes a local inflammation, with general septicæmia. Infection may also take place through the lungs or through the gastro-intestinal tract.

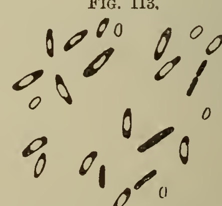
Bacillus of Tetanus. This is a rod-shaped organism which, owing to the formation of a spore at one end which distends it, is often of a drumstick shape (Fig. 112). It is anaërobic, being found especially in garden-earth, in the excrement of animals, and around stables. Infection follows wounds, especially punctured wounds by nails or splinters, which are liable to be contaminated from the earth; infection is also quite common in puerperal women and in the new-born. Suppuration in a wound favors its development. The bacterium apparently remains localized, producing its characteristic symptoms by the action of very powerful toxins, of which two, *tetanin* and *tetano-toxin*, have been isolated. An antitoxin has been isolated from immunized animals, and some good results reported from its administration in individuals suffering from tetanus, but it has often proved disappointing.

FIG. 112.



Tetanus bacillus. (ABBOTT.)

FIG. 113.



Bacillus of malignant œdema, spore stage. (ABBOTT.)

Bacillus of Malignant Œdema. This resembles the anthrax bacillus in appearance, being more slender, however, and, like it, has a tendency to form chains. It is motile, being provided with flagella, is anaërobic, and forms spores (Fig. 113). It occurs in the soil, in dust, and in the contents of the intestines of lower animals. In the lower animals it is the cause of the disease known as malignant œdema, which is associated with suppuration and necrosis of the subcutaneous tissues, emphysema, and gangrene. In man it has been found in certain cases of rapidly spreading traumatic gangrene and gangrenous emphysema, arising in connection with compound fractures and other deep punctured wounds.

Bacillus Aërogenes Capsulatus. This organism is from 3 to 6 micromillimetres in length, and may be found singly, clumped, or in chains. It is non-motile, anaërobic, and does not form spores. It finds entrance into the body through a wound or ulceration, external or internal, and its effects resemble somewhat those produced by the bacillus of malignant œdema; viz., necrosis, gangrene, and the production of gas, which in this case is found in any or all of the tissues and organs and in the blood, in the form of minute bubbles, in the walls of which the bacilli may be found. In man it produces the condition which has been described as gaseous gangrene, infectious emphysema, gas phlegmon, and emphysematous necrosis.

FIG. 114.

Actinomyces. (BAUMGARTEN.)

Actinomyces, or Ray Fungus. This organism probably belongs to the higher order of bacteria, and occurs in yellow masses, which may be visible to the naked eye. They consist of masses of the organism, with diverging rays consisting of threads, with bulbous ends (Fig. 114). It occurs rarely in man, commonly in the lower animals, from whom it has been obtained in pure culture. When implanted in the tissues, to which it is conveyed through a wound or carious tooth, sometimes apparently in seeds or in grains, it excites a chronic inflammation, with the presence of granulation tissue, necrosis, and suppuration. In man it occurs most frequently in the mouth, tongue, and internal organs. In cattle it affects the jaws, causing "*lumpy jaw.*"

Mycetoma, or the Streptothrix Maduræ. This is a branching micro-organism, resembling the actinomyces, and, like it, occurring in granular masses, composed of branching threads. It excites in the foot especially the formation of nodular masses, which break down and form abscesses and fistulæ, and causes caries and necrosis of the bones.

THEORY OF ASEPSIS AND ANTISEPSIS IN WOUND TREATMENT.

Before the introduction of Lister's method of treating wounds it was the rule in accidental and operative wounds to have profuse suppuration, fever, pain, and in many cases such wound complications as septicæmia, pyæmia, erysipelas, and hospital gangrene, and the mortality following operative and accidental wounds was very high. The mortality in compound fractures from sepsis was formerly very great, but by modern methods of wound treatment has been diminished to an insignificant percentage. The same diminished mortality has been found to follow amputations and other wounds, accidental or operative.

Lister's method of wound treatment was largely based upon the idea that the infection of the wound occurred from contact with the air, which contained spores and germs, and his method of treatment was chiefly directed to their destruction. The air can be a medium of wound infection to a certain extent, for it has been demonstrated that dry air contains dust in which spores and bacteria are present in much larger numbers than in moist air, and such air coming in contact with an open wound deposits there numbers of bacteria, which may set up inflammatory changes. Koch later demonstrated the fact that atmospheric microbes were chiefly of an innocuous character, and that wound infection was generally caused by bacteria or spores being brought in direct contact with the wound by the clothing and skin of the patient, the instruments and the hands of the surgeon and assistants, and unclean surgical dressings.

Cheyne has shown that the relative number of bacteria entering the tissues is an important factor in producing suppuration and septic infection, for we know that bacteria may exist in an aseptic wound and yet the wound heal and remain aseptic, the antiseptic qualities of the blood-serum and the cell-activity in healthy tissues being sufficient to destroy or remove a certain number of micro-organisms, and suppuration or septic infection occurring only when the tissues are ovewhelmed by the number of organisms, or when their power of resistance is diminished by injury or disease. This explains the satisfactory behavior of wounds which pursue an aseptic course where very imperfect details of aseptic or antiseptic treatment have been employed. It may, therefore, be assumed that infection does not necessarily depend upon the presence of a few microbes, but rather upon the quantity and quality of the germs which are present in the wound.

Pyogenic micro-organisms under different conditions can produce a series of different diseases, for it is now generally accepted that Fehleisen's *streptococcus erysipelatis* is identical with *streptococcus pyogenes*, which is recognized as the cause of very different inflammatory affections. The theory has been advanced by Reger that all the so-called pus-diseases are simply local expressions of a general infection caused by many different micro-organisms.

Sepsis. Sepsis is due to the entrance and multiplication of micro-organisms or the absorption of their products in the body, and is characterized by local inflammation of the wound, and marked constitutional symptoms, such as fever, disorders of the nervous system, and inflammation of the viscera. Microbic infection represents a pathological process which causes serious wound complications, and differs materially from that process which attends the repair of wounds that run an aseptic course. Aseptic chemical irritation of the tissues may result in the production of a *puruloid* fluid, which is not pus, but merely a fibrinous exudation containing numerous cells, and does not produce infection if injected into animals. Acute suppuration in a wound is considered clinically to be always due to the presence of bacteria, for their exclusion will prevent its occurrence.

Asepsis. Asepsis aims at thorough sterilization of the parts and of all objects brought in contact with the wound, and the exclusion of micro-organisms by occlusive sterilized dressings.

Antisepsis, on the other hand, has in view the destruction of micro-organisms by keeping germicidal agents constantly in contact with the wound. The object of antisepsis is, therefore, to produce asepsis.

No surgeon should undertake the performance of an operation or the treatment of an open wound without having clearly impressed upon his mind the important part that pyogenic and specific micro-organisms may play in the subsequent course of the wound.

Methods of Disinfection or Sterilization.

Since the majority of wound complications are due to the presence in the wound of micro-organisms, it is the duty of the surgeon to prevent their contact with it, or to employ means for their destruction. We must, however, employ means of disinfection or destruction of these micro-organisms which will not have any injurious effect upon the tissues with which they come in contact. *Mechanical disinfection or sterilization* is not applicable to wounds, but is employed to remove any micro-organisms which may be present upon the objects which are to come in contact with the wound—namely, the hands of the surgeon and assistants, instruments, and the skin surrounding the wound. Mechanical disinfection is accomplished by the use of friction with a brush, soap, and water. *Germicidal solutions* may be used for disinfection of wounds, but are most useful in the disinfection of the hands of the operator, the skin of the patient, the instruments, and the dressings. If these have been carefully employed before the wound is made, their subsequent use in the wound is usually unnecessary.

Some forms of *bacilli* contain spores which resist the action of germicidal substances, while the bacilli themselves are readily destroyed by these agents: the surgeon should, therefore, employ that means of disinfection which is generally applicable to the destruction of both bacilli and their spores. The bacilli of *anthrax*, *tuberculosis*, and *tetanus* contain spores; hence to destroy these organisms is a matter of more difficulty than to render harmless such micro-organisms as *staphylococcus pyogenes aureus*, *albus*, and *citreus*, *streptococcus pyogenes* and *streptococcus erysipelatis*, and the bacilli of *diphtheria* and *glanders*, which contain no spores.

Heat when used as a germicide cannot be applied to the wound itself, except in cases where a limited amount of the surface of the wound may be touched with the hot iron. Heat can, therefore, be used only for the disinfection of substances coming in contact with the wound, and for this purpose it is employed in the form of *steam*, *dry heat*, or *boiling water*.

Sterilization of the wound or the substances coming in contact with it may be accomplished by using either the *aseptic method* or the *antiseptic method*, and at the present time these two methods are to a certain extent combined—that is, it is impossible to be strictly aseptic without employing means of disinfection by the use of antiseptics. The aseptic method, which employs germicidal substances only for the purpose of sterilization of objects coming in contact with the wound, when their disinfection by heat is impossible, is the method which has been generally adopted.

Antiseptic Method. In the antiseptic method the sterilization of the field of operation, the hands of the surgeon and assistants, the instruments, ligatures, sponges, and sutures, is accomplished by the use of germicidal solutions, and, in addition, the wound is irrigated frequently during the operation with germicidal solutions, and is afterward covered with dressings impregnated with germicidal substances. The antiseptic method was that first employed, and, recognizing its value in surgical procedures, many surgeons still continue to employ this method, but it has certain disadvantages. Recent investigations have shown that many of the germicidal substances have not the power which was formerly attributed to them; many chemical germicides cause the formation of a dense layer of coagulated albumin around albuminous substances, and also fail to destroy micro-organisms associated with fatty or oily substances. *Chemical germicides* may also form combinations in the tissues with substances with which they come in contact, seriously impairing their germicidal action. Antiseptic substances which are active as germicides often cause irritation of the surface of the wound, interfering with its repair.

It has been shown that irrigation of a fresh wound with a 1 : 10,000 solution of bichloride of mercury is followed by distinct evidence of superficial necrosis of the tissues. Antiseptic irrigation of wounds is apt to cause very free oozing of serum, which necessitates the use of drainage, and makes the frequent dressing of the wound necessary. Many antiseptic substances produce marked toxic effects upon the patient, and also cause very severe irritation of the skin with which they come in contact.

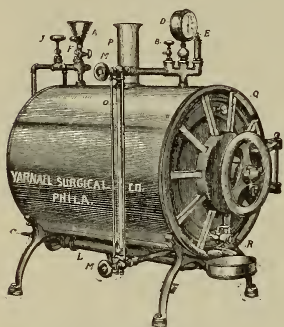
Aseptic Method. In employing the aseptic method in the treatment of wounds the field of operation, the hands of the surgeon and assistants, the instruments, ligatures, sponges, and sutures, are sterilized by the use of germicidal solutions and heat, and after this has been accomplished, relying upon the completeness of the sterilization, no germicidal substances are brought in contact with the wound, sterilized water or sterilized salt solution being used if it is necessary to flush the wound, and the dressings employed are those only which have been sterilized by moist or dry heat. The advantages of the aseptic method are as follows: the method is applicable to all parts of the body; wounds treated by this method heal more promptly and do not require such frequent dressing; there is no risk of toxic effects, and there is no irritation of the skin by the dressings. *Dry sterilized dressings* are efficient to produce absorption, and at the same time the dryness may be a factor in the destruction of germs, for exposing bacteria to dryness deprives them of one of the conditions necessary to their existence. The aseptic method is, therefore, to be preferred to the antiseptic method in the treatment of wounds wherever it is possible.

Agents Employed to Secure Asepsis.

A great variety of agents possessing more or less germicidal properties have been at different times employed in the practice of aseptic or antiseptic surgery; those most employed at the present time are heat, bichloride of mercury, carbolic acid, iodoform, formalin, beta-naphthol, formaldehyde, chloride of zinc, acetate of aluminum, peroxide of hydrogen, kreolin, permanganate of potassium, sulphocarbolate of zinc, salicylic and boric acid, acetanilid, aristol, and certain silver salts.

Heat. The most reliable and universally available agent for the destruction of micro-organisms is heat, either dry or moist; many forms of bacteria are rendered inert at a temperature of 140° F., and none can withstand the application of moist heat at a temperature of 212° F. continued for a short time. *Spores* which will resist the action of powerful germicides for a considerable time are destroyed by boiling for a few minutes. As moist heat is the most efficient sterilizer, it should be preferred, and can always be made use of for this purpose by boiling the instruments and dressings for a few minutes, and if for any reason it is thought advisable to employ dry heat as a sterilizer, this may be made use of by baking the instruments or dressings in a hot oven. The best results may be obtained by the use of one of the various dry or moist sterilizers (Fig. 115). An improvised sterilizer may be made by having a perforated metal stand placed inside a large kettle so that only the steam comes in contact with the instruments and dressings.

FIG. 115.



Steam sterilizer.

Bichloride of Mercury. This is employed as an antiseptic in watery solution, varying in strength from 1 : 500 to 1 : 10,000.

The solution of 1 : 500 to 1 : 1000 is used only for the irrigation and disinfection of the hands and skin; for the irrigation of wounds, a solution of 1 : 2000 or 1 : 4000 is generally employed. Where continuous irrigation is kept up, or where it is employed in large cavities, a still weaker solution, 1 : 5000 to 1 : 10,000, should be employed.

In using bichloride solutions the surgeon should watch the patient carefully for symptoms of poisoning due to the absorption of the bichloride of mercury; the symptoms denoting this are vomiting, fetid breath, salivation, inflammation of the gums, diarrhœa, blood-stained stools, and bleeding from the mouth and nose.

In preparing the solutions of bichloride of mercury for use it will be found convenient to have a concentrated solution of the salt in alcohol, one part of the bichloride of mercury to ten parts of alcohol; this can be kept in a well-stoppered bottle, and to this should be added one teaspoonful of common salt, which prevents the disintegration of the mercuric compound. One teaspoonful of this solution added to one quart of water makes a 1 : 2500 solution.

A 10 per cent. bichloride solution may be made as follows:

Bichloride of mercury	2 parts.
Sodium chloride	1 part.
Dilute acetic acid	1 "
Water	16 parts.

By adding water in an appropriate quantity, a 1 : 1000 or 1 : 2000 solution can be made.

Or the solution may be prepared with tartaric acid in the proportion of five parts of the acid to one part of the bichloride of mercury, the following formula being employed :

Hydrarg. chlor. corrosiv.	grs. xv.
Ac. tartaric.	grs. lxxv.
Aquæ dest.	Oij.

Pellets containing a definite amount of bichloride of mercury compounded with a few grains of common salt of muriate of ammonia, which, when dissolved in a definite quantity of water, make a solution of 1 : 1000 or 1 : 2000, will also be found very convenient for the preparation of solutions. The pellets should also contain a little coloring matter, which gives a faint color to the solution and serves to distinguish it from other solutions.

Carbolic Acid. This drug is employed in solutions of 1 : 20 or 1 : 40. The stronger solution, 1 : 20, is usually employed to sterilize the instruments, the latter being allowed to remain in this solution for thirty minutes before being used. As a carbolic solution of this strength benumbs and cracks the skin of the hands of the operator, it should be diluted just before the instruments are required, by adding an equal quantity of water, making it a 1 : 40 solution.

The 1 : 40 or 1 : 60 solution is used for the irrigation of wounds and the washing of sponges. A ready method of making a 5 per cent. carbolic solution is to add one tablespoonful of carbolic acid to one pint of hot water.

In using carbolic acid solutions continuously the surgeon should be on the watch for the symptoms of poisoning, which will show itself by dark-colored urine, headache, dizziness, vomiting, and in severe cases bloody diarrhœa, hæmoglobinuria, and death from collapse. Carbolic acid solutions should be used with great caution in young children, as they seem to be more susceptible than adults to the constitutional effects of this drug.

The use of weak solutions of carbolic acid seems to involve more risk of toxic action than does the employment of the pure drug, the superficial layer of tissue being coagulated by the latter, so that the absorption of the drug is prevented. Gangrene of the skin and subjacent tissues has frequently been observed to follow long-continued use of quite dilute solutions of carbolic acid or of ointments containing small quantities of the drug. Cases of gangrene of the fingers and toes from this cause are not infrequently seen.

Iodoform. Iodoform has been shown by experimental research to possess little direct germicidal action, but in spite of this fact, clinical experience has proved that it possesses powerful antiseptic properties, due, as shown by Behring and De Ruyter, not to the destruction of germs, but to its undergoing a decomposition in their presence, and thus rendering inert the ptomaïnes which have resulted from the germ-growth. It may be rendered absolutely sterile by exposing it to heat, and, as it is easily decomposed, fractional sterilization may be employed, or by washing it in a 1 : 1000 bichloride solution; it should then be dried and kept for use in closely stoppered bottles. Iodoform is employed as an application to wounds, and is frequently employed in aseptic wounds which are liable from their position to become infected, such as those about the mouth, rectum, and vagina, and is especially useful as a dressing in infected wounds and in tubercular or syphilitic ulcers. In operations upon the mouth, anus, rectum, uterus, and abdominal cavity iodoform gauze packing is largely employed, and serves to keep the discharges from becoming foul, thus often preventing septic intoxication. It is often used in the form of powder. *Iodoform collodion*, made by adding iodoform, gr. xlviii, to collodion, f℥j, is a useful dressing in superficial wounds. It may also be employed in the form of an *ethereal solution*, iodoform, gr. xv; ether, f℥j, as an application to wounds or ulcers. An *emulsion of iodoform* in glycerin, iodoform, ʒj; sterilized glycerin, ʒx, or an emulsion of iodoform made by adding sterilized iodoform, ʒj; to boiled olive oil, ʒx, is much employed as an injection in the treatment of tubercular abscesses and joints.

Numerous cases have been reported in which toxic symptoms have followed the use of iodoform, such as urticarial eruptions, headache, depression, delirium, mania, debility, and sleeplessness. Elderly persons and infants are very susceptible to the toxic action of iodoform.

Formaldehyde. This is a pungent, penetrating gas possessing valuable antiseptic properties, which is principally used for the disinfection of clothing, instruments, bedding, and rooms. The gas is generated in a lamp or generator by passing the vapor of methyl alcohol over a coil of glowing platinum wire or gauze, or over platinized asbestos.

Formalin. This is a 40 per cent. solution of formaldehyde gas in water, and has valuable antiseptic properties. A solution of this strength is a powerful irritant, and cannot be used in the treatment of wounds. It may be used in a 2 per cent. solution to disinfect wounds or instruments, or in a one-quarter of 1 per cent. solution for irrigation.

Formalin-gelatin or Glutol. This is a compound formed by evaporating an aqueous solution of gelatin over vapor of formalin. Its activity as an antiseptic depends upon the vapor of formalin given off when applied to the wound. It is a non-irritating and non-poisonous powder.

Beta-naphtol. Beta-naphtol, in a 1 : 2500 solution, is employed for much the same purposes as the bichloride of mercury solution; it is not, however, so powerful a germicide. It is employed in irrigating large cavities because it is not a poisonous agent, but is especially useful as a bath for instruments, as it does not corrode them, as does the sublimate solution. It also possesses the advantage over a carbolic acid solution of not irritating the skin of the surgeon's hands.

Silver Salts. Silver lactate (actol) and silver citrate (itrol) are two new antiseptics which have been recommended by Credé, who considers their germicidal properties superior to bichloride of mercury. These salts may be used in a 1 : 4000 or 1 : 8000 solution, which should be made in water free from chlorides, which precipitate the silver; distilled water should be employed. Credé speaks highly of an ointment made of metallic silver which may be employed as an inunction in septic diseases.

Acetanilid. This preparation possesses antiseptic properties and is frequently used as a substitute for iodoform. It may be used in the form of powder as an application to suppurating or ulcerating tissues, but in tubercular conditions is not as satisfactory as iodoform.

Chloride of Zinc. Chloride of zinc, in a solution of 30 to 40 grains to water f℥j, is a very powerful antiseptic. When employed upon raw surfaces it produces marked blanching of the tissues; it is especially useful in wounds which are infected or which have been exposed to infection. I have found it by all means the best application for the poisoned wounds which are received in dissecting dead bodies and in operating. In such cases the whole cavity or surface of the wound should be washed with a 30-grain solution of the chloride of zinc, and then the wound should be dressed with a moist bichloride dressing.

Sulpho-carbolate of Zinc. This drug has been found to possess more decided antiseptic properties than the chloride of zinc, and is much less irritating. It may be used in the same strength and for the same purposes as the former drug.

Acetate of Aluminum. This drug is used in solution and is prepared as follows: Aluminis, ʒvj (24 grammes); plumbi acetatis, ʒjxss (38 grammes); aquæ, Oij (1000 grammes). Mix and filter after standing twenty-four hours. It has decided germicidal qualities, is employed for irrigation and moist dressing where carbolic or bichloride solutions cannot be used, and is by all means the safest and best antiseptic substance for wet dressings.

Peroxide of Hydrogen. Peroxide of hydrogen is employed in what is known as the 15-volume solution. It may be used in this strength or may be diluted. It seems to have a direct action upon pus-generation by destroying the micro-organisms of pus, and is frequently employed in the sterilization of sinuses or suppurating cavities, such as remain after the opening of abscesses or result from diseases of or operations upon the bones. It is injected into the sinuses and cavities by means of a glass syringe, or may be applied to open wounds in the form of a spray. Its action is shown by the escape of bubbles of gas, which cleanse suppurating surfaces or sinuses mechanically, and it should be used as long as these continue to escape.

Pyrozone. Pyrozone possesses the same qualities as the peroxide of hydrogen, and apparently to a somewhat higher degree, and is used for the same purposes.

Kreolin. This substance is obtained from English coal by dry distillation, and has been found to possess powerful germicidal properties; it is non-irritating and practically non-toxic. It is insoluble in water, but forms an emulsion with it which possesses marked antiseptic properties.

It may be employed for the same purposes as carbolic acid, and has the advantage over the latter drug that it is not irritating to the skin, and is almost devoid of toxic properties.

It is used in an emulsion, in strength from 2 to 5 per cent., and is employed in the irrigation of large wounds or cavities of the body, and has been most favorably recommended in gynecological practice.

Boric Acid. This drug has not very marked antiseptic qualities, and is usually unirritating even in saturated solutions. It is frequently employed in a 5 per cent. solution to cleanse and disinfect mucous surfaces and large cavities. It is often employed to wash out the bladder before the operation for the removal of calculi or growths from that organ.

In the dressing of superficial wounds, or in wounds in which the bichloride or carbolic acid dressings produce irritation, an ointment of boric acid, 1 part, to petrolatum 5 parts, will be found very satisfactory.

Salicylic Acid. Salicylic acid does not have very marked antiseptic qualities, but possesses much less toxic action than carbolic acid, and is used for somewhat the same purposes. Its antiseptic power is said to be increased by the addition of boric acid, and a boro-salicylic lotion (Thiersch's solution) is prepared by adding salicylic acid, 1 part; boric acid, 6 parts; to hot water, 500 parts, making a bland solution, which, when reduced from 25 to 50 per cent. in strength, can be used for irrigation of the bladder or the peritoneal cavity.

Permanganate of Potassium. This drug, owing to its rapid absorption of oxygen, acts as an antiseptic, and is often employed for the disinfection of foul wounds and ulcers. It is also employed in solution for washing the operator's hands and for the washing of sponges. It is practically non-irritating, and may be used in quite concentrated solutions, but is usually employed in the following solution: Permanganate of potash, ʒj; water, f℥j. One fluid drachm of this solution to a pint of water makes a 1 : 1000 solution.

Aristol. Aristol, which is a compound of iodine and thymol, possesses germicidal properties, and has been introduced as a substitute for iodoform. It has the advantage over iodoform of not being poisonous, and is also without disagreeable odor. It may be employed for the same purposes as iodoform, and it seems to be particularly useful as a dressing to chronic and specific ulcers.

PREPARATION OF MATERIALS USED IN ASEPTIC OPERATIONS.

Sponges. Marine sponges are the best materials for the purpose of sponging, but their satisfactory sterilization is often a matter of difficulty. It is better to use a cheap grade of sponges and use them only once. The sterilization of sponges by boiling destroys to a certain extent their elasticity and their absorbent power. Schimmelbusch recommends the following method. The dried sponges are freed from dirt or sand by beating, and are then soaked for several days in cold water slightly acidulated with hydrochloric acid, being kneaded from time to time. They are next thoroughly washed in cold and in warm water, wrapped up in a linen sheet, and placed in a boiling 1 per cent. soda solution; the solution should not be allowed to boil after the sponges are placed in it. They are allowed to remain in this hot solution for thirty minutes, are then washed in boiled water to remove the soda, and are placed in a 0.5 per cent. bichloride solution for use.

Another method of preparing the sponges consists in beating them to remove any sandy matter which they may contain, and placing them for twenty-four hours in a solution of hydrochloric acid, 4 ounces; water, 4 pints; upon removing them from this solution, they are washed until free from acid; they are then placed for half an hour in a solution of permanganate of potassium, 180 grains to 6 pints of water; next they are washed and placed in a solution of hyposulphite of sodium, 10 ounces; hydrochloric acid, 5 ounces; water, 48 ounces, and allowed to remain in this solution for four hours; then they are removed and placed in running water for six hours, and afterwards in a 5 per cent. carbolic acid solution or a 1 : 1000 bichloride solution. Carbolic solution is the better one, as it is not so liable to decomposition.

Gauze Pledgets or Pads. On account of the difficulty of the satisfactory sterilization of sponges, as well as of their expense, folded gauze pledgets have largely superseded them.

Gauze Pledgets. Gauze pledgets are prepared by cutting a piece of gauze, composed of from twelve to sixteen layers, in pieces six inches square; the four angles of these pieces are then tied together or secured by a few stitches.

Gauze Pads. Gauze pads are made from a piece of gauze composed of from sixteen to twenty layers cut the desired size, the different layers in each pad being quilted together by a few stitches, and the edges loosely whipped with a thread to prevent them from fraying. Gauze pads are used as a substitute for the flat sponges formerly employed in abdominal surgery, and for the drying of wounds. The pads or pledgets may be sterilized by boiling or by exposure to steam or dry heat in a sterilizer, or may be sterilized and preserved at the same time in a 1 : 2000 bichloride solution. When so preserved, before being employed the moisture should be squeezed from them, or they should be washed in water which has been boiled before being brought in contact with the wound.

Silk Sutures and Ligatures. Silk for sutures or ligatures, either the plaited silk or the Chinese twisted silk, should be sterilized by boiling from ten to thirty minutes in a 5 per cent. solution of carbolic acid, or in water, the time of boiling depending upon the thickness of the threads; frequent boiling renders the silk weak. It should then be placed in stoppered bottles and covered with a 5 per cent. solution of carbolic acid or with absolute alcohol, or in 1 : 1000 bichloride and alcohol solution.

Silkworm-gut. Silkworm-gut is an excellent material for sutures, and may be sterilized by boiling it for fifteen minutes, or by placing it for one-half hour in a 5 per cent. carbolic solution; after being sterilized it should be kept in 95 per cent. alcohol. There has recently been introduced an iron-dyed black silkworm-gut, which makes the sutures more prominent, and thus facilitates their removal.

Catgut Ligatures and Sutures. Catgut is the ideal material for ligatures and sutures, but has the disadvantages of difficulty and uncertainty in its sterilization. Raw catgut is often infected with micro-organisms, and, therefore, thorough sterilization alone can render it a safe material for ligatures and sutures.

Von Bergmann's Catgut. This method of preparing catgut, which we have found one of the most satisfactory, consists in winding the catgut loosely upon glass rods or spools; these spools are placed in ether for twenty-four hours; the ether is then poured off, and the catgut is placed in the following solution : bichloride of mercury, 10 parts; absolute alcohol, 800 parts; distilled water, 200 parts. Remove from this solution in twenty-four hours, and place it in a similar solution for forty-eight hours; then place it in absolute alcohol. If you desire the gut to be soft, add 20 per cent. of glycerin to the absolute alcohol. To make the sterilization absolutely certain it has been found advantageous to soak the catgut for thirty minutes in a 1 : 1000 aqueous bichloride solution before placing it in the alcoholic solution of bichloride.

Dry Sterilized Catgut. Boeckman's process for sterilizing catgut consists in cutting the gut in pieces twenty to forty inches in length; each piece is wrapped in paraffin-paper, and sealed in a paper envelope. The envelopes are then placed in a sterilizer for three hours at a temperature of 284° F., and then for four hours longer at a temperature of 290° F. When required for use the envelope is opened, the paraffin-paper removed, and the gut is immersed for a few minutes only in sterilized water.

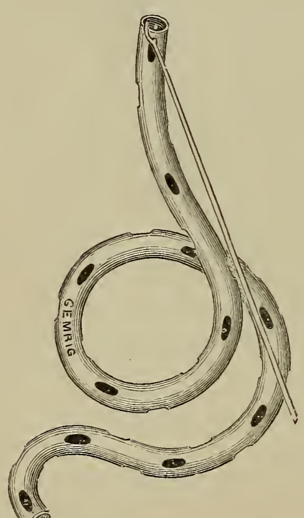
Boiled Catgut. Catgut may also be sterilized by boiling. The most satisfactory method is that devised by Fowler, which consists in placing a number of strands of catgut in an ordinary test-tube which is filled with 95 per cent. alcohol to within half an inch of the top; a wad of cotton is next pushed into the mouth of the tube, and a cork is introduced. The tubes thus prepared are placed inverted in a fruit-jar filled with 95 per cent. alcohol; the jar is then closed and placed in a water-bath and kept at a boiling temperature for an hour.

Formalin Catgut. This is prepared by winding catgut loosely on glass spools and keeping them for forty-eight hours in a vessel containing equal parts of alcohol and ether. They should next be washed for a few minutes in alcohol and placed in a jar containing equal parts of alcohol and formalin, and allowed to remain for several days. The excess of formalin should then be washed away with alcohol, and the catgut kept for use in 95 per cent. alcohol.

Cumol Catgut. This is prepared by first placing catgut in a hot-air oven at a temperature of 70° C. for two hours. It is then placed in cumol at a temperature of 165° C. for one hour. It should then be placed in petroleum benzine for permanent preservation.

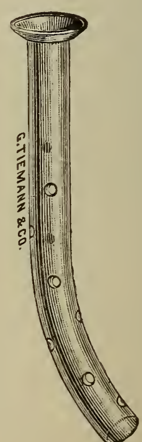
Chromicized Catgut. Owing to the fact that it undergoes very slow solution in the tissues, chromicized catgut is often of service for sutures or for the ligation of the larger vessels in their continuity. It may be prepared by placing catgut which has been sterilized by being treated with the alcoholic bichloride solution in one quart of a 5 per cent. carbolic acid solution which contains 30 grains of bichromate of potassium, allowing it to remain for forty-eight hours; this immersion should be longer when the larger sizes of catgut are used, but for the sizes of catgut which are ordinarily employed this length of immersion will prepare the gut to resist the action of the living tissues for a week or more. Catgut thus prepared may be dried and placed in closely stoppered jars, or may be kept in absolute alcohol. Before being used it should be soaked for thirty minutes in a 5 per cent. carbolic solution or a 1 : 2000 bichloride solution.

FIG. 116.



Rubber drainage-tube.

FIG. 117.



Glass drainage-tube.

A very simple method of carrying catgut and keeping it sterile consists in using a strong glass tube, about an inch in diameter and six inches in length, into each end of which is fastened a rubber cork. A number of glass spools wound with sterilized catgut of various sizes are fitted into this glass tube; one cork is introduced; the tube is then filled with alcohol or a 1 : 2000 bichloride solution in alcohol, and the other cork is introduced, or a test-tube and a rubber stopper may be used.

Drainage-tubes. The drainage-tubes usually employed are prepared from rubber-tubing of different sizes perforated at short intervals; the black rubber tubes are softer and more pliable than the red or white rubber tubes, and should be preferred (Fig. 116). Drainage-tubes are also made of glass, straight or curved (Fig. 117), which are almost exclusively used in abdominal surgery, and also of decalcified bone. Drainage-tubes should be kept in a 5 per cent. solution of carbolic acid, or, if kept dry, they should be well washed and sterilized by boiling water for a few minutes before being used.

Catgut and Horsehair Drainage. Catgut as ordinarily prepared for ligatures may be used to secure drainage in small and superficial wounds; a number of strands of catgut are placed in the bottom of the wound, and the ends are allowed to project from one or both extremities of the wound.

Horsehair may be employed for the same purpose, a number of strands of the hair being placed in the wound in the same manner. Before being used it should be well washed with soap and water and then soaked in a 5 per cent. carbolic solution or 1 : 1000 bichloride solution for thirty minutes.

Protective. Protective is employed to prevent the wound from being irritated by the antiseptic substances with which the gauze is impregnated or by its irregular surface. The great objection to the use of protective is that it sometimes interferes with drainage, and permits of the accumulation of serum beneath it, which may become infected and cause infection of the wound.

Various materials are employed as protectives, the principal requirement being that they are some tissue which can be readily rendered aseptic and does not absorb any irritating materials from the dressings.

The protective first employed by Mr. Lister, which is still generally used, is prepared by coating oiled silk with copal varnish, and when this is dry a mixture of 1 part of dextrine, 2 parts of powdered starch, and 16 parts of a 1 : 20 carbolic acid solution is brushed over its surface. Rubber-tissue may be employed very satisfactorily as a substitute for this protective.

Before applying the protective to the wound, it is soaked in a solution of bichloride of mercury or carbolic acid.

Silver Foil. The inhibitive action of metallic silver on the growth of micro-organisms is utilized in the employment of silver foil to cover the surface of wounds. The foil is sterilized by dry heat and placed directly on the surface of the wound after it has been closed by sutures. It is claimed that the foil prevents the infection of the wound from the exterior, and also destroys micro-organisms which may come in contact with it.

Mackintosh. This consists of cotton-cloth, with a thin layer of India-rubber spread on one side. It is employed in antiseptic dressings as the layer placed outside of the gauze, and should be applied with the rubber surface toward the wound, to prevent the entrance of air and to allow the serum from the wound to permeate the gauze and not soak directly through the dressings.

The mackintosh cloth is not at the present time as much employed as formerly, unless the moist method of dressing is adopted.

Rubber-dam. This is a thin, pure rubber-tissue, and as it has no cloth surface like mackintosh, it is cleaned and sterilized with greater facility. It is used in applying the moist method of dressing to cover the gauze dressings, and is attached to the drainage-tube in abdominal wounds to shut off the opening of the tube from the abdominal wound. Before being used it should be washed with soap and water, rinsed, and then placed in a bichloride or carbolic solution for a time sufficient to sterilize it.

Rubber-tissue. This consists of a very thin sheet of India-rubber with glazed surfaces, which can be obtained from the rubber-manufacturers; it is employed for the same purposes as the mackintosh, is much less expensive, and, as previously stated, may be used when properly sterilized instead of protective for covering the wound.

Gauze Dressings.

The most convenient and cheapest material for wound dressing is a material known to the trade as cheese-cloth or tobacco-cloth, and for surgical use should contain no sizing. From the fact that it has a very open mesh it absorbs well either the materials with which it is prepared or the discharges from the wound, and is soft and pliable, so that it is a comfortable form of dressing to the patient.

Bichloride or Corrosive Sublimate Gauze. Bichloride or corrosive sublimate gauze is prepared by placing cheese-cloth in a washing-kettle and covering it with water to which is added two pounds of washing soda or a pint of lye; the latter is added to remove any oily matter which the cheese-cloth contains, thus making it more absorbent. The gauze is boiled in this solution for an hour, and is then removed and washed in boiled water and passed through a sterilized clothes-wringer; it is then immersed in a 1 : 1000 bichloride solution for twenty-four hours; the excess of fluid is then squeezed out of it, and it may be packed in air-tight jars and preserved as a moist gauze, or may be dried in a warm oven and packed in sterilized jars and kept as a dry gauze.

In using the sublimate gauze on delicate skins there will sometimes result a dermatitis, which is known as mercurial eczema; this is particularly apt to occur if the gauze is moistened or covered with rubber-tissue or mackintosh. If this condition develops, the parts covered by the gauze should be rubbed over with boric acid ointment or vaseline before it is reapplied, or a sterilized gauze dressing should be substituted.

Iodoform Gauze. This may be prepared by soaking sterilized gauze in a mixture containing iodoform, 5 parts;

glycerin, 20 parts, and alcohol, 70 parts. This furnishes the 5 per cent. iodoform gauze; if 10 per cent. gauze is desired, the quantity of iodoform should be doubled. When the gauze is thoroughly saturated it should be of a uniform yellow color. It should then be thoroughly wrung out with sterilized hands to remove the alcohol, and packed in aseptic jars, with tight-fitting covers.

Iodoform gauze may also be prepared by saturating sterilized gauze with a mixture of ether and iodoform, and then allowing the ether to evaporate, the iodoform being distributed evenly through the gauze.

Carbolized Gauze. In preparing carbolized gauze, cheese-cloth which has been previously boiled and dried is soaked for a few hours in the following solution: resin, 1 pint; alcohol, 5 pints; castor oil, 24 ounces; carbolic acid, 12 ounces. The gauze is removed from this solution and passed through a sterilized clothes-wringer, and is then cut into pieces from four to six yards in length, which are folded and packed in air-tight jars for use.

Improvised Aseptic or Antiseptic Dressings. Aseptic dressings in cases of emergency may be improvised, where the ordinary gauze dressings cannot be obtained, by tearing a piece of muslin or mosquito netting into pieces half a yard square and throwing them into boiling water for a few minutes; they are then removed, the excess of moisture is wrung out of them, and they are applied to cover the wound.

If it is desirable, they may be used as antiseptic dressings by soaking them for a few minutes in a 1:1000 or 1:2000 bichloride solution, or in a 5 per cent. carbolic solution. This dressing will keep the wound aseptic until a more elaborate dressing can be obtained.

Aseptic or Antiseptic Bandages. Aseptic bandages are prepared by tearing or cutting gauze into strips from two and a half to three inches in width and forming these strips into rollers, which are sterilized by boiling or dry heat. They should be used soon after being prepared, or, if kept for any time, should be resterilized before being used.

Antiseptic bandages may be prepared from bichloride or carbolized gauze, but before being used, to render their sterilization more complete, may be soaked for a few minutes in a 1 : 1000 bichloride or a 5 per cent. carbolic solution.

Bichloride Cotton. This material is prepared by soaking absorbent cotton in a 1 : 1000 bichloride solution for twenty-four hours, and allowing it to dry, or it may be dried in a hot oven; when dry it is packed in jars or in air-tight boxes. Several layers of bichloride cotton are usually applied over the gauze dressing, as its great absorbing power and elasticity make it, when properly prepared, a most valuable dressing. Borated, carbolized, and salicylated cotton prepared in the same manner are also frequently employed for similar purposes.

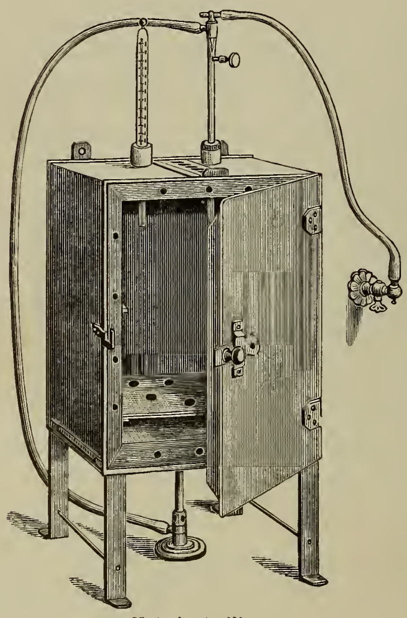
Sterilized Cotton. Sterilized cotton is prepared by placing absorbent cotton, enclosed in perforated metal cans, in a steam sterilizer and allowing it to remain for several hours. It is used for the same purposes in dressings as the bichloride cotton.

Moist Sterilized Gauze Dressings. Moist sterilized gauze dressings are prepared by subjecting gauze which has been boiled in soda solution to the action of boiling water or of steam for thirty minutes. Gauze thus treated should be used as soon as prepared.

Sterilized gauze may also be prepared by putting rolls or pieces of gauze, cut from eight to twelve inches square, into cylindrical tin boxes, three inches in diameter and eight inches in height, with perforated metal covers, and covering the gauze at each end of the cylinder with a layer of cotton before putting on the covers. The boxes should next be placed in a steam sterilizer for an hour or two, and when taken out may be kept with safety for some time if the cotton coverings are not disturbed. Cotton can be sterilized and kept in the same way.

Dry Sterilized Gauze Dressings. Dry sterilized gauze dressings are prepared by cutting gauze into proper lengths and packing it loosely in wire cages or perforated metal cans, which are next placed in a dry sterilizing-oven for several hours, and upon removal it is placed in air-tight jars or metal boxes. In using sterilized gauze dressings it is safer to have the dressings freshly sterilized immediately before each operation. A convenient form of sterilizing-oven is shown in Fig. 118. Towels and operating-gowns can be sterilized in the same oven.

Fig. 118.



Hot-air sterilizer.

Surgical Operating-bag. For operations in private practice the surgeon will find it convenient to have a bag or kit containing gauze dressings, bichloride pellets, carbolic acid, alcohol, turpentine, ligatures, sutures, needles, syringes, a metal tray in which instruments can be boiled, a nest of agate-ware basins, sponges, gauze pads, a sheet of rubber cloth, drainage-tubes, and operating-gown. These can all be packed in a comparatively small space, and when the surgeon is called upon to perform any special operation at short notice the instruments required may be selected, wrapped in a Canton-flannel scroll, and placed in the bag. Much time will be saved by having the materials required in operations always in readiness in such a bag.

METHODS AND DRESSINGS EMPLOYED IN THE TREATMENT OF WOUNDS TO SECURE ASEPSIS.

To prevent infection of wounds the various chemical sterilizers and dressings are employed in different ways, and the principal types of dressings are as follows:

Method by Simple Drying. This method is employed in small and not very deep wounds. The edges having been brought together by sutures the surface of the wound is dusted with powdered iodoform, the serum and blood forming with this, as it dries, a scab, which protects the wound from infection from without, and repair takes place promptly under this scab. Treves employs this method of dressing in compound fractures. A pledget of gauze saturated with iodoform-collodion or tr. benzoin, ʒij; collodion, ℥vj, may be employed instead of powdered iodoform in this method of dressing. Dry sterilized gauze and cotton dressings may also be employed in this method of dressing.

Method by Drying and Chemical Sterilization. The object of this method of dressing is to provide a means of sterilizing the blood or serum which escapes from the wound, and at the same time to insure the sterilization of the air coming in contact with the discharges of the wound. It is employed in large or deep wounds, where there is always more or less escape of blood or serum, and is accomplished by applying a number of layers of sublimate or iodoform-gauze and sublimated cotton over the wound. Evaporation not being interfered with, the whole dressing becomes hardened, and the wound is surrounded by a large antiseptic crust made up of the dressing and serum or blood.

Moist Dressings. In this method of dressing the wound is covered by layers of moist antiseptic gauze, which are kept moist and evaporation prevented by applying over them some impervious material, such as mackintosh or rubber-tissue.

Modified Moist Dressing. In using this method the wound itself is covered by a piece of protective or rubber-tissue; over this is placed the sublimated or iodoform-gauze dressing and some layers of bichloride cotton. In this way the wound itself is kept in a moist condition favoring particularly the organization of blood-clots; the external dressings become dry as the discharges which have escaped into them evaporate, forming an antiseptic crust or covering over the wound.

Preparation for Aseptic Operation.

Preparation of Room for Operation. In hospital practice suitable operating-rooms are provided; in private practice, however, the surgeon is often called upon to select a room and give directions as to its preparation. A well-lighted room should always be selected, and all unnecessary articles of furniture, such as ornaments, pictures, and curtains, should be removed. The carpet should be taken up, and the floor scrubbed. A few small tables and a large wooden table should be placed in the room, having previously been dusted and wiped off with a bichloride solution. All preparations should be made, if possible, upon the day before the operation, as the stirring up of dust incidental to the change in furniture in cleaning the room on the day of operation immediately before the time set is more dangerous than no cleaning of the room whatever, since the principal contamination of the wound is likely to come from germs contained in the dust. In case of emergency the floor may be well moistened by sprinkling with water to lay the dust. The preparation of the room is not, in my judgment, a matter that affects the results of operations as much as does the exercise of great care in regard to aseptic details of the operation itself.

Preparation of the Patient for Aseptic Operation. The patient should be given a general bath the night before the operation, and the skin surrounding the site of operation should be rubbed over with cotton saturated with spirits of turpentine, and should then be thoroughly scrubbed with a brush and soap and water; or a soap poultice may be applied to the part for a few hours before the final sterilization with alcohol and bichloride is made. In scrubbing the skin a soft brush should be used, since too forcible scrubbing may cause irritation or dermatitis. After this scrubbing has been continued for a few minutes the skin is washed with alcohol, and if turpentine has not been used it is better to rub the skin over with ether, then wash it with sterilized water and apply to the surface a folded towel or gauze dressing saturated with a 1 : 1000 bichloride solution; or if a moist dressing is uncomfortable to the patient, a few layers of sterilized gauze should be placed over the surface and held in place by a bandage. A similar washing and preparation of the seat of operation should be made upon the next morning, a few hours before the time fixed for operation.

The skin may also be sterilized by formalin. It should first be thoroughly scrubbed with soap and water, and then a few layers of gauze saturated with a 1 per cent. solution of formalin should be laid over it and covered by an impermeable dressing. The solution should be kept in contact with the skin for twenty-four or thirty-six hours, the compress being changed every twelve hours.

It is well to remember that regions of the body which contain hair and numerous sweat-glands, such as the axilla, navel, scrotum, groin, and the creases about the joints, are those in which micro-organisms grow with the greatest activity. All the surrounding hair should be shaved off, and if the operation be upon the skull it is well to shave the scalp completely.

Sterilization of the Feet. The feet should be thoroughly washed with soap and water and scrubbed vigorously with a brush; or a soap poultice should be applied to the whole surface of the feet for some hours and held in position by a bandage. A moist dressing favors the separation of the superficial layers of the epidermis, and after it has been worn for a few hours it is possible to remove a large amount of the latter by the use of the brush. After having been thoroughly washed with a 1 : 1000 bichloride solution they should be wrapped in a towel or a few layers of gauze saturated with bichloride of mercury solution, 1 : 1000.

Sterilization of the Vagina. According to Schimmelbusch, the best method of sterilizing the vagina is to scrub it thoroughly with pads of gauze saturated with green soap and water, and after this cleansing, to irrigate it with a 1 : 2000 bichloride solution or a 1 per cent. solution of kreolin.

Sterilization of the Bladder. It is impossible to employ any method that will sterilize completely the mucous membrane of the bladder. The best means we have at our disposal at the present time of sterilizing the mucous membrane of the bladder consists in irrigating the organ frequently with a 10 grain to the ounce solution of boric acid in boiled water.

Sterilization of the Rectum. When an operation is to be performed upon the anus and rectum the patient should be given a purgative and an enema some hours before the operation, to remove any fecal matter which may be in the rectum. The region of the anus should be disinfected with soap and water and thoroughly scrubbed, and after the patient has been anæsthetized the sphincter should be well stretched and the rectum irrigated with a boric-acid solution. A tampon of sterilized gauze, with a string attached, should be packed into the rectum above the seat of operation, to prevent the wound from becoming soiled with feces during the operation. The tampon can be removed by means of the string after the operation has been completed.

Sterilization of Instruments. The sterilization of instruments can be accomplished by dry or moist heat; they can be placed in a hot-air sterilizer or baked for twenty minutes in a hot oven. Sterilization of instruments by dry heat or baking is not often employed, as it is apt to spoil the temper of the steel. Instruments may be sterilized by the method suggested by Schimmelbusch, now almost universally employed, which consists in boiling them for fifteen minutes in water to which a tablespoonful of washing soda (carbonate of sodium) has been added for each quart of water; this prevents the rusting of the instruments, and also makes the water a better solvent for any fatty matter which may be upon the instruments, thus increasing the sterilizing effect of the heat. If wooden-handled instruments are used, which would be injured by boiling, they should first be thoroughly scrubbed with soap and water and a brush, and after having been rinsed in sterilized water they should be placed in a tray and covered with 1 : 20 watery solution of carbolic acid, and allowed to remain in this solution for at least half an hour; before being used they should be transferred to a solution of sterilized water, which will prevent the benumbing effect of the carbolic solution upon the surgeon's hands.

Instruments may also be sterilized by formalin; the latter is generated by heating pastilles of paraform with Schering's formalin lamp. The instruments are placed in racks in a metal case, and by burning from 10 to 15 grains of paraform the instruments may be rendered sterile in fifteen minutes.

Instruments which fall upon the floor or come in contact with the clothing of the surgeon or of the patient during the operation, should be again sterilized before being brought in contact with the wound.

Sterilization of the Hands. The hands of the surgeon, unless properly sterilized, may be the most efficient agents in producing infection of the wound; the region of the *finger-nails* and the *interdigital folds* are locations where germs are particularly abundant. The hands and forearms of the surgeons, assistants, and nurses who are to take part in the operation may be sterilized by first rubbing them with spirit of turpentine, and then thoroughly scrubbing them with Castile soap and water, using a nail-brush freely.

Care should be taken that the brush is sterilized. This scrubbing should be employed for several minutes; the hands are then rinsed to removed the soap, and are soaked for two minutes in a 1 : 1000 bichloride of mercury solution. If turpentine has not been employed before washing with the soap, strong alcohol or ether should be well rubbed over the hands before they are immersed in the bichloride solution. When the hands have been sterilized they should not be brought in contact with anything that is not sterile.

A method of sterilizing the hands which is very satisfactory is that employed by Kelly, which consists in washing the hands and forearms with soap for ten minutes, and then covering them with a warm saturated solution of *permanganate of potassium*, which stains them a deep mahogany color; they are then washed in a warm saturated solution of *oxalic acid* until all the permanganate stain is removed, and should next be washed in sterilized water to remove the oxalic acid which may adhere to the skin.

Weir recommends the following method of sterilizing the hands. After washing them with green soap, put a tablespoonful of commercial chloride of lime and an equal amount of carbonate of sodium (washing soda) in the hand, with enough water to make a paste. Rub this into a thick cream, which should be rubbed into the hands until the grains of lime disappear and the skin feels cool. The hands are then rinsed in sterile water.

Rubber or Cotton Gloves. Rubber gloves, which may be sterilized by washing with soap and water and immersion in a 1 : 1000 solution of bichloride of mercury or by boiling, have recently been employed by surgeons to avoid infection of wounds from the hands, as they can be rendered much more sterile than the skin of the hands. In operations upon septic or infected wounds, the use of rubber gloves protects the surgeon from infection, in case wounds or abrasions are present upon his hands. They interfere, however, with tactile sensation, and in delicate operations their employment is not satisfactory.

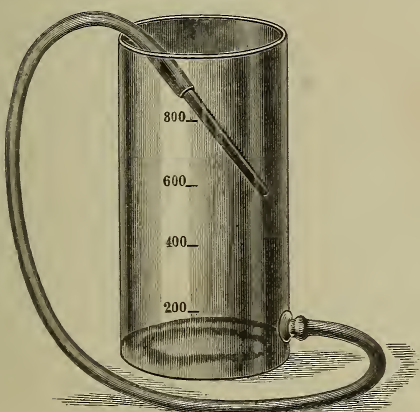
Cotton or *silk* gloves, which have been sterilized by boiling or by dry heat, have been recommended by Mikulicz and other surgeons, to be worn during operations. Experiments, however, have shown that cotton or silk gloves are not as safe as those made of rubber.

Clothing of Surgeon and Assistants. The surgeon and his assistants should wear sterilized linen or muslin suits, or be provided with gowns with sleeves reaching to the elbows, for the protection both of the patient and of their clothing. The operating-gown should be made of muslin or linen, which can easily be sterilized by boiling or heat; a variety of linen known as butcher's linen is very serviceable for this purpose. As a matter of additional precaution, many surgeons and their assistants wear during the operation closely fitting skull-caps of linen, and wear over the nose and mouth a pad composed of a number of layers of sterilized gauze to prevent infection of the wound by the expired air. The surgeon and assistants will often find it conventent to wear under their linen gowns India-rubber aprons, to prevent the soiling of the clothing by blood or solutions. The nurses should wear sterilized linen or muslin operating-gowns and dresses of washed goods. An operating-apron may be improvised from a clean sheet folded so as to be one and a half yards in width and from five to six feet in length, by turning in about ten inches of one end of the sheet over the upper part of the chest and placing a strip of bandage in this fold, which should be secured around the neck, and tied by a second strip of bandage over the sheet at the waist.

Details of an Aseptic Operation. The patient being prepared for operation as described, and having been anæsthetized, is placed upon the operating-table, the surgeon, assistants, and nurses also being prepared for the operation as previously described. If the operation be one upon the face, neck, or chest, it is well before the dressings covering the seat of operation are removed to cover the patient's hair with a towel or handkerchief bandage made of several layers of sterilized or bichloride gauze. The portions of the patient's body which it is not necessary to expose in the operation should be covered with a woollen blanket, and this covered with a sterilized sheet. Some surgeons prefer to have the patient wear a *sterilized gown*, which is ripped or cut to expose the part to be operated upon. The region of the wound and the operating-table are next protected with sterilized towels or cloths. The surgeon having assigned the assistants and nurses their duties, the dressing is removed from the part to be operated upon, and the operation is begun. Hemorrhage is controlled during the operation by the use of hæmostatic forceps, and sterilized gauze pledgets are employed to keep the wound free from blood. When the operation is completed, the vessels are ligated, the hæmostatic forceps are removed, and the wound is dried with gauze pledgets. If, for any reason, the surgeon deems it advisable to irrigate the wound, it may be done with hot sterilized water or with sterilized salt solution. If the surgeon decides that drainage is not necessary, the deeper parts of the wound may then be brought together by buried sutures of catgut or silk, and the edges of the superficial wound next approximated by sutures of catgut, silk, or silkworm-gut. If the surgeon decides to use drainage, before closing the wound, a few strands of catgut, a strip of sterilized gauze, a tent of rubber tissue, or a rubber drainage-tube is introduced into the deepest portion of the wound and brought out at its most dependent part. The wound is then dressed with a number of loose masses of sterilized gauze placed so as to cover the wound and extend beyond it in all directions, and these are covered by a number of layers of sterilized gauze. Over the gauze dressing are placed a few layers of sterilized cotton, extending on all sides well beyond the gauze, and the dressings are held in place by a sterilized gauze bandage. The dressings should be voluminous; it is always a mistake to apply scanty dressings. In redressing the wound the same care should be exercised as regards asepsis as was observed at the primary dressing.

Details of an Antiseptic Operation. The region of the wound being previously sterilized and the patient being anæsthetized and placed upon the table, the clothing is so arranged as to expose freely the part to be operated upon; the clothing or the skin surrounding this region is next covered with towels wet with a 1 : 1000 bichloride solution. If any considerable surface of the patient's body is covered by these towels, to avoid chilling the surface and adding to the shock which naturally follows the operation, they should be wrung out in a hot bichloride solution, and should be replaced as they become cold by hot towels prepared in the same manner. The patient being ready for

FIG. 119.



Irrigating apparatus. (ESMARCH.)

operation, the surgeon should assign the assistants and nurses their duties, and having previously sterilized their hands and forearms, and again immersed them in the bichloride solution, the operation is begun.

During the operation the wound is irrigated frequently with a 1 : 2000 bichloride solution, which may be allowed to run over the wound, or be applied by means of a syringe or irrigating apparatus (Fig. 119), and the hands of the surgeon and assistants should also be washed in this solution at not too long intervals. In prolonged operations, or in those in which a large wound is made, I think it is especially important that the irrigating solutions should be used as warm as can be comfortably borne by the hands of the surgeon; warm solutions, it has been shown by recent investigations, possess a greater germicidal power than those of the same strength when used cold, and they also possess the advantage of preventing the chilling of the patient, and thus diminish the shock of the operation.

Hemorrhage during the operation is controlled by the use of hæmostatic forceps, which are applied to the bleeding vessels, or the vessels may be ligatured as they are divided. After the operation has been completed, and all hemorrhage has been controlled, the wound is thoroughly irrigated with a 1 : 2000 bichloride solution.

The next step is to provide for drainage; this may be disregarded in small superficial wounds, but in a wound of any considerable size or depth it is safer to provide free drainage. This is accomplished by the use of perforated rubber drainage-tubes, or a number of strands of catgut, or strips of iodoform or bichloride gauze.

The rubber tube may be laid in the wound, the ends being allowed to extend from the extremities of the wound, or it may be so introduced that one end of the tube rests in the deepest part of the wound and the other extremity is brought out of the wound at its most dependent portion; in large or irregularly shaped wounds a number of tubes may be required to secure free drainage. The ends of the drainage-tubes are transfixed with safety-pins which have been sterilized and should next be cut off close to the pins so as to be as nearly as possible flush with the skin.

The wound being closed by sutures, a final irrigation of its deepest parts should be made, by injecting a stream of bichloride solution, 1 : 2000, into the end of the drainage-tube. The external surface of the wound and the skin for some distance surrounding it should next be washed with a 1 : 2000 bichloride solution, and a piece of protective, a little longer and wider than the wound, is next dipped in a bichloride or carbolic solution and placed over it. The use of this strip of protective over the wound is only important if it is desired to keep the wound moist, in order to obtain organization of the blood-clot, otherwise it need not be employed. Over this is laid the deep dressing, which consists of a pad of bichloride gauze from eight to sixteen layers in thickness, and large enough to overlap the wound two or three inches in all directions. This should be dipped in a 1 : 2000 bichloride solution, and wrung out as dry as possible before being applied. The superficial gauze-dressing is next applied, and consists of sixteen layers of gauze, which should be large enough to extend from three to six inches beyond the wound in all directions; this gauze is applied dry. Over the superficial gauze-dressing there is next applied a number of layers of bichloride cotton, so arranged as to extend a little beyond the margin of the superficial gauze-dressing. These dressings are next secured in position by the application of a gauze bandage, which is prevented from slipping by the introduction of a few safety-pins.

Iodoform, carbolized, or any other variety of medicated gauze, may be used in the place of the bichloride gauze in this method of dressing.

In this method of dressing no mackintosh or rubber-tissue is employed, outside of the superficial gauze-dressing; the discharges from the wound are disseminated through the dressing and become dry by evaporation, and the dressing forms an antiseptic scab which covers and surrounds the wound.

Moist Method of Dressing. If, for any reason, it is desired to adopt the moist method of dressing, a piece of mackintosh or rubber-tissue larger than the superficial gauze-dressing is placed over it, and over this are placed a few layers of bichloride-cotton, care being taken to see that the layers of cotton overlap the mackintosh or rubber-tissue by a few inches; the application of an antiseptic gauze-bandage then completes the dressing. On the removal of this dressing the gauze will be generally found to be soaked with the discharges from the wound, and in a moist condition. The disadvantage of this variety of dressing is that there is apt to be more irritation of the skin set up by the bichloride-gauze when kept moist than when applied in the manner of a dry dressing.

Redressings of the Wound. The redressing of a wound which remains aseptic need not be made for some days; if the temperature remains normal or a little above this point, and the patient exhibits no unfavorable constitutional symptoms, and the dressing is comfortable to the patient, it need not be disturbed for a week or ten days; at the expiration of this time it is well to examine the wound and to remove the drainage-tube if drainage has been used, and to remove a portion or all of the sutures if the superficial parts of the wound are firmly healed.

In redressing a wound in which the *antiseptic method* was employed, at the end of a week or ten days, to prevent any possible infection, as much care should be exercised as in the original dressing of the wound. The patient's clothes should be removed so as freely to expose the dressing, and a rubber cloth should be placed under the patient so as to protect the bed, and the clothing and skin in the region of the wound should be protected by towels wrung out in a 1 : 1000 bichloride solution. The surgeon should wash his hands and immerse them in a 1 : 1000 bichloride solution before removing the dressings. The bandage retaining the dressing should be divided with bandage-scissors and the gauze should be removed layer by layer, and when the deep dressing is removed care should be taken to see that the drainage-tubes are not pulled upon if they are adherent to the dressing; the protective should next be removed, and the surface of the wound should be irrigated with a 1 : 2000 bichloride solution. If the wound is found aseptic, the drainage-tube may be removed, and the superficial wound should next be irrigated with bichloride solution. If the wound is healed, the sutures may be removed at this dressing; but if the wound has been an extensive or deep one, it may be well to remove only a portion of the sutures; if catgut sutures have been employed, they need not be removed. The surface of the wound is next irrigated with a 1 : 2000 bichloride solution, and deep and superficial gauze dressings are applied as previously described, and covered with layers of bichloride-cotton, and the whole dressing is secured by the application of an antiseptic bandage. If the wound remains aseptic, the dressings need not be changed for a week or ten days, and at this time the wound will usually be found healed, so that further dressings are not required.

In the redressing of a wound in which the *aseptic method* was employed, the use of germicidal solutions is omitted, and the wound is redressed with sterilized gauze and cotton.

If, however, the wound is not running the typical course of an aseptic wound, constitutional symptoms will be developed, as evidenced by a rise in the temperature and pulse-rate and other constitutional disturbances. In this event the wound should be redressed as soon as possible, and if the cause of the disturbance can be found, it should be removed; for instance, hemorrhage may have taken place into the wound, and the blood not being able to escape through the drainage-tubes may have caused so much distention of the wound that the vitality of the skin covering the wound is threatened, or the sutures may be found to be causing irritation, or suppuration may be found to be present.

If, on exposure of the wound, it is found that it is distended with blood-clots and blood is escaping from the wound, the sutures should be removed, the clots should be turned out, and the bleeding vessel or vessels should be sought for and ligatured, and the wound, after a thorough irrigation with 1 : 2000 bichloride solution, should be drained and closed with sutures, and dressed as previously described.

If, however, on exposure of the site of the operation, and upon the removal of a portion or all of the sutures, the wound is found distended with a blood-clot, and no evidence of hemorrhage at the time exists, or of suppuration in the wound, the clot may be allowed to remain in place, and the wound should be redressed as in the original dressing, trusting to the organization of the blood-clot if it has remained aseptic. If the patient's condition improves after the dressing, and the temperature and pulse-rate become normal, it is an indication that the wound is still aseptic, and it need not be redressed for some days.

If, on the other hand, examination of the wound shows that the drainage is insufficient, or that the drainage-tubes are occluded by blood-clots, these should be removed by washing out the tubes with a 1 : 2000 bichloride solution by means of a syringe, and introducing additional drainage-tubes, if it is deemed necessary; the wound should then be redressed.

When it is found on examination of the wound that suppuration is present, it should be thoroughly irrigated through the drainage-tubes with a 1 : 2000 bichloride solution, and after thorough irrigation it should be redressed, and, if the patient's constitutional symptoms improve, it may be assumed that the wound has been rendered aseptic.

Aseptic or Antiseptic Treatment of Infected Wounds. It often happens that the surgeon is called upon to treat a wound which is septic when it comes under his care, as evidenced by the inflamed state of the wound, inflammation of the lymphatic vessels and skin, foul discharges and sloughing of the tissues, and the coexistent constitutional symptoms of sepsis. In such a case it would at first sight appear that the surgeon or his assistants could not introduce any material of infection worse than that which already existed in the wound, but he should bear in mind the fact that it is possible to introduce a new form of infection in addition to that already existing. With this possibility in view he should observe the same precautions as regards the sterilization of his hands, the region of the wound, the instruments, and dressings, as he would employ in treating a perfectly fresh wound.

Recent investigations, however, have shown that the germs in abscesses are to a great extent dead, and that the pus-formation is largely due to the irritation caused by their products. In view of these facts, it would seem that the most important part of the treatment of infected wounds is thorough drainage. It is a question whether the micro-organisms in the walls of infected cavities or sinuses can be destroyed by antiseptic irrigation. Some surgeons recommend active treatment, both mechanically and by the use of germicidal solutions, while others are satisfied simply to secure free drainage, and if irrigation is necessary they do not employ strong germicidal fluids, but use simply sterilized water or sterilized salt solution. I prefer to employ the antiseptic method in dealing with infected wounds, and can recommend the following plan. The skin surrounding the wound for some distance should be wiped over with spirits of turpentine and carefully scrubbed with soap and water, and should next be washed with a 1 : 1000 bichloride solution; the wound itself should next be washed with peroxide of hydrogen and a 1 : 1000 bichloride solution. With forceps and curette any dirt or sloughing tissue should be removed; then the wound again washed with peroxide of hydrogen and douched with a 1 : 2000 bichloride solution. The wound should then be dried with gauze pledgets and dusted with iodoform and loosely packed with strips of iodoform gauze. If from the appearance of the tissues the surgeon has reason to think that the infection has passed beyond the reach of the curette or scissors, he may swab the surface of the wound over with a solution of chloride of zinc, 30 grains to the ounce of water. Pure carbolic acid may be used, and is recommended by some surgeons, for the same purpose as chloride of zinc, but the toxic action of carbolic acid causes its employment to be attended with some danger. Free drainage being secured by the introduction of a few strips of iodoform gauze, the wound is dressed with a voluminous dressing of bichloride gauze and bichloride cotton. No attempt, as a rule, should be made to bring together the edges of such a wound by the introduction of sutures. In the dressing of infected wounds, when the discharges are ropy or viscid they are not well absorbed by dry dressings, and in this class of wounds it is, therefore, often of advantage to employ moist antiseptic dressings. By this method of treatment it is often possible to convert a septic wound into an aseptic one, and have rapid improvement follow both in the local condition of the wound and in the constitutional condition of the patient.

MATERIALS USED IN SURGICAL DRESSINGS.

Lint. This material is employed in surgical dressings, and is of two varieties: the domestic lint, which consists of pieces of old linen or muslin which have been thoroughly washed or boiled and then dried, or the surgical lint which resembles Canton flannel in appearance; the latter is the best material, as it has a greater absorbing capacity.

Lint is used as a material on which unctuous preparations are spread in the dressing of wounds, and is also employed as a material for saturating with the various solutions which are used in wet dressings, such as lead-water and laudanum; the lint, after being saturated with the solution, is covered with rubber-tissue or oiled silk when applied, to prevent too rapid evaporation of the solution. It is also one of the best materials from which to construct the compresses employed in the treatment of fractures.

Paper-lint. This is made from old rags or wood pulp, has great absorbing power for fluids, and may be used as a substitute for surgical lint in the application of wet dressings to surfaces when the skin is unbroken.

Oakum. This material, made from old tarred rope, was formerly much employed in the dressing of wounds before the introduction of the antiseptic method of wound-treatment. From its elasticity it is found to be an excellent material for padding splints or other surgical appliances. It is also employed in the form of pads to place under patients to relieve portions of the body from pressure, or to absorb discharges which soak through the dressings. A mass of oakum which has been well teased out and wrapped in a towel forms an excellent pillow on which to support a stump.

Cotton. Cotton is now employed in surgical dressings principally as a material to pad splints or to relieve salient parts of the skeleton from pressure in the application of splints or bandages; for instance, in the application of the plaster-of-Paris bandage, the bony prominences are generally covered by small masses of cotton; it possesses but little absorbent power unless used in the form of absorbent cotton, and is not much employed in surgical dressings except for the purposes mentioned above.

Absorbent Cotton. This material is prepared from ordinary cotton, which is boiled with a strong alkali to remove the oily matter which it contains. When so prepared it absorbs liquids freely, and by reason of its great absorbing capacity it is largely employed in surgical dressings. A small mass of sterilized absorbent cotton wrapped upon the end of a probe is now generally employed to make applications to wounds, and has taken the place of the sponge or brush which was formerly employed for this purpose. On account of its cheapness, after one application it can be thrown away and a new piece can be used, and thus the danger of carrying infection from one wound to another by the applicator is abolished. It is largely employed in gynecological practice for making applications to the female genital organs.

It may be impregnated with various antiseptic substances, such as the bichloride of mercury, carbolic acid, boric acid, and salicylic acid, and when thus treated forms the *bichloride*, *carbolized*, *borated*, and *salicylated cotton* so much employed in antiseptic dressings.

Wood-wool. Wood-wool made from wood-pulp, such as is employed in the manufacture of paper, is also furnished in the shape of lint, sponges, and pads, and may beused for the same purposes as the ordinary surgical lint.

Oiled Silk or Muslin. These materials are employed as an external covering for moist dressings to prevent rapid evaporation from the dressings; they form excellent materials for this purpose, but as they are quite expensive their use is limited.

Waxed or Paraffin Paper. This dressing is prepared by passing sheets of tissue-paper through melted wax or paraffin, and then allowing them to dry. Paper thus treated forms an excellent and cheap substitute for oiled silk or muslin, and may be employed for the same purpose for which the latter materials are used.

Rubber-tissue. This material, which is prepared by rubber manufacturers, consists of rubber run out into very thin sheets. It has a glazed surface, is very pliable, and at the same time strong, forming, therefore, a cheap and satisfactory substitute for oiled silk, and is employed for the same purposes.

Parchment Paper. This paper is prepared so as to render it water-proof; it is employed in surgical dressings for the same purposes as oiled silk and rubber tissue.

Compresses. Compresses are prepared by folding pieces of lint, muslin, linen, or gauze upon themselves, so as to form firm masses of variable sizes; oakum or cotton may also be used to form compresses. Compresses are employed to make pressure over localized portions of the body, as in the treatment of fractures, or to make pressure upon vessels for the control of hemorrhage.

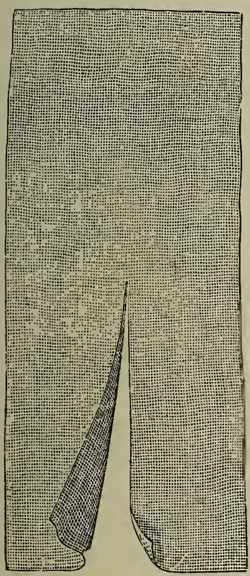
Tampon. A tampon is a form of compress which is employed in cavities to make pressure, to control hemorrhage, or to apply various solutions or powders to the surface of the cavity. Tampons used to control hemorrhage are generally made of strips of bichloride, iodoform or sterilized gauze. In applying these, the strips of gauze are packed into the cavity, and when the latter is full a compress is applied superficially and held in place by a bandage. The application of a tampon to the vagina is a favorite method of controlling uterine hemorrhage.

Glycerin Tampon. This is made by pouring half an ounce of glycerin on a piece of cotton or wool, and then turning up the ends and securing them by a string, one end of which is allowed to remain long enough to hang from the vagina, to facilitate its removal; it is a favorite application to the os uteri.

Tent. This consists of a small portion of lint, oakum, muslin, or sterilized or antiseptic gauze rolled up into a conical shape, which is employed to keep wounds open and to facilitate the escape of discharges.

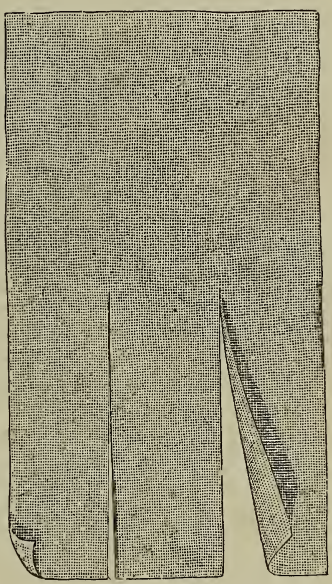
Retractors. Retractors are made by taking a piece of muslin four inches wide and twelve to eighteen inches in length and splitting it as far as the centre, thus making a *two-tailed retractor* (Fig. 120). A *three-tailed retractor* is made in the same way, except that the muslin is slit twice instead of once (Fig. 121). Retractors are used to retract the soft parts in amputation, to prevent their injury by the saw in the division of the bones. When one bone is sawed a two-tailed retractor is used, and when two bones are sawed a three-tailed retractor is employed.

Fig. 120.



Two-tailed retractor.

Fig. 121.



Three-tailed retractor.

Plasters. The varieties of plaster which are most commonly employed in surgical dressings are *adhesive* or *resin plaster, isinglass plaster* and *rubber adhesive plaster.*

Before using any of these plasters upon parts which are covered by hairs, the latter should be removed by shaving, otherwise traction upon them, if the plaster be used for the purpose of extension, will cause the patient discomfort, and unnecessary pain will also be inflicted at the time of its removal.

Resin Plaster. This plaster, which is machine-spread, is one of the most widely employed plasters in surgical dressings ; the spread surface is covered with a layer of tissue-paper, which should be removed before it is used ; it is cut into strips of the required width and length, and the strips should be cut lengthwise from the roll of plaster, as the cloth upon which it is spread stretches more transversely than in a longitudinal direction. When heated and applied to the surface it holds firmly; it is prepared for application by applying the unspread side to a vessel containing hot water, or it may be passed rapidly through the flame of an alcohol lamp.

This is the variety of plaster which is generally used in making the extension-apparatus for the treatment of fractures, for strapping the chest in fractures of the ribs and sternum, for strapping the pelvis in cases of fractures of the pelvic bones, and for strapping the breast, the testicle, ulcers, or joints.

Swan's-down Plaster. This plaster is much the same as resin plaster, but is spread upon a heavier material, and is an excellent plaster to use for an extension-apparatus, where it is to be worn for a long time.

Rubber Adhesive Plaster. This plaster is made by spreading a preparation of India-rubber on muslin, and has the advantage over the ordinary resin plaster that it adheres without the application of heat. It is employed for the same purpose as resin plaster, but when applied continuously to the skin it is apt to produce a certain amount of irritation, and for this reason when it is to be continuously applied for some time, as in the case of an extension-apparatus, it is not so comfortable a dressing as that made from resin plaster.

Isinglass Plaster. This plaster is made by spreading a solution of isinglass upon silk or muslin, and it has been found a most useful dressing in the treatment of superficial wounds. It is made to adhere to the surface by moistening it, and when used in the treatment of wounds it should be moistened with an antiseptic solution. The best variety is spread on muslin, and when properly applied adheres as firmly and possesses as much strength as the ordinary resin plaster.

Soap Plaster. Soap plaster for surgical purposes is prepared by spreading *emplastrum saponis* upon kid or chamois.

It is not employed for the same purposes as the resin or rubber plaster, as it has little adhesive power, and is used simply to give support to parts or to protect salient portions of the skeleton from pressure. It is found to be a most useful dressing when applied over the sacrum in cases of threatened bedsores, and may be applied for the same purpose to other parts of the body where pressure-sores are apt to occur.

In the treatment of sprains of joints a well-moulded soap-plaster splint secured by a bandage will often be found a most efficient dressing, and in the treatment of fractures the comfort of the patient is often materially increased by applying small pieces of soap plaster over the bony prominences, upon which the splints, even when well padded, are apt to make an undue amount of pressure.

Strapping.

This consists in applying pressure to parts by means of strips of plaster firmly applied; it is a procedure often employed in surgical practice.

Strapping the Testicle. In strapping the testicle strips of resin plaster are usually employed; a dozen or more strips one-half an inch wide and twelve inches in length will be required.

The scrotum should be first washed and shaved, and the surgeon next draws the skin over the affected organ tense by passing the thumb and finger around the scrotum at its upper portion, making circular constriction; a strip of muslin is passed in a circular manner around the skin of the scrotum above the organ, and is tightly drawn and secured by passing around it a strap of plaster which has been heated; this isolates the part and prevents the other straps from slipping. Straps are now applied in a longitudinal direction, the first strap being fastened to the circular strap and carried over the most prominent part of the testicle, and then carried back to the circular strap and fastened. A number of these straps are applied in an imbricated manner until the skin is covered (Fig. 122), and the dressing is completed by passing transverse straps around the testicle from its lowest portion to the circular strap; care should be taken to see that no portion of the skin is left uncovered.

FIG. 122.

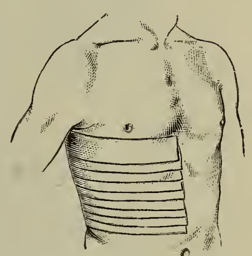
Strapping the testicle. (SMITH.)

Strapping the testicle is employed with advantage in the subacute stage of orchitis or epididymitis; as the swelling of the testicle diminishes the straps become loose, and the part will require re-strapping. It will also be found a useful means of applying pressure to the scrotum after the injection-treatment of hydrocele.

Strapping of the Chest. To strap one-half of the chest, strips of resin plaster two and a half inches wide, and long enough to extend from the spine to the median line of the sternum, are required—eighteen to twenty inches in length. . The first strap is heated and one extremity is placed upon the spine opposite the lower portion of the chest; it is then carried over the chest, and its other extremity is fixed upon the skin in the median line of the sternum. Straps are next applied from below upward in the same manner, each strap overlapping one-third of the preceding one, until the axillary fold is reached (Fig. 123); a second layer of straps may be applied over the first, if additional fixation is desired, or a few oblique straps may be employed.

Adhesive straps applied in this manner very materially limit the motion of the chest-wall upon the affected side, and are frequently employed in the treatment of fractures and dislocations of the ribs, in contusions of the chest, and in cases of plastic pleurisy when the motions of the chest-wall are extremely painful to the patient.

Fig. 123.



Strapping the chest.

Strapping of Ulcers. To strap ulcers of the leg, strips of resin plaster one and a half inches wide, and long enough to extend two-thirds of the distance around the limb, are required. The ulcer should be thoroughly cleansed, and the skin surrounding it should be well dried; the first strap, being heated, is applied transversely to the long axis of the leg about two inches below the ulcer, and is carried two-thirds of the distance around the limb; another strap is applied to a corresponding point of the skin above this one, so that it overlaps one-third of the strap first applied, and it is carried two-thirds of the way around the limb. Additional straps are thus applied until the ulcer is covered in, and the straps are carried several inches above the ulcer. (Fig. 124.) Strapping of ulcers may also be accomplished by using narrow straps of plaster one and a half inches in width. The ends of two straps are placed upon the limb some distance below the ulcer and the straps are brought up and made to cross each other so as to draw the tissues toward the point of crossing; a number of imbricated straps are applied in this way until the parts are sufficiently covered in and supported (Fig. 125). Care should be taken to see that the straps are so applied as not to meet or cover the entire circumference of the limb, as by so doing injurious circular compression might result.

Chronic ulcers upon other portions of the body may be strapped in the same manner.

Strapping of leg ulcers is usually reinforced by the application of a firmly applied spiral reversed or spica-bandage of the lower extremity.

Fig. 124.

Strapping an ulcer of the leg.

Strapping of ulcers of the leg applied in the manner described will be found a most satisfactory method of treating chronic ulcers in this location in patients who have to work during the course of treatment; the straps need only be removed at intervals of a week, and if well applied, the dressing is generally a comfortable one to the patient.

FIG. 125.

Strapping an ulcer of the leg.

Strapping of Joints. Strips of resin plaster two inches in width and long enough to extend two-thirds around the joint are required. The first strap is applied a few inches below the joint, and straps are then applied over this, each strap covering in two-thirds of the preceding one until the joint is covered in and the dressing extends a few inches above the joint.

Strapping will be found a satisfactory dressing in the treatment of sprains of joints in their acute or chronic state.

Strapping the Ankle-joint. In applying strapping in sprains of the ankle or tarsal-joints, strips of rubber adhesive plaster one and a half inches in width and eighteen inches in length are required. The first strap is started at the junction of the middle and upper part of the leg, either upon the inner or the outer side, and applied closely to the edge of the tendo Achillis, and carried across the sole of the foot to the base of the great or little toe; several of these straps are applied, covering in the inner or outer surface of the ankle. A strap is next placed with its middle at the point of the heel, the ends being carried to a point on the foot at the junction of the metatarsal bones and the tarsus; a number of these ascending straps are applied, alternating with the vertical straps, until the ankle-joint is covered in. These straps should not be applied so as to meet in front of the foot or ankle and make circular constriction (Fig. 126). After the ankle has been strapped as above described, the foot and ankle are covered with a gauze bandage, and the patient is allowed to walk upon the injured foot.

Fig. 126.

Strapping applied to ankle-joint.

Strapping of a Carbuncle. To strap a carbuncle strips of resin plaster one to one and a half inches in width are required; these straps are applied at the margin of the swelling and are laid on concentrically until all except the central portion is covered. If a number of openings exist, the straps are so placed as not to cover these. Strapping applied in this manner in the treatment of carbuncle is often a comfortable dressing for the patient, and at the same time the concentric pressure favors the extrusion of the slough.

Poultices.

This form of dressing was formerly much employed in the treatment of inflammatory conditions and injuries as a means of applying heat and moisture to the part at the same time, and although the use of poultices is now very much restricted since the introduction of the antiseptic method of wound-treatment, yet I think there are still conditions in which their employment is both useful and judicious.

They are often employed with advantage in inflammatory affections of the chest and of the abdominal organs, and in inflammatory affections of the joints and of bone, combined with rest, their action is most often satisfactory.

They constitute a form of dressing which is conducive to the comfort of the patient in cases of deep suppuration by their relaxing effect upon the tissues, and their previous use does not prevent the surgeon from using all aseptic precautions in the opening and drainage of these abscesses, and the employment of aseptic or antiseptic dressings in their subsequent treatment.

Flaxseed Poultice. This poultice is prepared by adding first a little cold water to ground flaxseed, and then boiling and stirring it until the resulting mixture is of the consistency of thick mush. A piece of muslin is next taken which is a little larger than the intended poultice, and this is laid upon the surface of a table and with a spatula or knife the poultice-mass is spread evenly upon it from one-quarter to one-half an inch in thickness; a margin of the muslin of one or one and a half inches is left, which is turned over after the poultice is spread, and serves to prevent it from escaping around the edges when applied. The surface of the poultice may be thinly spread over with a little olive oil, or may be covered with a layer of thin gauze to prevent the mass from adhering to the skin.

It is next applied to the surface of the skin and is covered with a piece of oiled silk, rubber-tissue, or waxed paper, and held in position by a bandage or a binder.

Soap Poultice. This is made by saturating a number of layers of gauze in a mixture of one part of green soap to six parts of water. It is then applied to the surface and covered with oiled muslin or waxed paper. It may be employed as a primary dressing for some hours to the feet or other parts of the body where the epidermis is thick, before sterilizing these parts before operations.

Starch Poultice. This poultice is prepared by mixing starch with cold water until a smooth, creamy fluid results; boiling water is then added, and it is heated until it becomes clear and has about the same consistency as the starch used for laundry purposes. When sufficiently cool it is spread upon muslin, applied to the part, and covered with oiled silk or waxed paper. This variety of poultice is principally useful in the treatment of diseases of the skin, especially those of the scalp accompanied by the formation of scabs or crusts, to facilitate their removal and to afford a clean surface for the application of ointments or wet dressings.

Fermenting Poultice. This poultice may be prepared by adding yeast, two tablespoonfuls, to a mixture of flaxseed with hot water, making a thin poultice-mass, and allowing it to stand for a few hours in a warm place; it rises and becomes light, and is then spread upon muslin and applied as required. A few ounces of porter or a piece of yeast-cake may be used as a substitute for the yeast in preparing this poultice; animal charcoal may also be added to it to increase its disinfectant power. This poultice was formerly used as an application to gangrenous parts to hasten their separation and to diminish the odor arising from the necrosed tissues.

Antiseptic Poultice. This is prepared by soaking a pad of sterilized gauze in hot bichloride or carbolic solution and wringing it out to remove the excess of fluid. It is next applied to the part and covered with oiled silk or rubber-tissue, which may be held in place by a bandage. Such a dressing will absorb a considerable amount of discharge.

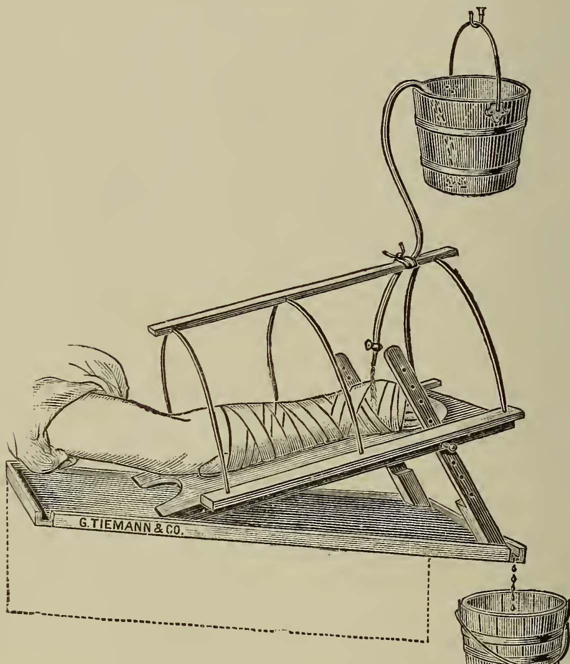
Hot Fomentations. Hot fomentations are employed to keep up the vitality of parts which have been subjected to injury, as seen in severe contusions resulting from railway or machinery accidents; also to combat inflammatory action. Gauze, several layers in thickness, or surgical lint should be soaked in sterilized water having a temperature of 120°; these are wrung out, placed over the part, and covered with waxed paper or rubber-tissue; a second cloth should be placed in the hot water, ready to apply as soon as the first-applied cloth begins to cool, and so by continuously reapplying them the part is kept constantly covered by a hot dressing. The use of these hot fomentations may in many cases require to be continued for hours before the desired result is obtained. *Hot compresses* applied in this manner are frequently employed in treating inflammatory conditions of the eye, and are also of the greatest service in keeping up the vitality of parts which have been subjected to severe injury interfering with their blood-supply. I have seen contused limbs, which were cold and seemed to be doomed to gangrene by reason of diminished blood-supply, have their temperature and circulation restored by the patient and persistent use of this dressing. After the vitality of such a part is restored it should be covered with cotton and a flannel bandage and surrounded by hot-water bags or hot-water cans.

Irrigation.

This may be accomplished by allowing the irrigating fluid to come in contact with the wound or inflamed part, *immediate irrigation*, or by allowing the cold or warm fluid to pass through rubber tubes which are in contact with or surround the part; the latter method is known as *mediate irrigation.*

Immediate Irrigation. In employing immediate irrigation in the treatment of wounds or inflammatory conditions, a funnel-shaped can with a stop-cock at the bottom, or a bucket, is suspended over the part at a distance of a

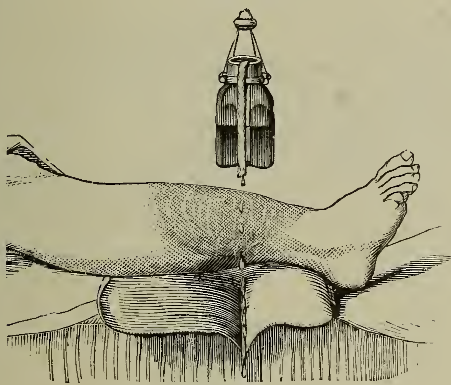
FIG. 127.



Apparatus for continuous irrigation. (ESMARCH.)

few inches (Fig. 127), or a jar with a skein of thread or lamp-wick arranged to act as a siphon may be employed (Fig. 128). The can or jar is filled with water, and this is allowed to fall drop by drop upon the part to be irrigated, which should be placed upon a piece of rubber sheeting so arranged as to allow the water to run off into a receptacle so as to prevent the wetting of the patient's bed. The water employed may be either cold or warm, in accordance with the indications in special cases. If it is desired to make use of antiseptic irrigation, the water is impregnated with carbolic acid or bichloride of mercury; a 1 : 5000 to 1 : 10,000 bichloride solution, or a 1 : 60 carbolic acid or acetate of aluminum solution being frequently employed with good results.

FIG. 128.



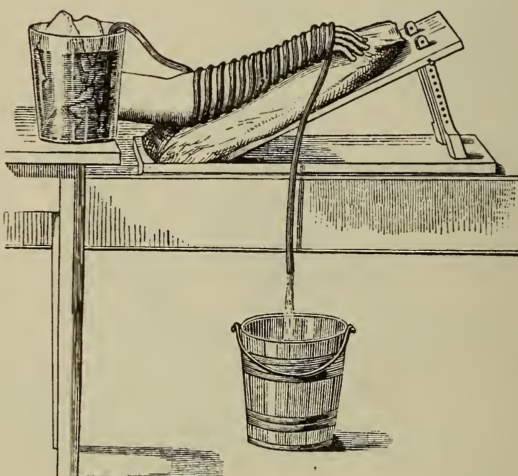
Irrigating-apparatus. (ERICHSEN.)

Antiseptic irrigation employed in this manner will be found a most useful method of treating lacerated and contused wounds of the extremities in which the vitality of the tissues is much impaired; and in such cases warm water should be preferred to cool water, the temperature being from 100° to 110°.

Under the use of warm irrigation it is surprising to see how tissues apparently devitalized regain their vitality; the absence of tension from the non-introduction of sutures and firm dressings, and the warmth and moisture kept constantly in contact with the wound by this method of irrigation, are the important factors in the attainment of this favorable result.

Mediate Irrigation. In this method of irrigation cold or warmth is applied to the surface by means of cold or warm water passing through a rubber tube in contact with the part. A flexible tube of India-rubber half an inch in diameter, with thin walls, and sixteen or twenty feet in length, is applied to the limb like a spiral bandage, or is applied in a coil to the head, breast, or joints, and held in place by a few turns of a bandage; the end of the tube is attached to a reservoir filled with cold or warm water

FIG. 129.



Cold coil applied to arm. (ESMARCH.)

above the level of the patient's body, and the water is allowed to flow constantly through the tubing and escape into a receptacle arranged to receive it (Fig. 129).

Cold-water Dressings. These dressings are applied by bringing the cold water either directly in contact with the part or by applying it by means of a rubber bag or bladder. The temperature of the water may vary from cool water to that of ice-water.

These dressings are employed in local inflammatory conditions; a favorite method for the employment of this dressing is by means of *cold compresses*, which are made of a few layers of surgical lint, dipped in water of the desired temperature and applied to the part; they are renewed as soon as they become warm. When it is desirable to have the compresses very cold, they may be laid upon a block of ice or in a basin with broken ice; to obtain the best results from their employment they should by renewed at very short intervals.

A convenient method of applying cold without moisture is by the use of the *ice-bag*. This is either a rubber bag or bladder, which is filled with broken ice and applied to the part. In using an ice-bag it is better to cover the part first with a towel or a few layers of lint or muslin, which prevents the surface from becoming wet by absorbing the moisture which condenses upon the surface of the bag or bladder, and thus renders the dressing more comfortable to the patient. The ice-bag is often employed as an application to the head in inflammatory conditions of the brain or membranes; to the abdomen in cases of appendicitis, and is also used upon the surface of the body to control internal hemorrhage.

COUNTER-IRRITATION.

Counter-irritants are substances employed to excite external irritation, and the extent of their action varies according to the material used and the duration of their application; superficial redness or complete destruction of the vitality of the parts to which they are applied may result.

The use of counter-irritants under favorable circumstances is found to have a decided effect in modifying morbid processes, and they are widely employed as local revulsants in cases of congestion or inflammation, and in cases of collapse for their stimulating effect.

Caution should be exercised in applying counter-irritants to patients who are comatose or under the influence of a narcotic, for here the sensations of a patient cannot be used as guide to their removal, and their too long-continued application when the vitality of the tissues is impaired may result in serious consequences.

Rubefacients. These agents, by reason of their irritating properties when applied to the skin, produce intense redness and congestion.

Hot Water. When it is desired to make a prompt impression upon the skin, the application of muslin or flannel cloths wrung out in hot water and renewed as rapidly as they become cool will soon produce a superficial redness of the integument.

Spirits of Turpentine. This drug applied to the skin is a very active counter-irritant; it may be rubbed upon the surface of the skin until redness results. When used upon patients whose skin is very delicate its action may be modified by mixing it with equal parts of olive oil before applying it; this will be found useful in applying it as a rubefacient to the tender skins of young children.

When redness of the skin has resulted from the application the skin should be wiped dry by means of a soft towel or absorbent cotton to remove any turpentine from the surface, which by its continued contact may cause vesication.

Turpentine Stupe. This is prepared by sprinkling spirits of turpentine over flannel cloths which have been wrung out in hot water, or by dipping hot flannel in warm spirits of turpentine; prepared in either way the stupe should be squeezed as dry as possible to remove the excess of turpentine before being applied to the surface of the body. A turpentine stupe may cause vesication if allowed to remain for too long a time in contact with the skin; its application for from five to ten minutes will usually produce the desired effect; it should be removed after this time, and it can be reapplied if desired.

If the patient complains of severe burning of the skin after the use of turpentine, the painful surface should be freely smeared with vaseline or lard, which will relieve the uncomfortable symptom.

Chloroform. A few drops of chloroform applied to the surface of the body by means of a piece of lint, muslin, or flannel, and covered by oiled silk or rubber-tissue, will excite a rapid rubefacient effect.

Mustard. Ground mustard or mustard flour prepared from either *Sinapis alba* or *Sinapis nigra* is one of the most commonly used substances to produce rubefacient action. It is generally employed in the form of the *mustard plaster* or *sinapism*, which is prepared by mixing equal parts of mustard flour with wheat flour or flaxseed meal, and adding to this enough warm water to make a thick paste; this is spread upon a piece of old muslin, and the surface of the paste should be covered with some thin material, such as gauze, to prevent the paste from adhering to the skin. In making a mustard plaster for application to the tender skin of a child, 1 part of mustard flour should be mixed with 3 parts of wheat flour or flaxseed meal.

A mustard plaster or sinapism may be allowed to remain in contact with the skin for a period varying from fifteen to thirty minutes, the time being governed by the sensations of the patient; if it is allowed to remain longer, it may cause vesication, which is to be avoided, as ulcers produced by mustard are very painful and extremely slow in healing. After removing a sinapism the irritated surface of the skin should be dressed with a piece of muslin or lint spread with vaseline, boric acid or oxide of zinc ointment.

To excite a rapid revulsive action the *mustard foot-bath* is often employed; it is prepared by adding two or three tablespoonfuls of mustard flour to a bucket or foot-tub of water at a temperature of 100° to 110°; in this the patient is allowed to soak his feet for a few minutes.

Mustard Papers. *Charta Sinapis*, which can be obtained in the shops ready for use, are a convenient means of obtaining the rubefacient action of mustard. They are dipped in warm water, and as they are generally very strong, it is well to place a layer of muslin between the surface of the plaster and the skin before applying it to the surface.

Capsicum. This is also sometimes employed as a rubefacient, but it is generally employed in combination with spices, forming the well-known *spice plaster;* this is prepared by taking equal parts of ground ginger, cloves, cinnamon, and allspice, and adding to them one-fourth part of Cayenne pepper; these are thoroughly mixed, enclosed in a flannel bag, and evenly distributed; a few stitches should be passed through the bag at different points, to prevent the powder from shifting its position; before applying it, one side of the bag should be wet with warm whiskey or alcohol. Capsine plasters are also employed to obtain the rubefacient effect of Cayenne pepper.

Aqua Ammonia. This may also be employed for its rubefacient action. A piece of lint saturated with the stronger water of ammonia, placed upon the skin and covered with waxed paper, and allowed to remain for one or two minutes, will produce a marked rubefacient effect.

Paquelin's Cautery. By rapidly stroking the surface of the skin with the point or button of Paquelin's cautery at a black heat a marked counter-irritant action may be produced.

Vesicants. Where it is desirable to make a more permanent counter-irritant effect than that produced by rubefacients, substances are employed which by their action on the skin cause an effusion of serum, or of serum and lymph, beneath the cuticle, thus giving rise to vesicles or blisters; they are known as vesicants.

The substance most commonly employed to produce vesication is *Cantharis,* or Spanish fly, and the preparation commonly used is the *Ceratum cantharidis.*

Fly Blister. This is prepared by spreading ceratum cantharidis upon adhesive plaster, leaving a margin one-half an inch in width uncovered, which will adhere to the skin and hold the blister in position. The time required for a fly blister to produce vesication is from four to six hours; it should then be removed and the surface should be covered with a flaxseed-meal poultice, or with a warm-water dressing. When the blister or vesicle is well developed, it may be punctured at its most dependent part to allow the serum to escape, and it should be dressed with vaselin or boric ointment. If for any reason it is desired to keep up continued irritation, after allowing the serum to escape, the cuticle should be cut away and the raw surface should be dressed with some stimulating material, such as the compound resin cerate.

Cantharidal Collodion. This may be employed to produce vesication; it is applied by painting several layers upon the skin with a brush over the part on which the blister is to be produced. It is a convenient preparation to use when the patient would disturb the ordinary blister, as in the case of a child or an insane patient, or where the surface is so irregular that the ordinary blister cannot be well applied. The after-treatment of blisters produced by cantharidal collodion is similar to that previously described.

Caution should be observed in using blisters upon the tender skins of children; if employed, they should be allowed to remain in contact with the skin for a short time only. They are contraindicated in patients in whom the vitality of the tissues is depressed by adynamic diseases, and in aged persons.

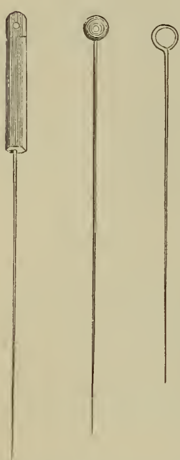
Strangury, which is shown by frequent and painful micturition, the urine often containing blood, sometimes occurs from the use of cantharidal preparations as blisters. This condition should be treated by the use of opium and belladonna by suppository, demulcent drinks, and warm sitz-baths, and by leeches to the perineum if the symptoms are very severe.

To avoid the development of strangury small blisters should be employed, and should not be allowed to remain too long in contact with the surface, and cantharidal preparations should not be employed in cases where renal or vesical irritation has existed or is present. It is said that strangury may also be avoided by incorporating opium and camphor with the cantharidal cerate.

Aqua Ammonia Fortior and Chloroform. These drugs may be employed to produce rapid vesication, a few drops being placed upon the surface of the body and covered by an inverted watch-glass for a few minutes, or lint saturated with aqua ammonia or chloroform may be placed upon the skin and covered with waxed paper or oiled silk. Either of these agents applied in this manner, and allowed to remain in contact with the skin for fifteen minutes, will produce marked vesication. The blisters resulting from these agents are painful, and they are only to be used where a rapid result is desired.

Acupuncture. Counter-irritation is effected by this method by thrusting steel needles deeply into the subcutaneous tissues. The needles employed should be of steel, from two to four inches in length, strong, highly polished, and sharp-pointed, and should have round metallic heads or be fixed in handles (Fig. 130). Before being used they should be immersed for a few minutes in boiling water or in a carbolized solution to sterilize them thoroughly. In performing the operation of acupuncture, localities containing important organs, large bloodvessels, the joints and viscera, should be avoided. When introduced the needles should be passed through the skin with a rotary motion, the skin being rendered tense between the thumb and fingers, and pushed into the deep-seated structures. They are allowed to remain in position for a few moments and are then withdrawn, the skin being supported by the thumb and fingers.

FIG. 130.



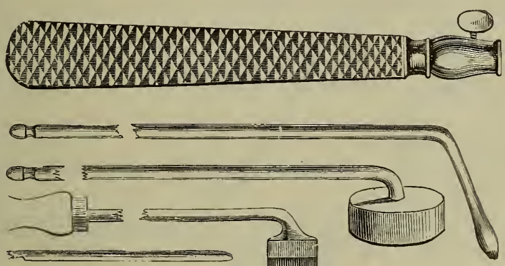
Acupuncture needles.

Acupuncture has been found of service in cases of deep-seated neuralgia, obstinate rheumatic affections, and sciatica.

Actual Cautery. This method of counter-irritation is accomplished by bringing in contact with the skin some metallic substance brought to a high degree of temperature. This constitutes one of the most powerful means of counter-irritation and revulsion; it is rapid in its action, and is not more painful than some of the slower methods.

The cauteries generally employed are made of iron, and are fixed in handles of wood or other non-conducting material, and have their extremities fashioned in a variety of shapes (Fig. 131). The irons are heated by placing their extremities in an ordinary fire, or by holding them in the flame of a spirit-lamp until they are heated to the desired point, either a white or a dull-red heat. They are then applied to the surface of the skin at one point, or drawn over the skin in lines either parallel to or crossing one another. The intense burning which follows the use of the cautery may be allayed by placing upon the cautery-marks compresses wrung out in ice-water or saturated with equal parts of lime-water and sweet oil.

FIG. 131.



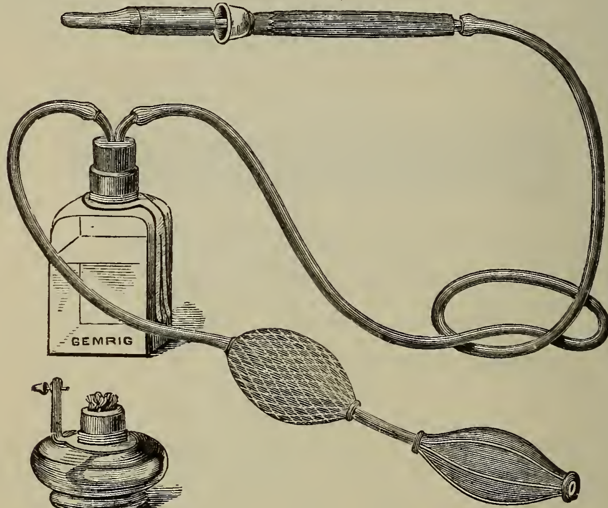
Cautery irons.

Where the ordinary cautery irons are not at hand, a steel knitting-needle or iron poker heated in the flame of a spirit-lamp or in a fire may be employed with equally satisfactory results. Where the cautery iron is held in contact with the surface for some time to make a deep burn, the pain of its application may be allayed by placing a mixture of salt and cracked ice upon the spot to be cauterized for a few minntes immediately before its application. The cautery iron should not be placed over the skin covering salient parts of the skeleton or over important organs.

The actual cautery, in addition to its use in producing counter-irritation and revulsion, is often employed to control hemorrhage and to destroy morbid growths.

Paquelin's Thermo-cautery. A very convenient and efficient means of using the thermo-cautery is the apparatus of Paquelin, which utilizes the property of heated platinum-sponge to become incandescent when exposed to the action of the vapor of benzole or rhigolene (Fig. 132). The cautery is prepared for use by attaching the gum tube to the receiver containing benzole and heating the platinum knife or button, which is also attached to the benzole receiver by a rubber tube, in the flame of the alcohol lamp

Fig. 132.



Paquelin's cautery.

for a few moments, and then passing the vapor of benzole through the platinum-sponge, which is enclosed in the knife or button, by compressing the rubber bulb. The point may be brought to a high degree of white heat, or may be brought only to a dull-red heat.

This form of cautery may be employed for the same purposes as that previously mentoned; its great advantage consists in the ease with which it can be prepared for use.

The knives heated to a dull-red heat will be found of great service in operating upon vascular tumors, where the use of an ordinary knife would be accompanied by profuse or even dangerous hemorrhage. Wounds made by the actual cautery are aseptic wounds, and when dusted with an antiseptic powder, generally heal promptly under the scab without suppuration.

Seguin's Method of Counter-irritation. This consists in stroking the surface of the skin lightly and rapidly with the point of a Paquelin cautery; the lines of stroking may be made at right angles; the application is practically painless, but a very decided counter-irritant effect is produced. It is employed with advantage in neuralgic affections, and is of marked service in cases of neuralgic affections of the spine and joints, and in cases of neuritis of superficial nerves.

BLOODLETTING.

This procedure is often resorted to, to obtain both the local and the general effects following the withdrawal of blood from the circulation. Local depletion is accomplished by means of some one of the following procedures: *scarification*, *puncturation*, *cupping*, and *leeching*, and general depletion is effected by means of *venesection* or by *arteriotomy*.

Scarification. Scarification is performed by making small and not too deep incisions into an inflamed or congested part with a sharp-pointed bistoury; the incisions should be in parallel lines and should be made to correspond to the long axis of the part, and care should be taken in making them to avoid wounding superficial veins and nerves. Incisions thus made relieve tension by allowing blood and serum to escape from the engorged capillaries of the infiltrated tissue of the part. Warm fomentations applied over the incisions will increase and keep up the flow of blood and serum. Scarification is employed with advantage in inflammatory conditions of the skin and subcutaneous cellular tissue and in acute inflammatory swelling or œdema of the mucous membrane; for instance, of the conjunctiva, and in acute inflammation of the tonsils, tongue, and epiglottis it is an especially valuable procedure.

A modification of scarification known as *deep incisions* is practised in urinary infiltration to establish drainage and to relieve the tissues of the contained urine, and to prevent sloughing; in threatened gangrene and phlegmonous erysipelas the same procedure is adopted to relieve tension by permitting of the escape of blood and serum, and its employment is often followed by most satisfactory results.

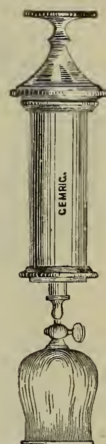
Puncturation. This procedure consists in making punctures into inflamed tissues with the point of a sharp-pointed bistoury, which should not extend deeper than the subcutaneous tissue; it is an operation similar in character to that just described, its object being to relieve tension and bring about depletion. It is employed in cases similar to those in which scarification is indicated, and is resorted to in cases of diffuse areolar inflammation or erysipelas.

Cupping. Cupping is a convenient method of employing local depletion by inviting the blood from the deeper parts to the surface of the body. Cupping is accomplished by the use of *dry* or *wet* cups. When the former are used, no blood is abstracted and the derivative action only is obtained; when wet cups are employed there is an actual abstraction of blood or local depletion as well as the derivative action.

Dry Cupping. Dry cups as ordinarily applied consist of small cup-shaped glasses, which have a valve and stop-cock at their summit; these are placed upon the skin and an air-pump is attached, and as the air is exhausted in the cup the congested integument is seen to bulge into the cavity of the cup. When the exhaustion is complete the stop-cock is turned and the air-pump is removed, the cup being allowed to remain in position for a few minutes, and is then removed by turning the stop-cock and allowing the air again to enter the cup. This procedure is repeated until a sufficient number of cups have been applied. (Fig. 133).

In cases of emergency, when the ordinary cupping-glasses and air-pump cannot be obtained, a very satisfactory substitute may be obtained by taking a wineglass and burning in it a little roll of paper, or a small piece of lint or paper wet with alcohol, and before the flame is extinguished rapidly inverting it upon the skin, or the air may be exhausted by the introduction, for a moment or two, of the flame of a spirit-lamp into the cup. Applied in this manner cups will draw as well as when the more complicated apparatus is used, and when they are to be removed it is only necessary to press the finger on the skin close to the edge of the cup until air enters it, when it will fall off. Although dry cups do not remove blood directly, there is often an escape of blood from the capillaries into the skin and cellular tissue, as is evidenced by the ecchymosis which frequently remains at the seat of the cup-marks for some days.

Fig. 133.



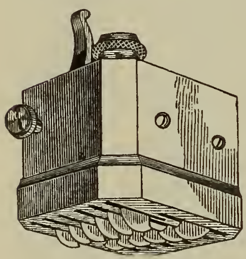
Cupping-glass and air-pump.

Wet Cupping. When the abstraction of blood as well as the derivative action is desired wet cups are resorted to, and here it is necessary to have a scarificator as well as the cups and air-pump (Fig. 134).

Before applying wet cups the skin should be washed carefully with bichloride or carbolic solution, and the scarificator should also be dipped in a carbolic solution. A cup is first applied to produce superficial congestion of the skin; this is removed and the scarificator is applied, and the skin is cut by springing the blades. The cups are immediately reapplied and exhausted, and they are kept in place as long as blood continues to flow. When the vacuum is exhausted and blood ceases to flow, they should be removed and emptied, and can be reapplied if it is desirable to remove more blood. A sharp-pointed bistoury which has been sterilized may be employed to make a few incisions into the skin instead of the scarificator, and the improvised cups may be employed if the ordinary cupping-apparatus cannot be obtained.

After the removal of wet cups the skin should be washed carefully with a bichloride or carbolic solution, and an antiseptic dressing should be placed over the wounds and held in place by a roller bandage.

FIG. 134.



Scarificator.

Leeching. In the abstraction of blood by leeching two varieties of leeches are used — the *American* leech, which draws about a teaspoonful of blood, and the *Swedish* leech, which draws three or four teaspoonfuls.

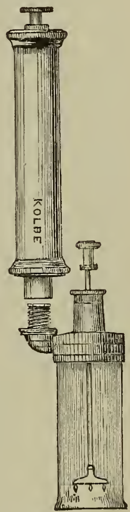
Before applying leeches the skin should be carefully washed, and the leech should be placed upon the part from which the blood is to be drawn, and confined to this place by inverting a tumbler or glass jar over it; if it does not bite or take hold, a little milk or blood should be smeared upon the surface, which will generally secure the desired result. As soon as the leech has ceased to draw blood it is apt to let go its hold and fall off; if, however, it is desired to remove leeches, they may be made to let go their hold by sprinkling them with a little salt. After the removal of leeches bleeding from the bites may be encouraged, if desirable, by the application of warm fomentations. Leech-bites should be washed with a bichloride or carbolic solution, and a compress of bichloride or iodoform gauze placed over them and secured by a bandage.

It sometimes happens that free bleeding continues from the leech-bite after the removal of the leeches; in this event, if a compress does not control the hemorrhage, the bleeding point should be touched with a stick of nitrate of silver or with the point of a steel knitting-needle heated to a dull-red heat, and if this fails to control the bleeding a delicate harelip pin should be passed through the skin under the bite and a twisted suture thrown around this;

the wound should then be washed and dressed as previously described.

In applying leeches in or near mucous cavities care should be taken to see that they do not escape into the cavities and pass out of reach. Leeches should not be employed directly over inflamed tissue, but should be applied to parts surrounding it; they should not be allowed to take hold directly over a superficial artery, vein, or nerve, and should never be applied to a part where there is delicate skin and a large amount of loose cellular tissue, as in the eyelid or scrotum, as unsightly ecchymoses will result, which will persist for some time. Leeches should not be used a second time.

Fig. 135.



Mechanical leech.

The Mechanical Leech. The mechanical leech is an apparatus which has been constructed to take the place of the leech; it consists of a scarificator, cup, and exhausting syringe or air-pump. (Fig. 135.) In using this apparatus, after the scarificator has been used the piston of the exhausting-instrument should be drawn out slowly, which secures a better flow of blood than if a sudden vacuum is made.

The mechanical leech may be employed when the natural leech cannot be obtained, but possesses no advantage over the latter, and is apt to get out of order if not in constant use.

Venesection. Venesection, as its name implies, consists in the division of a vein, and it is the ordinary operation by which general depletion or bleeding is accomplished. Venesection at the bend of the elbow is the operation which is now usually resorted to for general blood letting; the vein selected is the median cephalic, which is further from the line of the brachial artery than the median basilic vein. (Fig. 136.)

To perform venesection the surgeon requires a bistoury or lancet—the spring lancet was formerly much used, but it is not employed at the present time—several bandages, a small antiseptic dressing, and a basin to receive the blood.

FIG. 136.

Venesection. (HEATH.)

The patient's arm should be carefully cleansed, washed over with a bichloride solution, and a few turns of a roller bandage placed around the middle of the arm, being applied tightly enough to obstruct the venous circulation and make the veins below become prominent, but not tight enough to obstruct the arterial circulation. The patient at the same time should be instructed to grasp a stick or a roller bandage and work his fingers upon it. The surgeon should next assure himself that there is no abnormal artery beneath the skin, and having selected the vein, the median cephalic by preference, he then steadies the vein with his thumb and passes the point of the bistoury or lancet beneath it and cuts quickly outward, making a free skin opening. The blood usually escapes freely, and the amount withdrawn is regulated by the condition of the pulse and the appearance of the patient. For this reason it is better to have the patient sitting up or semi-reclining when venesection is performed, as the surgeon can judge better as to the constitutional effects of the loss of blood while the patient is in this position.

When a sufficient quantity of blood has been removed, the thumb is placed over the wounded vein and the bandage is removed from the arm above. The wound is next washed with a bichloride solution, and a compress of antiseptic gauze is applied over the wound and held in position by a bandage which should be so applied as to envelop the limb from the fingers to the axilla. The dressing need not be distured for five or six days, at which time the wound is usually found to be healed.

Wounds of the brachial artery have occurred in opening the veins at the bend of the elbow, but if care is taken, this accident should not take place.

Venesection may be practised on the *external jugular vein* when, from excess of fat or in the case of children, the veins at the bend of the elbow cannot be easily found. The vein is rendered prominent by placing the thumb or a pad over the vein at the outer edge of the sterno-cleido-mastoid muscle just above the clavicle. The vein is next opened over this muscle by an incision parallel to its fibres. After a sufficient quantity of blood has escaped, the wound is washed with an antiseptic solution and closed by a compress of antiseptic gauze held in position by a bandage carried around the neck.

The *internal saphenous vein* is also sometimes selected for venesection, and here care should be taken not to wound the accompanying nerve which lies directly behind the vein.

Arteriotomy. This operation is now scarcely ever performed, but if done the vessel generally selected is the anterior branch of the temporal artery. The position of the vessel is fixed by the finger and thumb, and it is opened by a transverse incision with a bistoury. After a sufficient quantity of blood has escaped the wound is inspected, and if the vessel is not completely divided, its division is completed and the ends of the vessel should be secured with ligatures, and the wound irrigated with an antiseptic solution and closed with sutures. A gauze compress should next be applied and held in position by a firmly-applied bandage.

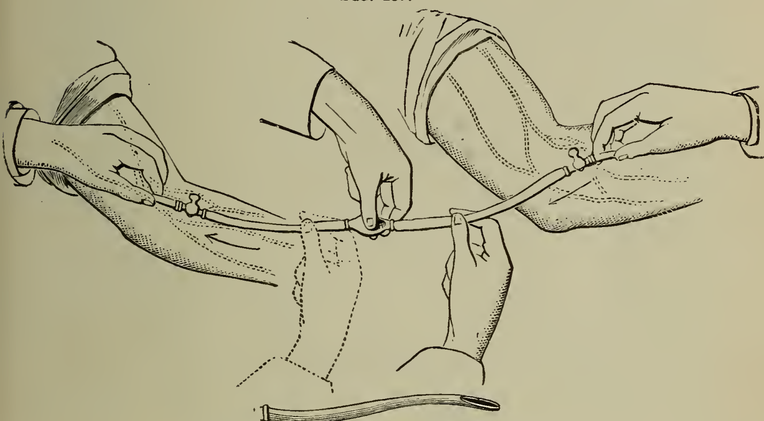
TRANSFUSION OF BLOOD.

This operation may be employed to introduce a certain quantity of blood into the circulaion of a patient who has suffered from profuse hemorrhage; it is rarely employed at the present time, being almost entirely superseded by the transfusion or infusion of saline solution. There are two methods by which transfusion may be effected: the *direct*, by which the blood is conveyed directly and without exposure to the air from the bloodvessel of one person to that of another, and the *indirect*, in which the blood is first drawn from one person and is then injected into the veins of another, being first deprived of its fibrin before being injected.

Direct Transfusion of Blood. This is best accomplished by using Aveling's apparatus, which consists of a rubber tube, about eighteen inches in length, with a small bulb in the centre, having metallic extremities provided with stop-cocks, and two bevel-pointed metallic canulæ to be used to connect the tube with the bloodvessels. In performing the operation of direct transfusion the bulb and tube are first placed in a shallow basin containing warm normal saline solution (0.7 per cent.), and the bulb and tube are filled with this solution to displace any air which they may contain. The person supplying the blood places his arm near the arm of the patient, and the operator exposes a prominent vein on the patient's arm at the bend of the elbow, opens it, and inserts into it one of the canulæ filled with saline solution, with the point directed toward the body, and at the same time an assistant should introduce the other canula into a vein at the bend of the elbow of the party who supplies the blood.

The canulæ are held in position by assistants, and the tube is quickly connected with them, the stop-cocks being closed before it is taken out of the saline solution, to prevent the entrance of air; then upon opening the stop-cocks a direct communication is established between the circulation of the patient and that of the person who supplies the blood. (Fig. 137.) The introduction of the contents of the bulb into the vein of the patient is effected by the operator slowly compressing the bulb with one hand, while he keeps the tube closed on the side of the donor with the finger and thumb of the other hand. By relaxing the pressure on the tube on the donor's side of the bulb and closing it on the patient's side, blood will flow from the donor's vein into the bulb as it slowly expands, and when filled the communication with the patient's circulation is again made, and the manipulation is repeated until a sufficient quantity of blood has been introduced, as indicated by the condition of the patient's pulse.

FIG. 137.



Apparatus for the direct transfusion of blood.

The quantity of blood introduced can be calculated by remembering that at each emptying of the bulb two drachms of fluid are introduced into the circulation. When a sufficient quantity has been introduced the canulæ are removed and the wounds are dressed as ordinary venesection wounds.

Indirect Transfusion of Blood. Indirect transfusion of blood, which is now rarely employed, is accomplished by withdrawing from a vein of the donor by venesection about ten ounces of blood, which is received in a sterilized glass or porcelain vessel, which is placed in water at a temperature of 110°. The blood thus kept warm is next defibrinated by whipping it with a bundle of broom straws or a wire brush, and after being filtered through a fine linen cloth or wire strainer, it is injected by means of an ordinary syringe attached to a canula which has previously been inserted into a vein of the patient; care should be taken that no air is introduced with the blood. When a sufficient quantity of blood has been introduced the canula is removed and the wound is dressed in the usual manner. The success of this operation largely depends upon the expedition with which it is performed; to prevent the coagulation of the blood not more than two minutes should be allowed to intervene between the reception of the blood in the syringe and its introduction into the patient's vein.

Arterial Transfusion. This procedure, which consists in injecting defibrinated venous blood into an artery, is occasionally practised. An artery, usually the radial at the wrist or the posterior tibial behind the inner malleolus, is exposed and secured by a ligature; it is then opened on the distal side of the ligature and the point of a canula or the nozzle of a syringe is introduced, directed toward the distal extremity of the limb, and blood, which has been previously defibrinated, is slowly injected. When a sufficient quantity has been introduced the canula is removed, and the division of the artery is completed and its extremities are secured by ligatures, and the wound is closed and dressed.

Auto-transfusion. This procedure is recommended in cases of excessive hemorrhage to support a moribund patient until other means of resuscitation can be adopted. It consists in the application of rubber bandages or of muslin bandages to the extremities for the purpose of forcing the blood toward the vascular and nervous centres.

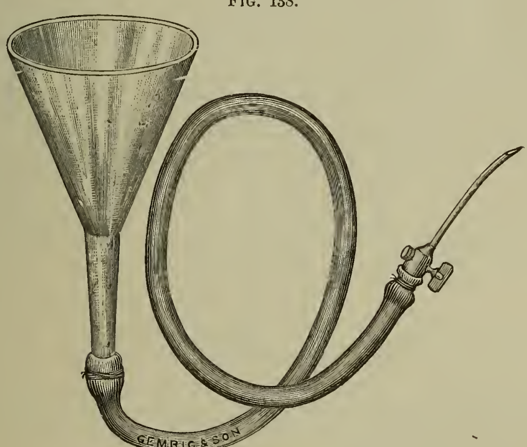
INTRAVENOUS INJECTION OF SALINE SOLUTION.

It has been proved by experiments and by clinical experience that human blood is not more efficacious in supplying volume to and restoring a rapidly failing circulation than normal salt solution, and as the latter can be obtained with much more ease than blood, its use has largely superseded the former. The saline solution which is found most satisfactory to employ for this purpose is known as *normal saline solution* (0.7 per cent.). It is prepared by adding sodium chloride, ʒjss, sodium bicarbonate, grs. xv, to distilled water, Oij. In emergencies a solution prepared by adding a drachm of common salt to a pint of water, which has been sterilized by boiling, will be equally satisfactory.

The solution should be prepared with water which has been boiled to sterilize it, and should be of a temperature of about 100° when used.

A vein of the patient, at the elbow, should be exposed and should have placed under it, about one-half inch apart, two catgut ligatures; the distal ligature is then tied and an opening is made into the vein between the ligatures; a

FIG. 138.



Funnel and tube for intravenous injection.

canula is next inserted into the opening in the vein, and is secured in position by tying the proximal ligature. The canula is first filled with the saline solution, and is then connected with a funnel by means of a rubber tube (Fig.

138), which is filled with saline solution to displace the air, and upon raising the funnel above the part the solution enters the vein; care should be taken to see that the funnel is kept well supplied with the solution until a sufficient quantity has been introduced. The quantity introduced is regulated by the condition of the patient's pulse.

Saline solution may also be introduced into a vein by means of a syringe when the apparatus described cannot be obtained.

Infusion of Saline Solution. The introduction of saline solution into the cellular tissue has been followed by results equally as satisfactory as those obtained by intravenous injection, and this procedure is now very frequently employed.

The saline solution is conveyed into the cellular tissue through a large hypodermic needle, which should be sterilized by boiling, and is then introduced into the connective tissue, being previously connected by a rubber tube with a reservoir containing warm sterilized salt solution. The usual situations for the introduction of the solution are the external portions of the thighs and the anterior and lateral portions of the abdominal walls. As much as two or three pints of the solution are often introduced in this manner, with very satisfactory results. Infusion of saline solution may be used with most satisfactory results in cases who have suffered from profuse hemorrhage, and has also proved of great service in cases of shock.

ARTIFICIAL RESPIRATION.

This procedure is resorted to in cases of threatened death from apnœa consequent upon drowning, profound anæsthetization, electric shock or the inhalation of irrespirable gases, or when from any cause there is interference with the function of breathing. Before resorting to artificial respiration care should be taken to see that nothing is present in the mouth or air-passages which will obstruct the entrance of air into the lungs, such as mucus, foreign bodies or liquids, and also that all tight clothing interfering with the free expansion of the chest-walls is removed from the chest.

In cases where the apnœa is due to the presence of a foreign body in the larynx or trachea it is evident that no efforts at respiration can be successful until the air-passages are freed from the occluding body; and if it cannot be removed through the mouth, tracheotomy should be performed before artificial respiration is attempted; the tracheal wound should be held open by retractors, which in a case of emergency can be made from bent hairpins, or by a dressing forceps or a tracheotomy-tube, if one be at hand.

When artificial respiration is resorted to the operator should persevere with it for some time, even when no apparent spontaneous respiratory movements are excited; for resuscitation has been accomplished in seemingly hopeless cases by patient perseverance with the manipulations. When the first natural respiratory movement is detected the operator should not cease making artificial respiration, but should continue these movements in such a way as to coincide with the spontaneous inspiratory and expiratory movements until the breathing has assumed its regular character.

The temperature of the body should also be restored by friction to the surface of the body by the hands or by rough towels and hot-water bottles, and warm coverings should be applied for the same object.

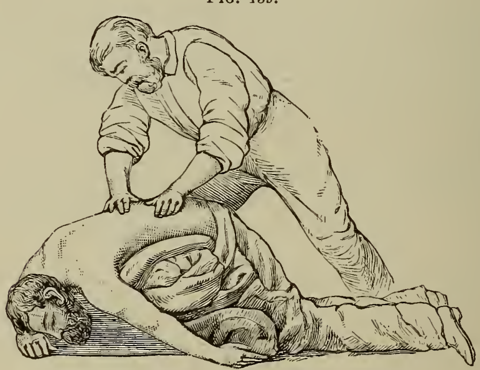
Mouth-to-mouth Inflation. This method of artificial respiration has been resorted to in cases of great emergency, especially in very young children. The operator draws the tongue forward, closes the nostrils, and applies his mouth directly to the mouth of the patient, and by a deep expiratory effort endeavors to force air into the chest; when this is accomplished the air can be expelled from the lungs by pressure upon the walls of the chest, and the procedure should be repeated about sixteen times in a minute. The same object may be accomplished by passing a flexible catheter into the trachea through the mouth, and the lungs can be inflated by the operator blowing into the catheter.

Direct Method of Artificial Respiration (Howard's). This method of artificial respiration is at the present time considered the most efficacious, and is the one adopted by the United States Life-saving Service, and although the rules given are for the resuscitation of cases of apparent drowning, the same procedures may be adopted in cases of apnœa arising from other causes.

The rules laid down by Dr. Howard are as follows:

Rule I.—"To expel water from the stomach and lungs strip the patient to the waist, and if the jaws are clenched separate them and keep them apart by placing between the teeth a cork or a small piece of wood. Place the patient face downward, the pit of the stomach being raised above the level of the mouth by a large roll of clothing placed beneath it. (Fig. 139.) Throw your weight forcibly two

FIG. 139.



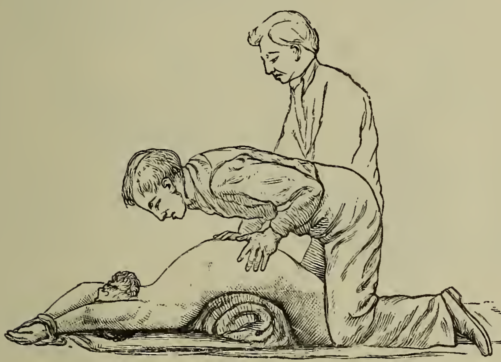
First manipulation in Howard's method.

or three times upon the patient's back over the roll of clothing so as to press all fluids in the stomach out of the mouth."

The first rule applies only to cases of drowning, and in using Howard's method in apnœa from other causes it is to be omitted.

Rule II.—"To perform artificial respiration, quickly turn the patient upon his back, placing the roll of clothing beneath it so as to make the breast-bone the highest point of the body. Kneel beside or astride of the patient's hips. Grasp the front part of the chest on either side of the pit of the stomach, resting the fingers along the spaces between the short ribs. Brace your elbows against your sides, and steadily grasping and pressing forward and upward throw your whole weight upon the chest, gradu-

FIG. 140.

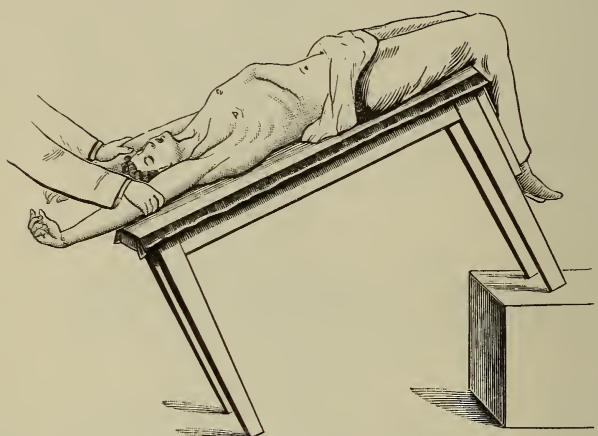


Direct method of artificial respiration.

ally increasing the pressure while you count *one—two—three.* Then suddenly let go with a final push which springs you back to your first position. (Fig. 140.) Rest erect upon your knees while you count *one—two;* then make pressure again as before, repeating the entire motions at first about four or five times a minute, gradually increasing them to about ten or twelve times. Use the same regularity as in blowing bellows and as seen in the natural breathing which you are imitating. If another person is present, let him with one hand, by means of a dry piece of linen, hold the tip of the tongue out of one corner of the mouth, and with the other hand grasp both wrists and pin them to the ground above the patient's head." This method may be employed in cases of still-birth, or in young children, the operator holding the body of the child in his left hand and compressing it with the right hand.

Silvester's Method of Artificial Respiration. In employing this method of artificial respiration the patient should be placed on his back upon a firm flat surface; a cushion of clothing is placed under the shoulders, and the head should be dropped lower than the body by tilting the surface on which he is laid. The mouth being cleared of mucus or foreign substances, the tongue is drawn forward

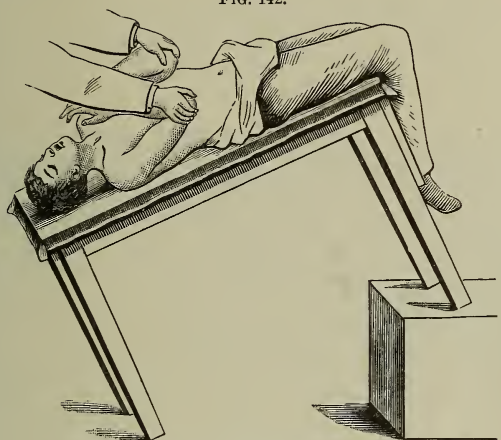
Fig. 141.



Silvester's method—Inspiration. (Esmarch.)

and secured to the chin by a piece of tape tied around it and the lower jaw, or may be pulled out of the mouth and held by an assistant. The operator, standing at the patient's head, grasps the arms at the elbows and carries them first outward and then upward until the hands are brought together above the head; this represents inspiration (Fig. 141); they should be kept in this position for two seconds, after which time they are brought slowly back to the sides of the thorax and pressed against it for two seconds; this represents expiration (Fig. 142.) These movements are repeated fifteen times in a minute until the breathing is restored, or until it is evident that the case is a hopeless one.

FIG. 142.



Silvester's method—Expiration. (ESMARCH.)

Marshall Hall's Method of Artificial Respiration. In this method the mouth should first be freed from mucus or foreign bodies, and the patient is turned upon his face with one wrist under his forehead, and a roll of clothing is placed beneath his chest. By turning the body briskly on the side and a little beyond, and then on the face, alternately, respiration is imitated. As the body is brought in the prone position compression is to be made upon the posterior aspect of the chest. These manipulations should be made fifteen times in a minute.

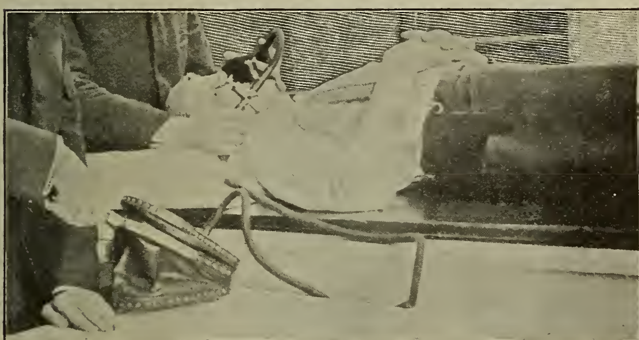
Laborde's Method of Artificial Respiration. Laborde has shown that systematic and rhythmic traction upon the tongue is a powerful means of restoring the respiratory reflex, and consequently the function of respiration. The procedure is accomplished as follows: The body of the tongue is seized between the thumb and fingers, and traction is made upon it with alternate relaxation, fifteen or twenty times a minute, imitating the function of respiration, taking care to draw well on the tongue. When a certain amount of resistance is felt it is a sign that the respiratory function is being restored. Noisy respiration first occurs, termed by Laborde *hoquet inspirateur* (inspiratory hiccough). Tongue forceps or dressing or hæmostatic forceps may be used in place of the fingers to grasp the tongue. It is important to persist in the manipulations for half an hour to an hour, unless the case is absolutely hopeless. This procedure, which cannot be employed with advantage when there is fixation of the tongue from inflammation or malignant disease, has been employed with success in cases of drowning, toxic asphyxia, asphyxia during anæsthesia, and arrest of respiration from electric shock.

Forced Respiration. By this method of artificial respiration air is forcibly passed into the lungs. This procedure is strongly advocated by Fell, who has devised an apparatus by which it may be satisfactorily accomplished. Prof. H. C. Wood has also made use of forced respiration in the resuscitation of animals with an apparatus somewhat similar to that devised by Fell with good results. Wood's apparatus consists of a pair of bellows, a few feet of rubber tubing and a face mask of rubber, and one or two intubation-tubes; the mask or intubation-tube is attached to one end of the rubber tube and the bellows to the other end of the tube. The mask is applied over the mouth, or, if this is not used, the intubation-tube is introduced into the larynx, and air is forced into the lungs by working the bellows. He also advises that in the tubing a double metal tube be introduced, with the openings so placed that their size can be so regulated by turning the outer tube that the operator can allow any excess of air thrown by the bellows to escape.

The apparatus of Fell, which he has used in a number of cases with good results, consists of a mouth-mask or tracheotomy-tube, and a tube connected with the air-control valve, which is attached to an air-warming apparatus, which in turn is connected with a bellows by another tube. (Fig. 143.) By means of this apparatus air is forced into the lungs, and allowed to escape, when the lungs have been expanded, by the elasticity of the lung tissue and the chest walls.

Forced respiration has proved of value in cases of narcotic poisoning and other accidents in which death is produced by paralysis of the respiratory centres.

FIG. 143.

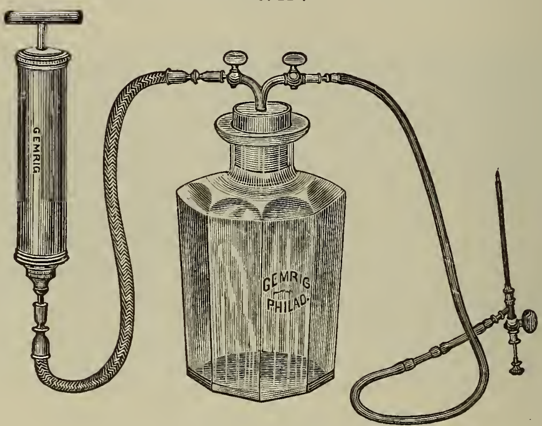


Fell's apparatus for forced respiration.

Aspiration. This procedure is adopted to remove fluid from a closed cavity without the admission of air, and the instrument which is employed to accomplish this object is known as an aspirator. The form of aspirator most generally employed is that of Potain.

Potain's aspirator consists of a glass bottle, into the stopper of which is introduced a metallic tube, which is connected with two rubber tubes, one of which is connected with an exhausting-pump, and the other with a delicate canula carrying a fine trocar; the apparatus is provided with stop-cocks to prevent the admission of air. (Fig. 144.) In using this aspirator the air is exhausted from the bottle by using the air-pump; the canula enclosing the trocar is next pushed through the tissues into the cavity containing the fluid to be removed; the trocar is then removed, and upon opening the stop-cock the fluid is forced out of the cavity by atmospheric pressure and passes into the bottle or receiver. If the fluid contains masses of lymph or clots which block the canula, interrupting the flow of fluid, a stylet may be passed through the canula to free it from the obstruction.

FIG. 144.



Potain's aspirator.

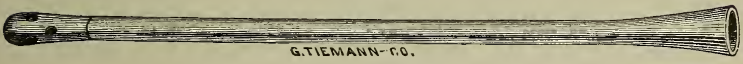
To diminish the pain produced in introducing the trocar and canula, the skin at the point to be punctured may be rendered less sensitive by holding in contact with it for a few minutes a piece of ice wrapped in a towel, or a towel containing broken ice and salt. Care should also be taken to see that the trocar and canula have been perfectly sterilized; to accomplish this they should be carefully washed and placed in boiling water or a 5 per cent. carbolic solution before being used. In introducing the trocar and canula the operator should be careful to avoid injuring any important veins, arteries, or nerves.

After removing the canula the small puncture should be dressed with a compress of antiseptic or iodoform gauze held in place by a bandage or adhesive straps.

The aspirator is frequently employed in cases of hydrothorax, empyema, and ascites, to evacuate the contents of cold abscesses in diseases of the hip and spine, and to remove the contents of a distended bladder until a more radical operation can be performed. It is also a valuable instrument for diagnostic purposes, being frequently used to ascertain the character of the contents of deep-seated tumors containing fluid.

The Stomach-tube. This consists of a partially flexible tube about twenty-eight inches in length and three-eighths of an inch in diameter, which is introduced while the patient is in the sitting posture, the head being thrown backward so as to bring the mouth and gullet as nearly as possible in the same line. The tube being warmed and oiled, the surgeon standing in front of the patient passes it directly back to the pharynx, at the same time introducing the index finger of the left hand to guide its point over the epiglottis; it is then passed gently downward into the stomach. If any obstruction is met with in its passage, it should be withdrawn a little way and then pushed gently downward; all manipulations should be made without much force, to prevent perforation of the wall of the œsophagus.

Fig. 145.



The stomach-tube.

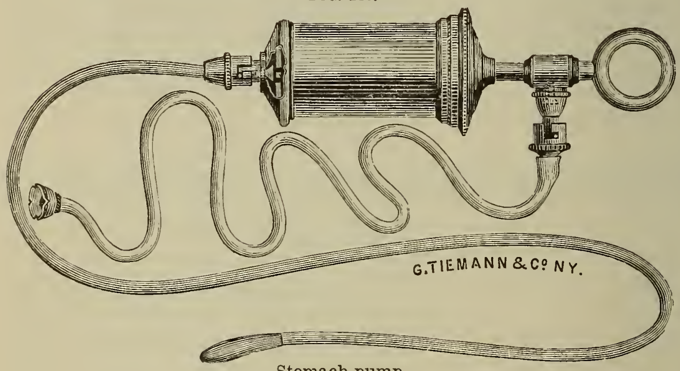
The introduction of the stomach-tube may be required for the evacuation of poisons from the stomach, or to wash out the cavity of this viscus. It may also be used to introduce liquid nourishment into the stomachs of patients who are unable or unwilling to swallow food. In introducing liquid nourishment a syringe or funnel is fitted to the exposed end of the tube which has been passed into the stomach; the syringe or funnel having been filled with milk or beef-tea or broth, the contents are injected gently or allowed to run into the stomach.

In cases of poisoning, where it is desirable to withdraw the contents of the stomach and to wash out the organ, a stomach-tube and syringe may be employed; several syringefuls of warm water are first thrown into the stomach and then withdrawn by suction, but in such cases the use of the stomach-pump will be found more satisfactory.

Lavage. In the recently introduced method of treating disorders of the stomach and intestines by washing them out, the introduction of a flexible rubber stomach-tube is required; the tube here employed is from twenty-four to thirty inches in length (Fig. 145), and the fluid is introduced by means of a funnel attached to its free extremty, or it may be attached to a stomach-pump.

The Stomach-pump. This consists of a brass syringe, the nozzle of which is connected with two tubes, one at the end, the other at the side. The passage through the nozzle is regulated by a valve controlled by a lever. The nozzle of the pump is attached to a stomach-tube, and the

FIG. 146.



Stomach-pump.

end of the lateral tube is placed in a pan of warm water. By raising the piston and opening the valve, water may be drawn from the basin, and by closing the valve and depressing the piston it is passed through the stomach-tube into the stomach; when a sufficient quantity has been injected in this manner, by reversing the action of the valve the fluid is drawn out of the stomach and discharged through the lateral tube into a basin (Fig. 146). This manipulation is continued until the water returns clear and the stomach has been completely washed out.

Œsophageal Bougie. This instrument—which may be passed through the œsophagus into the stomach for the purpose of diagnosis, or for the purpose of dilating strictures of the œsophagus—is passed in exactly the same manner as the stomach-tube, and, as in the case of the latter instrument, it should be introduced without the use of much force, as perforations of the œsophagus have followed the forcible introduction of such instruments.

The Rectal Tube. The introduction of the rectal tube is best accomplished by placing the patient upon his left side, and the surgeon should introduce his index-finger well oiled into the rectum and guide the tube upon this through the anus, when by gentle pressure it is gradually passed into the rectum; if a stricture exists in the rectum within reach of the finger, the latter should be used to guide the tube through the opening in this; if the tube becomes caught in a transverse fold of the mucous membrane, and becomes doubled upon itself, it should be withdrawn and a fresh attempt should be made to pass it; in passing a rectal tube all manipulations should be made with extreme gentleness, as it has been shown that its passage is not without danger, perforations of the intestine having followed its use in some cases. In cases of stricture of the rectum high up the operator has to depend upon the sense of resistance experienced in passing the tube, and in such cases the manipulations should be most carefully made. When the rectal tube is employed to introduce fluids into the large intestine the fluids may be introduced by means of a syringe, or by pouring them into a funnel attached to the free end of the tube, or by attaching the tube to a fountain syringe, thus allowing the liquid to pass slowly into the intestine.

The rectal tube is often employed with good results in relieving the intestine of excessive flatus, and in introducing water or oil into the intestine in cases of intestinal obstruction, and in those cases where the obstruction results from intussusception or fecal accumulations its use will often prove satisfactory.

Rectal Bougies. These instruments are made of India rubber or the same material as the English flexible catheter, and are of various sizes. They should first be oiled, and carefully introduced in the same manner as the rectal tube. They are generally employed in cases of stricture of the rectum, and they should be introduced with great care to avoid perforating the wall of the rectum; this accident has occurred in the hands of skilful surgeons. A very satisfactory substitute for a rectal bougie is a tallow candle, one end of which is melted or rubbed down to a conical shape.

Enemata. These may be administered by means of the ordinary syringe, or by means of a gravity or fountain syringe; the precautions which should be observed are to introduce the nozzle of the syringe gently and in the right direction, as perforation of the lower portion of the rectum has taken place from the careless and forcible introduction of the nozzle of the enema-syringe; the fluid should also be injected slowly, as by so doing there is less resistance and less tendency for the patient to pass the fluid before the desired quantity has been introduced.

The enema most commonly employed to empty the lower bowel is made by adding a tablespoonful of sweet oil and two teaspoonfuls of spirits of turpentine to one or two pints of warm water in which a little castile soap has been dissolved; warm water and sweet oil are also frequently used for the same purpose.

Glycerin Enema. One or two teaspoonfuls of glycerin injected into the rectum, or a *suppository* made of glycerin, will often be found an efficient substitute for the larger enemata of water.

Nutritious Enema. When it is found necessary to resort to feeding by the rectum, the substances employed should be injected into the rectum by means of a syringe, and care should be taken to see that the quantity is not too large, and that it is of such a nature as not to cause any irritation of the walls of the rectum, or it will not be retained; two to four ounces in the case of an adult is generally a sufficient quantity to inject at one time.

Peptonized milk or beef juice, or the yolk of an egg beaten up with milk, is often employed, and any unirritating drugs may be mixed with the enema and administered at the same time.

Vaccination. This is a minor surgical procedure which every physician is called upon to perform. The surface may be prepared for the reception of the lymph by abrading the skin at one or two points with a dull lancet, or by making several superficial incisions with a knife, or by scratching the surface of the skin with the ivory point charged with lymph, in lines with crossing lines, *cross-scratch*, until a little serum exudes. It is not advisable to draw blood, which washes away the lymph, and for this reason we prefer the abraded surface made by the dull knife or the ivory point.

The lymph used may be the *humanized* or the *bovine.*

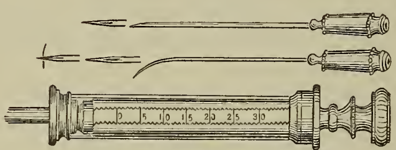
Bovine lymph or *virus*, which is now most generally employed, is taken from the vaccine vesicles upon the udders and teats of heifers. The lymph may be mixed with sterilized glycerin and placed in fine glass tubes which are sealed, or ivory points or quills are dipped in the lymph and allowed to dry, and in using them they are dipped in water for a moment, to moisten the lymph, before being applied to the abraded surface. The ivory-point is one of the most convenient means of vaccination, as the surface may be abraded with it before the lymph is applied.

It has recently been advised that antiseptic precautions be exercised in performing vaccination, and although all of the details cannot be carried out, we have found that the exercise of care as regards cleanliness of the surface has been followed by much fewer inflammatory complications in vaccination wounds.

The surface to be abraded, usually the left arm below the deltoid, is first washed with soap and water, and then with a 1 : 2000 bichloride solution. Two points of this surface, an inch apart, are then abraded by using a knife which has been washed or dipped in boiling water, or by using the ivory point which has been dipped in water which has been boiled and cooled down. When the surface has been prepared in the manner described, the moistened virus is rubbed upon it and allowed to dry. Vaccination upon the leg, which is practised by some physicians to prevent the scar from showing, I think is not to be recommended, and I never practise it in this situation, as it is more difficult to keep this part at rest.

Hypodermic Injections. The syringe used to make hypodermic injections is provided with a perforated needle, which is passed into the cellular tissue (Fig. 147). Care should be taken to see that the instrument and needle are

FIG. 147.

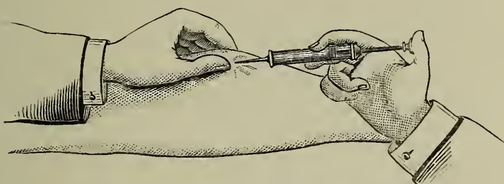


Hypodermic syringe and needles.

perfectly clean before being used; they should be rendered aseptic by soaking them for a few minutes in boiling water or in a 5 per cent. carbolic solution. Hypodermic injections are generally made into parts in which the cellular tissue is abundant, and great care should be observed to avoid introducing the needle into a large vein or artery, as by neglect of this precaution serious symptoms have resulted, from the drug being thrown rapidly into the circulation instead of being slowly absorbed from the subcutaneous cellular tissue; the injury of superficial nerves should also be avoided. Care should also be taken to see that the solutions employed are sterilized if possible, and freshly made solutions should be preferred.

To avoid using solutions for hypodermic use which undergo change from being kept, it will be found convenient to use the compressed pellets which are prepared by the manufacturing chemists, the alkaloids being compressed with a little sulphate of sodium, which increases their solubility, the solution being prepared with boiled water just before being used.

FIG. 148.

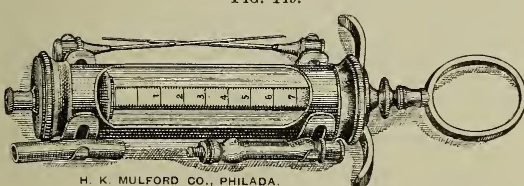


Method of giving a hypodermic injection.

The portions of the body usually selected for hypodermic injection are the outer surface of the thighs or arms and the anterior surface of the forearm. In making a hypodermic injection the syringe is charged and the needle is fastened to the nozzle of the syringe; the skin is next pinched up and the needle is quickly thrust through this into the cellular tissue (Fig. 148); the syringe is then emptied by pressing down the piston, and when the cylinder is empty the needle is withdrawn.

Injection of Antitoxins. In the treatment of diseases such as diphtheria and tetanus by the injection of serum, the

FIG. 149.



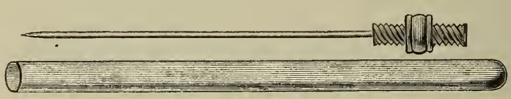
Syringe for serum-injection.

hypodermic method is made use of; in using antitoxin injections in diphtheria the dose of the antitoxin is proportionate to the age and weight of the patient as well as to the severity and duration of the disease. A child three years old should be given 600 to 1000 units; an adult, not less than 1000 units, and the injection should be repeated in twelve to twenty-four hours. Before employing the injection the skin should be sterilized, and the best variety of syringe to employ is one holding about 20 c.c. (Fig. 149).

It is well to have the needle connected with the syringe by a short rubber tube, so that the needle will not be broken if the patient struggles. The injections are usually made below the angle of the scapula or in the lumbar region, and the serum is introduced slowly to avoid local reaction.

Exploring-needle. This consists of a fine-grooved needle fitted into a handle (Fig. 150), which is introduced into tumors or swellings to ascertain the nature of their

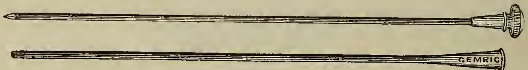
FIG. 150.



Exploring-needle.

contents, and its use is often of service for purposes of diagnosis. The exploring-trocar (Fig. 151) is employed for the same purpose, or the needle of the hypodermic syringe or a fine needle attached to an aspirator may be used for a like purpose. When either the exploring-needle or trocar is employed care should be taken to see

FIG. 151.



Exploring-trocar.

that it is rendered perfectly aseptic before being used; otherwise its employment is not without danger, for we have seen the introduction of an exploring-needle into an effusion in a joint for diagnostic purposes followed by suppuration and destruction of the joint, which subsequently necessitated its excision.

Skin-grafting. This is a surgical procedure which may be employed to fill a gap in the tissues or to hasten cicatrization where large granulating surfaces are exposed, such as result from extensive operations and from burns.

The operation consists in applying shavings of the epidermis or of the epidermis and cutis together, to the granulating surface and holding them in contact with it for a few days; the grafts often seem to disappear, but at the end of a few days, if the part is closely inspected, bluish-white points will be seen to occupy the positions at which the grafts were applied, which become converted into isolated cicatrices from which the healing process rapidly extends. To have a successful result follow the use of skin-grafts the surface of the ulcer should be healthy, and its surface as well as the surrounding skin rendered aseptic, and the grafts should be applied at a number of points.

The surface from which the grafts are to be taken should also be rendered aseptic, and the skin should be removed by scissors or by a sharp razor, or by raising the epidermis with a needle or with forceps, and cutting out a small portion of it with a sharp scalpel. The graft is next applied to the granulating surface with its raw surface in contact with the granulations; after a sufficient number of grafts have been applied, a piece of sterilized protective is laid over them and is held in place by means of a few strips of isinglass plaster. A sterilized gauze dressing is next applied, and the dressing is not disturbed for a week or ten days, at which time, if the grafts have taken, isolated cicatrices at the points where the grafts were applied will be found to exist.

Thiersch's Method. In skin-grafting, according to this method, the surface of the ulcer is rendered aseptic, and all antiseptics are washed away with sterilized salt solution. The surface of the ulcer is next curetted to remove soft granulations, and it is then irrigated and covered with protective, and a compress is applied to control all bleeding.

Shavings of skin are then removed from a surface—which has been rendered aseptic—by means of a razor or section knife. Each graft should be as long and broad as possible, and when cut it should be floated from the section knife by a stream of salt solution and placed upon the prepared surface of the ulcer and gently pressed into place.

After a sufficient number of grafts have been applied, strips of protective are laid over the surface of the grafts, and over these is placed a compress moistened with salt solution and covered by protective, and a few layers of sterilized gauze and cotton are next applied over this, and the dressing is held in position by a bandage.

The dressings need not be removed for a week or ten days, and a second dressing should be applied in the same manner until the grafts have become thoroughly vitalized. The skin of the bellies or backs of frogs, or the hairless skin of young animals may be used in the place of human skin.

Krause's method. Skin-grafting is sometimes accomplished by immediately applying a large piece of skin to a raw surface to fill a gap; the graft in such cases includes the whole thickness of the skin, but has all of the cellular tissue removed from it, and should be cut one-third larger than the gap to be filled to allow for the shrinking after its removal, and is secured in position by sutures.

Bone-grafting. This procedure is resorted to to replace portions of bone which have been separated, to fill up cavities in bone, or to restore the continuity of the long bones. The bone to be introduced should be rendered thoroughly aseptic and should be placed in a sterilized salt solution at a temperature of 100° to 105° F.; it may be inserted in one piece or broken into fragments and laid over the surface.

When it is desired to restore the continuity of one of the long bones, after the surfaces of the bone have been exposed and rendered aseptic, a bone is removed from a freshly killed animal, is rendered aseptic, and fitted into the gap and secured to the ends of the bone by sutures. Or a portion of the bone may be partially separated by a chisel and fitted into the gap, or is split into strips and packed into the cavity.

In the case of parallel bones, such as the tibia and fibula, where there has been a loss in substance of the tibia, the fibula has been divided on a line with the lower end of the tibia, and after freshening the end of the tibia the upper end of the lower fragment of the fibula is shifted over to the tibia and secured to it by sutures.

Bone grafting may also be very satisfactorily accomplished by means of Senn's *decalcified bone plates or chips* which will be found useful in filling up the cavities resulting from the extensive removals of bone in the operations for necrosis or caries.

In such cases, after the cavity has been sterilized, it is dusted with iodoform and is then packed with bone chips; iodoform is next dusted over them and a piece of protective is placed upon them. A compress of iodoform or sterilized gauze and bichloride cotton is next applied, and the dressing is held in position by a bandage.

When bone plates are employed they are cut to fit the cavity, and provision should be made for drainage.

Preparation of Decalcified Bone Chips or Plates. Take sections of the compact tissue of the fresh tibia or femur of an ox, several inches in length, remove the periosteum and medullary tissue, and split in pieces one-half an inch in width, and place them in a 15 per cent. watery solution of hydrochloric acid, allowing them to remain in this for three weeks, changing the solution daily. At the end of this time they should be removed, thoroughly washed and cut in thin strips or plates. They should then be washed in a weak solution of caustic potash, and placed for forty-eight hours in a 1 : 1000 bichloride solution.

After this they may be kept in a solution of iodoform in ether, or in a 1 : 500 solution of bichloride in alcohol until required for use; before being used they should be soaked in a 1 : 2000 bichloride solution.

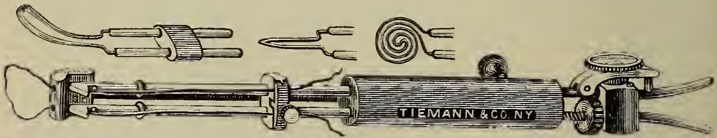
Muscle-grafting and *nerve-grafting* are also occasionally resorted to to supply deficiencies in muscles or nerves, fresh muscle or nerve tissue being employed to fill up the gap.

Electrolysis. Electrolysis, or the chemical decomposition induced by electricity, is employed in surgery to destroy morbid products, tumors, or exudations. For this procedure a galvanic or continuous-current battery is required, which is provided with electrodes and needles of suitable shapes. In applying electrolysis to a tumor, for instance, the needle connected with one of the poles of the battery is inserted into the tumor, and the other rheophore is applied to the surface of the body, or two fine needles, carefully insulated nearly to their extremities, are connected with both poles of the battery by conducting cords; these are introduced into the tumor and a weak current is allowed to pass. The strength of the current is gradually increased as the operation advances; the current is passed for fifteen or twenty minutes, and the procedure is repeated at intervals of several days, until some decided change occurs in the tumor.

Electrolysis has been applied with success in the treatment of aneurism inaccessible to other operative procedures, in malignant growths, in nævi, goitres, cysts, and hydatids. It is at the present time the most satisfactory method of removing superfluous hairs from those portions of the body in which their presence causes disfigurement.

Galvano cautery. Galvano-cautery batteries are constructed with plates of large size, placed closely together,

FIG. 152.



Electrodes for galvano-cautery.

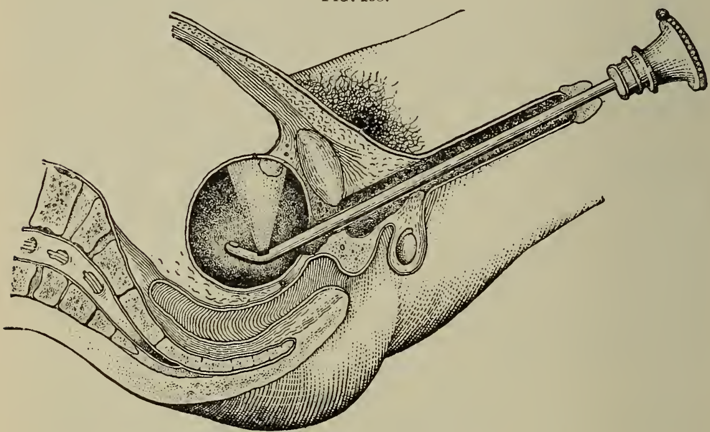
so that the internal resistance is reduced and a current is quickly obtained which will keep a metallic electrode at a white heat. The advantage in the use of this form of cautery is that the electrode can be introduced into the various cavities of the body while cold and quickly heated to the desired temperature. The electrodes are made of various shapes and sizes, according to the object desired (Fig. 152). The galvano-cautery is applied for the same purpose as the actual cautery, but, as previously stated, its use is more convenient in the various cavities of the body, its action can be more easily localized, and by its use hemorrhage is avoided. It is frequently employed to destroy morbid growths in the nasal passages, the throat, vagina, or uterus, and also may be employed in the treatment of superficial external growths; in using it for the removal of growths from the mucous membrane its application may be rendered practically painless by previously thoroughly cocainizing the parts.

Faradization. The application of electricity in this form is often employed in surgical affections; in cases of wasting of the muscles following fractures or sprains, in some forms of club-foot, and in lateral curvature of the spine the judicious use of the faradic current will often be found to be followed by the most satisfactory results. The current is applied in such a manner as to bring about contraction of the affected or wasted muscles, and thus improve their nutrition.

Franklinization. The earliest application of electricity in the treatment of disease was made by the use of statical electricity, and although it fell into disuse it has recently, with the perfection of modern machines, been very widely revived. In applying statical electricity the patient may be treated by insulation, or the so-called dry electric bath. The second method of using statical electricity is by sparks or shocks from a Leyden jar which is charged from the prime conductor of an electrical machine in motion, or by the electric brush. McClure states that in the static induced current we have a means of producing muscular contractions when failure results from the strongest faradic currents that can be borne by the patient.

The Cystoscope. This is an instrument employed for ocular examination of the walls of the bladder, and is one of the most important and useful of the electric-lamp instruments. A cystoscope consists of a beaked sound in which there is a telescopic arrangement by which the inner surface of the bladder is viewed through a small window of rock crystal. The lamp is inclosed in the beak of the instrument and throws its light through another window, also of crystal, upon any part of the bladder wall. For examining the upper part of the bladder, a separate instrument with a small reflecting prism is used. The bladder should contain six or eight ounces of clear urine or clear

FIG. 153.

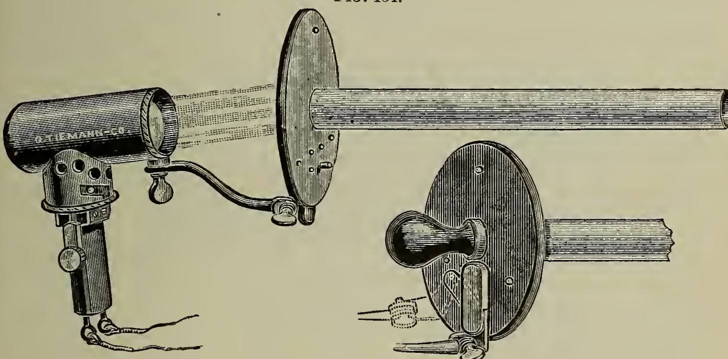


Illumination of the wall of bladder by cystoscope. (PARK.)

water if a proper view of the walls is to be obtained. If the fluid is turbid or contains blood the view is very much obscured; if too little fluid be present in the bladder, the beak of the instrument containing the lamp is likely to become buried in the folds of mucous membrane and the light will be cut off, and, the mucous membrane may be burned. A certain amount of practice is required to use the cystoscope properly and to recognize the appearance of the mucous membrane of the bladder in health and in its varied morbid conditions.

The Urethroscope. The urethroscope consists of a straight metal tube provided with an obturator of hard rubber which projects slightly beyond the end of the tube. This tube is introduced into the urethra until the bladder is reached, when it is slightly withdrawn and the obturator is removed. The instrument is then attached to a mirror or an electric lamp, by which a strong light is thrown into the tube, and as the tube is withdrawn various parts of the urethra are exposed to the view of the surgeon. By

FIG. 154.



The urethroscope.

means of the urethroscope a very accurate inspection of all portions of the urethra can be obtained.

The Panelectroscope. This instrument, introduced by Leiter, consists of an electric lantern with tubes and a mirror. The light from a small incandescent lamp is projected by the mirror along the tube, which is inserted into the part to be examined. Tubes of various sizes are adapted to the instrument. It is employed for endoscopy of the urethra, ear, pharynx, and stomach.

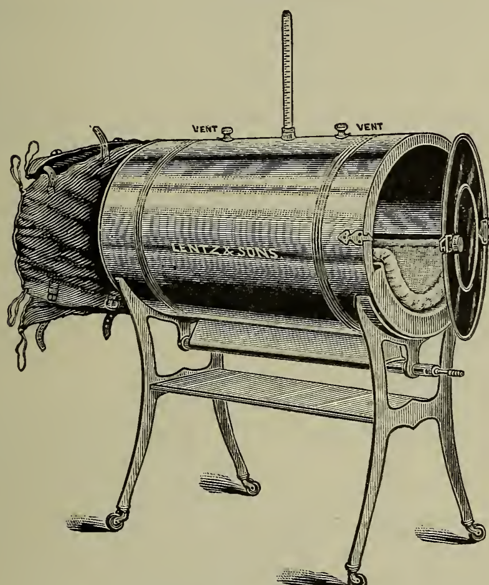
Massage. Massage consists in a variety of manipulations, such as pinching up the integuments and muscles, and rolling them between the thumb and fingers, in stroking or rubbing the surface with the palm of the hand from the periphery toward the centre, to empty the distended veins and lymphatics; rubbing the parts circularly with the extremities of the fingers and thumb or the palm of the hand, or kneading of the parts is another method of practising massage. Massage may also be practised by tapping the surface of the affected part with more or less force with the tips of the fingers held in a row, or with the ulnar border of the hand or with the palm of the hand. Before applying massage to an affected part, if there be a heavy growth of hair, it should be carefully shaved off; otherwise the manipulation may give the patient pain, and irritation of the hair follicles resulting in abscesses will be apt to occur. The part should also be rubbed over with olive oil, vaseline, or cocoa-butter before and during the manipulations.

Massage is often employed with advantage in the treatment of sprains and strains in their subacute and chronic stages. Lucas-Championniére advocates and practises immediate and continuous massage in the treatment of fractures. It will also be found of great service in the later treatment of fractures involving the joints or their vicinity, in restoring the motion of the parts as well as in improving the nutrition of the muscles which have become wasted from disuse.

Passive Motion. This manipulation consists in alternately flexing and extending or rotating the limb to imitate the normal joint-movements. The motions should be carefully practised, and in cases of fracture they should not be undertaken until there is quite firm union at the seat of fracture, or if for any reason passive motion is made use of before this time the fragments should be firmly supported while it is being employed. Other forms of massage, such as stroking and kneading, may be employed in conjunction with passive motion in the treatment of the troublesome stiffness of joints resulting from fractures, dislocations, and sprains; passive motion applied in this manner will often restore the function of a stiff joint more satisfactorily and with less pain to the patient than the forcible manipulations of the joint which are practised under an anæsthetic.

Application of Hot Air. The employment of a continuous hot-air bath has been recently advocated in the treatment of painful and partially anchylosed joints, synovitis, teno-synovitis, and chronic rheumatism. In applying this method of treatment the limb is wrapped loosely in lint, and introduced into a metallic cylinder (Fig. 155),

Fig. 155.

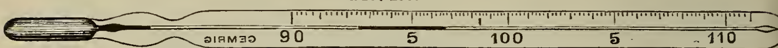


Apparatus for hot-air treatment.

the temperature of which is raised to a point about 300° F. The part is exposed to this temperature for three-quarters of an hour to one hour and at intervals of twenty minutes the door is opened for a short time to allow the ingress of fresh air, and if the part is perspiring it is wiped dry, for if moisture is present upon the limb, burns are more likely to result. Under this form of treatment pain is often temporarily or permanently relieved, synovial effusions disappear, and adhesions are softened and disappear. Clinically it has been found that the best results following this method of treatment have occurred in painful and anchylosed joints following traumatisms, and although temporary improvement has occurred in rheumatic, gouty, tuberculous and gonorrhœal affections of joints, permanent improvement is not so likely to result.

The Clinical Thermometer. For clinical observations two thermometer scales are in general use, the Centigrade and Fahrenheit; the latter is the one commonly employed

FIG. 156.



Clinical thermometer.

in America and in England. This scale has a limited range above and below the normal bodily temperature, which is $98\frac{2}{5}°$ Fahrenheit or 36° Centigrade. Thermometers are now made with a convex surface, which serves to magnify the column of mercury, and thus enables the observer without difficulty to note the position of the index (Fig. 156).

The temperature of the body may be taken in the mouth, axilla, vagina, or rectum; the two former positions are those generally employed. When taken in the axilla care should be exercised to see that no clothing is interposed between the skin and the instrument, and when the

FIG. 157.

Surface thermometer.

mouth is used for thermometric observations the patient should be instructed to keep his lips tightly closed and breathe through his nose. The thermometer should be kept in place for from three to five minutes.

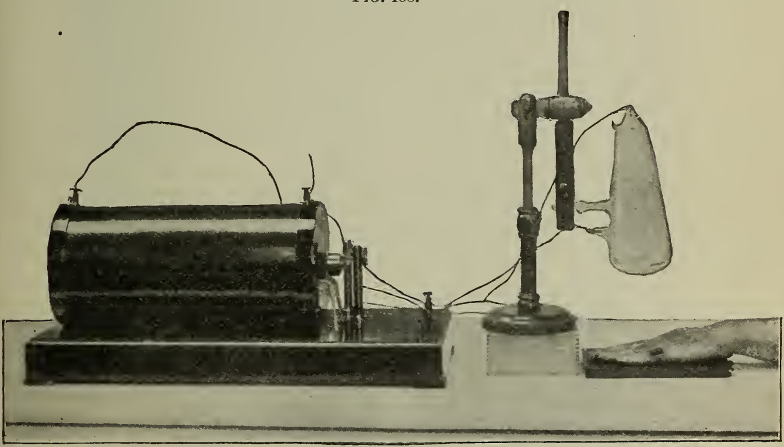
Surface thermometers are sometimes employed, the instruments for this purpose having bulbs of a discoid shape, or being drawn out in the form of a spiral or coil (Fig. 157).

In using this form of thermometer to determine the amount of variation of the surface temperature, the temperature of corresponding parts of the body on the opposite side and the general temperature of the body should be taken at the same time.

SKIAGRAPHY, OR EMPLOYMENT OF THE RÖNTGEN RAYS.

Röntgen, in 1895, while investigating the cathode rays as developed in Crooke's tubes, discovered the energy which he named X-rays. The rays are invisible, but have

FIG. 158.



Apparatus for taking skiagraphs. (PARK.)

great power of penetration, and pass through many substances which are opaque to sunlight and ordinary electric light. If the rays are intercepted by a body not readily permeable, which is placed between the Crooke's tube and a dry photographic plate, a shadow will be formed, and an impression of this shadow will be formed upon the plate.

Such a shadow is known as a *skiagraph*. The *fluoroscope* consists of a fluorescent screen which is so placed that the rays emanating from the Crooke's tube and passing through any intercepted substance to be studied are reflected directly upon it. If the body is more or less resistant, the observer can see it clearly through the skin and subcutaneous tissue.

FIG. 159.

Skiagraph of fracture of both bones of the forearm.

The time of exposure to the rays varies with the strength of the current and the thickness of the tissues. The exposure is usually from three to fifteen minutes. The tube should not be placed too near the surface of the body, and the exposures should be as short as possible.

FIG. 160.

Skiagraph of bullet in knee-joint. (WILLARD.)

There occasionally develops after the use of the X-rays a peculiar disturbance of the tissues, probably trophic in nature, which is known as an X-ray burn. The skin, several weeks after exposure to the rays, may become ulcerated, the nails may be lost, and a very intractable form of ulceration or gangrene develop.

The X-rays are of great value in locating foreign bodies, such as needles, pins, bullets, pieces of glass. They are also employed with advantage in locating mineral calculi in the bladder, ureter, and kidney. They are also of great

FIG. 161.

Skiagraph of fracture of tibia and fibula.

value in detecting the presence of fractures and dislocations. In fractures about the joints, epiphyseal separations, and ununited fractures, their use has proved most satisfactory. Skiagraphs of a fracture are shown in Figs.

159 and 161, of a bullet in the knee-joint in Fig. 160, and of an epiphyseal separation of the humerus in Fig. 162.

Fig. 162.

Skiagraph of separation of upper epiphysis of the humerus.

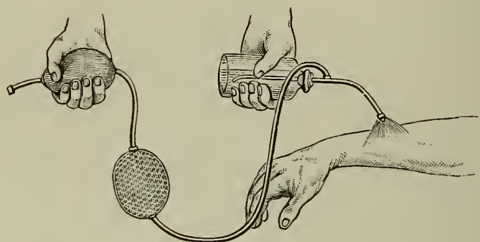
ANÆSTHETICS.

The substances which are employed at the present time to produce either local or general anæsthesia are ice, cocaine, ethyl chloride, rhigolene, nitrous oxide, chloroform, ether, and ethyl bromide.

Local Anæsthesia.

Cold. Local anæsthesia may be produced by the application of cold, either by a piece of ice or a mixture of ice and salt held in contact with the part for one or two minutes, or by directing a spray of *rhigolene* or *sulphuric ether* upon the surface of the part whose sensibility is to be obtunded. (Fig. 163.)

FIG. 163.



Application of rhigolene spray.

Chloride of Ethyl. This substance is also used to produce local anæsthesia, and is conveniently furnished in glass tubes, one end of which is drawn out into a fine point and hermetically sealed. When used the end of the tube is broken off and a fine jet of ethyl is projected upon the surface, the warmth of the hand being sufficient to force the fluid from the tube.

This form of local anæsthesia is made use of in minor surgical procedures, such as aspiration, the opening of abscesses, and the removal of superficial tumors.

Rapid Respiration. Rapidly repeated deep inspirations kept up for a few minutes will produce insensibility to pain, but sensibility to contact is not obliterated. This form of anæsthesia may be made use of in slight operations, such as the opening of an abscess.

Cocaine. Local anæsthesia produced by the employment of an aqueous solution of the hydrochlorate of cocaine, in strength from 1 to 4 per cent., is often made use of in minor surgical procedures. Solutions as strong as 10 or 12 per cent. were formerly employed, but experience has proved that there is always danger in the use of the stronger solutions of cocaine, so that it is now considered wise not to use a solution stronger than 1 or 2 per cent., as the full analgesic effect can be obtained by a solution of this strength. Where the mucous membrane is to be operated upon or growths removed from it, analgesia is produced by brushing the surface over with the solution of cocaine, or by applying a compress of absorbent cotton saturated with the solution to the part for a few minutes; in mucous cavities the latter method of application will be found most convenient. In using a solution of cocaine to produce anæsthesia in operations upon the eye a 2 or 4 per cent. solution is dropped into the eye, and the application is repeated until analgesia is complete.

In applying cocaine to the urethra a 1 to 2 per cent. solution is injected into the urethra, and is allowed to remain for two or three minutes; more than one or two grains should not be injected at one time, as fatal results have followed the injection of larger quantities; this is especially the case in using cocaine in the urethra and the rectum, and in these situations great caution should be exercised in its use.

When it is desired to produce local anæsthesia of the skin or deeper tissues the application of the solution of cocaine to the surface is not satisfactory, and it should in such cases be injected *hypodermically* into the deeper layers of the skin and into the cellular tissue of the parts to be operated upon; to avoid multiple punctures the needle is not completely withdrawn from the wound, but its direction is changed and the solution is thrown into different portions of the tissues. It is well in situations where it can be accomplished to cut off the circulation from the part to be operated upon by placing around it a rubber strap or tube, which prevents the rapid absorption of the cocaine into the general blood-current.

Corning recommends injection of cocaine by the galvanic current. The skin of the region to be anæsthetized is perforated by a number of fine needles, and the perforated area is covered with several thicknesses of flannel cloth saturated with a 5 per cent. solution of cocaine. A layer of potter's clay of the consistence of bread-dough, containing a thin sheet of copper, is placed upon the flannel and the copper plate connected by an insulated wire with the positive pole of a galvanic battery. The negative pole should consist of a broad, flat sponge wrung out in hot water and held as near as possible to the positive pole without touching it. The more extensive the surface to be anæsthetized the stronger should be the current. From three to six cells may be used, and the time required is from ten to twenty minutes.

Some persons have an idiosyncrasy for cocaine, and children seem more susceptible to its constitutional effects than adults. I have seen several instances in children in which marked symptoms of cocaine poisoning resulted from the application of a 4 per cent. solution to the nasal mucous membrane.

The treatment of cocaine poisoning consists in placing the patient in the recumbent position and the hypodermic injection of morphine, strychnine or ether.

Cocaine anæsthesia may be employed with advantage in minor surgical operations, such as amputations of the fingers, circumcision, opening of abscesses, and removal of superficial tumors, but its utility is most marked in operations upon the eye and upon the mucous membranes of the nose, throat, rectum, vagina, and urethra. Applied for a few minutes to the surface of an ulcer which is to be cauterized, it will render the operation almost painless to the patient.

Eucaine Hydrochlorate. This drug, which possesses the same properties as cocaine, as regards the production of analgesia, has recently been employed as a local application to mucous surfaces, and hypodermically in the deeper tissues to produce local anæsthesia. It has the advantage over cocaine that it can be used with safety in much larger quantities, as it is apparently free from toxic action. Kiessel states that 2 grammes have been injected without the production of toxic symptoms. It may be used in solutions varying in strength from 2 to 10 per cent., which can be sterilized by heating ; a 4 per cent. solution is that most usually employed hypodermically.

Guiacol. This drug may be used for its analgesic effect, and is employed in a solution of guiacol, grains xv; alcohol, ʒv, or may be employed in the form of an ointment of guiacol, 5 parts, to vaseline, 30 parts. Or it may be use hypodermically in a one-tenth or one-twentieth solution in olive oil. Its hypodermic use is not unattended with danger.

Infiltration Anæsthesia. It has been shown by Liebreich that the injection of simple water into the tissues in such a way as to produce an artificial œdema induces a transitory anæsthesia.

Schleich found that the combination of a minute quantity of cocaine and morphine with a weak salt solution, when injected hypodermically, produced a local anæsthesia of longer duration.

The anæsthesia is produced by the artificial ischæmia, by the pressure of the injected fluids upon the nerves, and by the direct action of the anæsthetic substances on the nerves.

A solution of 1 part of cocaine to 1000 parts of sterilized water may be used, or the following solution may be employed :

Cocaine hydrochlor.	gr. iss.
Morphiæ hydrochlor.	gr. ⅓.
Sodii chloridi	gr. iij.
Aquæ	℥iijss.

The injection should be first made into the substance of the skin itself, and then into the cellular tissues and deeper structures as desired.

Barker recommends the following solutions for employment in obtaining infiltration anæsthesia : Eucaine, 1 part to 1000 parts of sterilized water, with 8 parts of chloride of sodium. He also recommends elastic constriction applied above the part, as a means of increasing the action of the drug. Solutions with the same freezing-point as the normal fluids of the body should, if possible, be used, as they are indifferent to the tissues; that is, they possess no osmotic action.

Infiltration anæsthesia has been widely employed in minor surgical operations, and also may be employed in major operations, such as herniotomy and amputations, when for any reason a general anæsthesia is not desirable. In children and nervous subjects it cannot be employed with advantage.

General Anæsthesia.

General anæsthesia may be produced by the administration of nitrous oxide gas, ether, chloroform, A. C. E. mixture, Schleich's mixture, or ethyl bromide.

Choice of Anæsthetic. In selecting an anæsthetic the most important considerations are its safety and its suitability to the individual case. In point of safety nitrous oxide gas holds the first place; but, unfortunately, its use is restricted to cases in which only a few minutes' anæsthesia is required. Statistics show that the mortality following the administration of nitrous oxide is about 1 to 5,250,000; of ether, 1 to 16,675; of chloroform, 1 to 3749. Gardner's statistics show that in 22,219 chloroform administrations there were 14 deaths; while in 17,067 administrations of ether or nitrous oxide gas and ether, there was 1 death. It should be remembered, however, that both ether and chloroform are employed in the most serious surgical procedures, while nitrous oxide gas is only used in trivial operations, so that many of the deaths attibuted to ether and chloroform may have been due to conditions resulting from the operations themselves.

Nitrous Oxide Gas. This gas is administered for the purpose of producing anæsthesia, and the apparatus best suited for its administration consists of a cylinder of metal in which the gas is compressed ; this is attached to a rubber bag which has a mouthpiece fastened to it; this is provided with a double valve, which prevents the expired air from passing back into the bag. The mouthpiece is adjusted over the mouth, and after removing any false teeth, or foreign bodies, from the mouth, the patient is instructed to take deep, full breaths, and in from one-half to one minute the face becomes congested and dusky, and the breathing becomes stertorous, indicating that the patient is fully under the influence of the gas. The anæsthesia from nitrous oxide cannot be prolonged for more than a few minutes, so that it can only be employed in operations which take a short time for their performance, such as the extraction of teeth and the opening of abscesses. Unfortunately, it cannot be used in the reduction of fractures or dislocations, as it does not produce complete muscular relaxation. In England nitrous oxide is frequently used to produce anæsthesia, and when this result is accomplished the anæsthesia is kept up by the administration of ether by the employment of a special apparatus devised for this purpose. Nitrous oxide gas is most commonly employed in dental surgery to produce anæsthesia for the removal of teeth, but is also occasionally employed in minor surgical operations; but from the fact that the apparatus for its administration is a bulky one, its use is not so convenient as ether or chloroform, and in this country it is not much employed in general surgery.

Nitrous oxide gas may also be administered by the open method, or by an open inhaler resembling in structure that of Allis. The gas, being heavier than the air, is introduced into the inhaler and falls to the bottom. Flux, who has employed this method of administration in a number of cases, claims that by its employment excitement, stertor, lividity, struggling and convulsive movements are done away with.

Ether. Sulphuric ether is one of the most widely employed substances in surgery to produce anæsthesia; it is probably the safest of all anæsthetics, except nitrous oxide gas, ~~and for~~ this reason should be given the preference over all others.

Preparation of Patient. A patient should be prepared for the administration of ether by not allowing him to have any solid food for at least six hours before its inhalation; he should be in the recumbent posture, and any garments about the chest or neck should be loosened so that the respiratory movements are not interfered with. The surgeon should also see that any false teeth or foreign bodies which may be present in the mouth are removed before the administration of the drug is begun. As the vapor of ether often causes irritation of the mucous membrane of the lips and nasal passages, it is well to anoint these parts with a little vaseline or cold-cream before administering the ether.

Some surgeons recommend that the stomach, if it contains food, should be washed out by means of the stomach-pump, and insist upon this washing out of the stomach before operation in cases of intestinal obstruction, as the stomach may contain stercoraceous matter which may be drawn into the respiratory passages if vomiting occurs, and cause aspiration pneumonia.

It should also be borne in mind that the vapor of ether is very inflammable, and that it is heavier than the air, so that lights brought near the patient while being etherized should be held at a higher level than the ether-can or inhaler.

The anæsthetizer should always listen to the patient's heart before giving an anæsthetic; this enables him to detect any irregularity in its action, and at the same time has a good moral effect upon the patient, especially if he can assure him that he is in good condition to take the anæsthetic.

It is also well to have another physician present during the administration of a general anæsthetic, as unforeseen difficulties occasionally arise. There should always be at hand tongue forceps, instruments with which tracheotomy may be performed if necessary, also nitrite of amyl, digitalis, strychnine, and a hypodermic syringe.

In debilitated patients or those who are weak from the loss of blood the administration of half an ounce to an ounce of whiskey from fifteen to thirty minutes before the anæsthetic is given is often advisable.

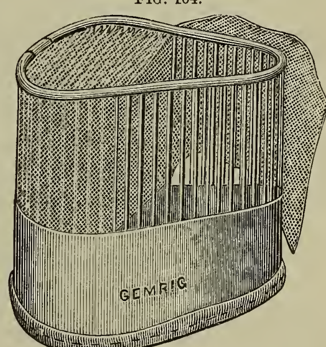
The person instrusted with the administration of the anæsthetic should watch the patient closely, and should not have his attention diverted by the operation; he should carefully observe the pulse, respiration, and color of the patient's face, and be ready to withdraw the anæsthetic upon the development of any symptom of danger, and to treat such symptoms should they arise.

An anæsthetic should never be given to a woman without the presence of a third person, as in some cases these agents give rise to erotic dreams, and it may be difficult to disabuse the patient's mind of the idea that an assault has been committed unless the evidence of eye-witnesses at the time of the anæsthetization can be brought forward to prove that such was not the case.

Ether produces more irritation of the respiratory tract than chloroform, and administration of the former anæsthetic is sometimes followed by the development of bronchitis, pulmonary congestion, or pneumonia. These complications are less likely to occur if care is taken to avoid the administration of ether in patients who are suffering from bronchial irritation, and to see that a patient who has taken ether is not exposed to draughts and is not allowed to go out into the cold or moist air immediately after taking the anæsthetic.

Administration of Ether. In the administration of ether a towel folded into a cone or one of the various ether inhalers may be employed. The best of these is Allis's inhaler, which consists of a metallic framework covered with leather or a nickel-plated case, which carries a number of folds of a roller-bandage, giving a large surface for the rapid evaporation of the drug (Fig. 164).

Fig. 164.



Allis's ether inhaler.

If a towel folded into a cone is used, a few layers of stiff paper interposed between the outer layers of the towel will keep the cone in shape and will prevent the evaporation of the ether from its external surface.

For the administration of an anæsthetic the patient should be in the recumbent posture and the head should be turned to one side, as in this position mucus is less apt to collect in the pharynx and interfere with the breathing.

In administering ether two to four drachms of ether are poured into a cone or inhaler and placed over the nose and mouth of the patient. He is then requested to take deep breaths, or to blow the ether away, which latter procedure causes him to take deep inspirations. In the beginning of etherization the patient will resist the inhalation much less if the ether is given slowly with a plentiful admixture of air. The first effect of the inhalation of ether is to produce acceleration of the pulse and respiration; the mucous membrane of the air-passages is irritated, and coughing often occurs; there is also in this stage a disposition to muscular movements, and it is frequently necessary to restrain the patient; the brain is also excited, and the patient is apt to cry out. These symptoms call for a continuance of the administration of the ether, and not for its withdrawal. To avoid the irritation of the mucous membrane of the air-passages during the administration of ether, it has been suggested that the nasal mucous membrane be sprayed with a 2 per cent. solution of cocaine just before administration of the anæsthetic, and this spraying should be repeated every half hour while the anæsthetic is used. By the use of cocaine in this manner the nasal reflexes are diminished, the stage of excitement is shortened, the sense of suffocation is diminished, and vomiting is less likely to occur. Succeeding the stage of excitement, if the ether be pushed, profound anæsthesia takes place, as is evidenced by the loss of consciousness, relaxation of the muscular system, moist skin, loss of special senses, contracted pupils, and slow and deep respiration, tending to become stertorous. When the conjunctiva is insensitive to the touch of the finger, anæsthesia is usually profound. When the anæsthesia is complete the amount of ether inhaled should be diminished, and the patient given only so much as will keep him well under its influence. It is surprising how small a quantity of ether the careful and watchful anæsthetizer will require to keep the patient fully under its effects for a very considerable time.

The time required to produce anæsthesia by ether varies in different cases : anæsthesia is produced in children in a few minutes; in adults, from ten to twenty minutes are usually required; drunkards and those who have taken ether frequently require a larger amount of ether, and take a longer time to come under its influence. When the administration of the drug is stopped the patient may continue for some time in an unconscious condition, resembling a quiet sleep, or he may awake and exhibit more or less symptoms of cerebral excitement.

First Insensibility from Ether. There often exists in the early course of the administration of ether a stage of primary anæsthesia, which lasts for a minute or more, and which may be taken advantage of to perform such a minor surgical operation as the opening of an abscess, the reduction of a dislocation or fracture, or the extraction of a tooth. The recovery from this condition is usually very prompt, and is not followed by nausea or the after-effects which attend the prolonged administration of ether.

Accidents During Etherization. During the administration of ether, particularly in the early stage, the patient may suddenly stop breathing, the face at the same time becoming cyanosed. This condition calls for the withdrawal of the ether, and if an inspiratory effort does not quickly follow, pressure should be made upon the front of the chest, and when this is relaxed, a deep inspiration usually takes place, and no further difficulty is experienced. This condition should not be confounded with the very common effort of holding the breath, the latter occurring with the chest fully expanded, the former with the chest empty.

Vomiting may occur during etherization, and the vomited matter may accumulate in the pharynx or the mouth, and obstruct the breathing, or may enter the larynx or trachea and cause a like result. Vomiting is more apt to take place if solid food has been taken shortly before the administration of the anæsthetic. If this accident occurs and interferes with breathing, the jaws should be opened and the head turned to one side, and the vomited matter will usually escape without difficulty. If, however, food has entered the larynx, and is not ejected by coughing, it will be necessary to perform tracheotomy promptly, and hold the tracheal wound open, or to introduce a tube and practice artificial respiration. The breathing may also be obstructed by the accumulation of *mucus* and *saliva* in the pharynx. This is less likely to occur if the head is kept to one side during the administration of the drug; if it occurs, the head should be turned to one side, the jaws opened, and the material removed by small sponges or pieces of gauze fixed to sponge-holders.

The *tongue* may fall backward and obstruct the breathing when muscular relaxation is complete during anæsthesia; this accident is also less likely to occur if the head is

Fig. 165.

Pushing the jaw forward.

kept on one side during etherization. If asphyxia results from falling back of the tongue, it should be brought forward by placing the fingers on each side beneath the angles of the inferior maxillary bone, and pushing the jaw forward, at the same time over-extending the neck by bending the head backward (Fig. 165), or the mouth should be opened and the tongue drawn forward by tongue forceps. Either of these manipulations is usually sufficient to reestablish the respiratory movements.

If, however, in any of these forms of mechanical asphyxia respiratory action is not promptly restored, some form of artificial respiration should be promptly resorted to, either Laborde's, Silvester's, Howard's, or forced respiration, and of these Laborde's method, by rhythmical traction of the tongue, and Silvester's have yielded the most satisfactory results. Efforts at resuscitation in these cases should be persevered in for at least half an hour, as apparently hopeless cases have been saved by persistent use of these means.

Failure of respiration may also occur from paralysis of the respiratory centres, or spasm of the respiratory muscles; the former may occur from an overdose of the anæsthetic, or from intercurrent asphyxia, syncope, or morbid states of the respiratory system.

Spasmodic respiratory failure may occur before complete anæsthesia, and is liable to arise in muscular and emphysematous subjects. Respiratory failure from either of these causes should be promptly treated by artificial respiration and the hypodermic use of strychnine, atropine, or digitalis.

After-effects of Ether. After complete anæsthesia from ether nausea and vomiting are very common, and both are more apt to follow in case the patient has taken food shortly before the administration of the anæsthetic. They may last for only a short time, or may persist for hours. If persistent, the swallowing of a few mouthfuls of hot water will often relieve the condition, or the administration of cocaine hydrochlorate, grain one-quarter, with crushed ice, repeated two or three times, or the use of crushed ice with champagne or brandy, may be followed by satisfactory results. The inhalation of the fumes of *vinegar* will often prevent nausea and vomiting, the vinegar being poured upon a towel or a piece of gauze, which is held over the mouth and nose of the patient, and it should be applied as soon as the administration of the ether is stopped; it should be used continuously for some time to be followed by the best results.

Chloroform. A patient is prepared for the administration of chloroform as in the case of ether, the same precautions being taken as regards the removal of false teeth or foreign bodies from the mouth, and to see that the clothing about the chest and neck does not restrict the circulation or respiratory movements. Chloroform is certainly a much more dangerous anæsthetic than ether, and although it is widely used in the British Islands and upon the Continent, it is not extensively used in this country except in certain districts—as in the southern and southwestern districts of the United States, and here its use is followed by fewer fatalities than in the northern districts, so that it is possible that its use is safer in warm climates. Clinical experience has demonstrated the fact that chloroform can be used in aged and very young subjects and in puerperal patients with comparative safety; deaths from chloroform are more common in the middle period of life. It is also to be preferred to ether in patients suffering from emphysema of the lungs, bronchitis, and vascular degeneration of the kidneys. It is also employed by some surgeons instead of ether in operations upon the mouth when the actual cautery is employed, on account of its less inflammable character.

Considerable diversity of opinion exists among different observers as to whether death resulting from chloroform is due to failure of the heart or failure of the respiration, and each has brought forward a large amount of evidence to prove his views correct. Although it has been demonstrated that chloroform is a direct depressant and paralyzant to the heart-muscle or its contained ganglia, and that cardiac dilatation of varying degrees may be brought about by the administration of chloroform, yet clinical experience shows that paralysis of the respiratory centres is probably the most important factor in causing death during chloroform anæsthesia, for circulatory failure in these cases is due to embarrassed or suspended breathing, and the only method of treatment which has been found of value is that which tends to bring about respiratory action—namely, some one of the various forms of artificial respiration.

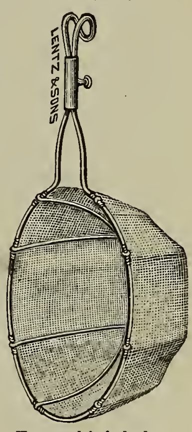
Chloroform is more dangerous in the earlier stages of the administration, and the gravity of the operation appears to have little effect in increasing its danger, as statistics show that the greatest number of fatalities have occurred in minor surgical procedures, such as extracting teeth, amputation of the finger, reduction of dislocations, and opening abscesses.

Administration of Chloroform. Chloroform is administered by pouring a drachm of the drug upon a folded towel, which is first held a few inches from the mouth and nose, and gradually brought nearer, but is not allowed to come in contact with the face, as from its local irritating action it will blister the surface; the lips and anterior nares should be anointed with vaseline.

The anæsthetizer should remember that one of the dangers in the administration of chloroform is the risk of too great concentration of its vapor, so that he should see that a sufficient admixture of atmospheric air takes place.

Chloroform may also be administered with Esmarch's inhaler, which consists of a wire frame covered with gauze (Fig. 166).

Fig. 166.



Esmarch's inhaler.

Various inhalers have been devised to regulate the amount of chloroform administered and to secure the proper admixture of atmospheric air, and the best of these is probably Mr. Clover's apparatus.

Profound chloroform anæsthesia is manifested by insensibility of the conjunctiva to the touch, absence of the reflexes, complete muscular relaxation, and, usually, contracted pupils. When this stage is reached the inhalation should be stopped, and after this time only so much chloroform should be administered as is sufficient to keep the patient fully under its influence.

Complete anæsthesia should be produced before any operation is begun; if undertaken before that time, syncope may be produced by reflex inhibition of the heart. If convulsive movements take place before the patient is fully anæsthetized, and the face becomes cyanosed, the inhalatation should be discontinued until these symptoms disappear. The pupils should also be carefully watched, to see if they respond to light or if they are contracted. If the anæsthesia is not complete, insensibility to light or wide dilatation is a sign of danger which calls for the removal of the anæsthetic and active treatment to stimulate the circulation and respiration. If the inhalation of chloroform has been stopped and is again in a short time resorted to, it should be given very carefully and slowly, for syncope may suddenly develop from the fact that the heart or the respiration may feel the effect of the previous use of the drug.

Accidents During Chloroform Anæsthesia. *Mechanical asphyxia* may occur during anæsthesia produced by chloroform, as well as that by ether, by the obstruction of the respiratory passages by blood, mucus, foreign bodies, or the tongue falling backward over the epiglottis. These accidents should be treated in the same manner as similar accidents occurring during etherization.

Death during the administration of chloroform may result from cardiac syncope or from respiratory arrest, and the dangerous symptoms develop so rapidly that the greatest promptness is required to meet them. The person administering chloroform should constantly watch both the pulse and the respiration, and should not for a moment have his attention diverted from the patient; great vigilance is here, if possible, more important than during the administration of ether.

Respiratory Arrest. During chloroform anæsthesia paralysis of the respiratory centres may occur, giving rise to respiratory arrest. If this dangerous symptom appears the patient's head should be lowered and artificial respiration should be promptly employed to re-establish the respiratory function.

Cardiac syncope developing during the administration of chloroform, manifested by pallor, fluttering or arrested pulse, and cessation of respiration, should be treated by lowering the patient's head, or inverting the patient, the use of a rapidly interrupted electric current, the hypodermic injection of digitalis, atropine, or strychnine, and the employment of artificial respiration, either Silvester's, the direct method, or Laborde's method, and, as in cases of threatened death from ether, the treatment should not be desisted from for some time, as by persistent employment of these means apparently hopeless cases have been resuscitated.

Ether and Chloroform. The production of anæsthesia by the administration of ether followed by chloroform, as recommended by Hewitt, has been employed in a large number of cases with satisfactory results. In producing anæsthesia by this method, ether is first given until anæsthesia is produced, and the anæsthetic effect is then kept up by the administration of chloroform. Hewitt considers it advisable in this method of anæsthesia to let the patient come up slightly, so that there is conjunctival reflex before the chloroform is substituted, and also advises that the operation should not be undertaken until the change has been made.

The A.–C.–E. Mixture. This mixture, which consists of 3 parts of chloroform, 1 part of ether, and 1 part of alcohol, has been employed by some surgeons in the place of ether or chloroform, with the idea that the dangers of chloroform are diminished by its combination with ether and alcohol. Clinical experience, however, has not proved this view to be correct. If administered with as much care as chloroform, its administration is accompanied with the same safety. It should be administered upon a towel or inhaler in the same manner as chloroform, and the patient should be watched as carefully during its inhalation as during the administration of the latter drug, and any complications occurring should be treated in the same manner as those arising during the use of chloroform.

Schleich's Anæsthetic Mixture. Schleich has recently introduced an anæsthetic mixture which he considers safer than ether or chloroform. He maintains that the absorption of a general anæsthetic is chiefly regulated by the boiling-point or point of maximum evaporation of the anæsthetic. An anæsthetic is unsafe in direct proportion to the amount absorbed, and the lower the boiling-point of the anæsthetic the less is absorbed; hence an anæsthetic to be safe should have a low boiling-point. A safe anæsthetic is one in which the point of maximum evaporation is near the temperature of the patient, so that as much of the anæsthetic will be exhaled upon expiration as is inhaled on inspiration. Schleich employs three mixtures. The *first* contains by volume chloroform, ℥iss; petroleum ether, ℥ss; sulphuric ether, ℥vj. The *second* contains chloroform, ℥iss; petroleum ether, ℥ss; sulphuric ether, ℥v. The *third* contains chloroform, ℥j; petroleum ether, ℥ss; sulphuric ether, ℥ij, ʒiiss. This anæsthetic can be administered upon a towel or inhaler. It is claimed that by the use of these anæsthetic mixtures little excitement is produced and cyanosis rarely occurs; that there is no hypersecretion of mucus and no consecutive bronchitis or pneumonia, and that the anæsthetic state is quiet, reaction is rapid, and vomiting occurs in less than half the cases.

Bromide of Ethyl. This drug was introduced as an anæsthetic some years ago, but as a number of deaths followed its use, it was abandoned. The time required to produce anæsthesia is shorter than for ether, but there is often induced violent muscular spasm, which renders it an unsuitable anæsthetic in many cases.

Bromide of ethyl has again been revived as an anæsthetic, but clinical experience has found that its use is not devoid of danger, that it is not as safe an anæsthetic as ether, and that it possesses no advantages in point of safety over chloroform. When used it should be administered by pouring a drachm or two upon an inhaler or a towel, and the patient should be watched with the same care as during the administration of chloroform.

Oxygen Gas with Ether or Chloroform. Ether and chloroform have recenly been administered with oxygen gas, and this seems to be a useful addition to our methods of producing anæsthesia by these anæsthetics.

The combination of ether vapor and oxygen forms a highly explosive mixture, so that care should be exercised not to bring a flame near the patient during its administration. Chloroform when mixed with oxygen does not form an explosive mixture. In employing these combinations to produce anæsthesia the patient is first allowed to inhale a small amount of ether or chloroform from an inhaler, and a tube connected with a receiver and wash bottle is introduced into the inhaler, and the oxygen gas is then turned on, so that the patient is allowed to inhale at the same time the vapor of the anæsthetic and oxygen gas.

Special forms of apparatus are also furnished in which the gases are mixed before being introduced into the inhaler.

By the administration of oxygen gas with the anæsthetic substance cyanosis is less likely to develop, accidents are more rare, and it is claimed that vomiting is often entirely avoided, and that the patient recovers much more promptly from the condition of anæsthesia.

After-effects of Anæsthesia. Nausea is not common after chloroform anæsthesia. The treatment of this condition following etherization has been previously described. The temperature is usually notably lowered by anæsthetics, so that it is always well to apply artificial heat and keep the patient well covered. A form of mental disturbance known as *confusional insanity* is often attributed to the use of anæsthetics, but, as it does not usually develop until some time, often two or three weeks, after their employment, H. C. Wood is of the opinion that the relation between the mental symptoms and the anæsthesia has not been clearly proved in these cases, and that it is rather the outcome of a peculiar depression of the cerebral cortex produced by the shock of the operation itself, or by the emotional strain due to the surgical illness. This view seems to be confirmed by the fact that many of the cases of emotional insanity which are observed follow injuries in which no anæsthetic has been given. Albuminuria and glycosuria may follow the administration of ether or chloroform, but are usually only temporary conditions.

Paralysis of the nerves of the brachial plexus may follow prolonged anæsthesia when the arm is drawn high above the head, and is not due to the anæsthetic, but results from stretching of the nerves over the head of the humerus or their compression between the clavicle and the first rib.

TRUSSES.

A truss for the palliative treatment of hernia is a mechanical contrivance with one or more pads and a strap; these are held in position by a spring to which they are attached, which holds the pad in contact with the skin over the hernial opening.

They are usually applied in cases of reducible and sometimes in irreducible herniæ, and are used in the treatment of herniæ at all ages; in infants and young children the continued use of a properly fitting truss is often followed by a radical cure of the hernia.

Trusses are made with steel or rubber springs and with pads of wood, rubber, celluloid, or horsehair, covered with chamois, and their shape and the pressure which they should exert vary with the variety of hernia for which they are applied.

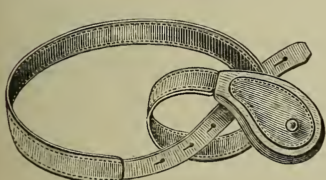
A firm compress applied over the inguinal canal or crural ring, secured in position by a firmly applied spica-of-the-groin bandage, forms a very satisfactory temporary means of preventing the descent of a hernia.

A properly fitting truss should be worn without discomfort to the patient—that is, should not make too much pressure upon the skin at the points where the pads are applied, and should absolutely prevent the descent of the hernia. In testing the adequacy of a truss, after application, to prevent the escape of the hernia, the patient should be instructed to separate his legs, bend forward over the back of a chair, and cough or strain deeply; if this does not bring the hernia down, its control of the rupture may be considered satisfactory.

Trusses should be applied after the complete reduction of the hernia, while the patient is in the recumbent posture. When first applied the truss should be worn both during the night and day, and if the skin becomes tender at the points of pressure, it should be sponged with alcohol and alum, then dried and dusted with powdered starch or lycopodium. Patients at first sometimes complain of discomfort in wearing a truss, but they soon become accustomed to its presence. After a truss has been worn for some time its use at night, while the patient is in bed, may be dispensed with, but the patient should not remove it until he is in bed in the recumbent posture, and he should reapply it before he rises in the morning. In children it is better to have the truss worn continuously, and if it is removed for bathing the nurse should be instructed to place her finger over the ring to prevent the descent of the hernia until the truss is reapplied. In applying trusses to male children care should be taken not to make pressure upon an undescended testicle.

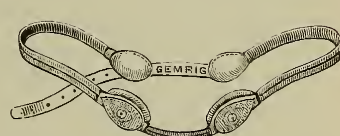
Trusses for Inguinal Hernia. In measuring a patient for this form of truss the circumference of the body midway between the crest of the ilium and the great trochanter should be taken, and the distance from the symphysis

Fig. 167.



Truss for inguinal hernia.

Fig. 168.



Hood's truss.

pubis to the anterior superior spinous process of the ilium may also be given, as half of this distance corresponds to the position of the internal abdominal ring. In reducible inguinal hernia the truss-pressure should be exerted upon the inguinal canal and directly backward. To control this variety of hernia a single-spring truss (Fig. 167) may be employed, or the use of a truss having a double spring with flat pads on each side of the spine attached to the springs, and a smaller pad over the inguinal canal on the unaffected side, with a full pad on the side of the hernia, will often be found most satisfactory. This, which is known as Hood's truss, is one which will be found a very satisfacrory instrument both in inguinal and femoral hernia (Fig. 168).

Trusses for Femoral Hernia. In measuring a patient for this variety of truss, the circumference of the body midway between the crest of the ilium and the great trochanter should be taken; the distance of the saphenous opening from the symphysis pubis, as well as from the anterior iliac spine, should also be taken. In reducible femoral hernia the truss-pressure should be directed backward against the femoral canal, and the pad should be large enough to make pressure upon the adjacent tissues through which the hernia passes, as well as upon the relaxed tissues covering the femoral canal. As in inguinal hernia, either a single or a double spring truss may be employed (Fig. 169).

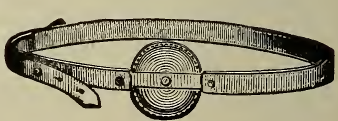
In applying a truss for femoral hernia, care should be taken to see that the pad does not rest upon the pubis, and thus remove the pressure from the crural ring and adjacent tissues and prevent the proper control of the hernia.

Trusses for Umbilical Hernia. In measuring a patient for this variety of truss, the circumference of the body over the umbilicus should be taken.

FIG. 169.

Hood's truss for femoral hernia.

FIG. 170.



Truss for umbilical hernia.

In reducible umbilical hernia the truss-pressure should be directed backward, and the pad should bear rather on the tendinous margins of the ring than on the hernial opening. A truss for this variety of hernia should have a flat or slightly convex pad, which is held in position over the umbilical ring by means of springs having counter-pads on either side of the spine attached to their extremities; these are fastened together by a strap (Fig. 170).

A simple and satisfactory truss for umbilical hernia in infants consists of a penny covered by adhesive plaster, or a small flat compress of linen, held over the umbilical ring by one or two strips of adhesive plaster about two inches in width, or by a broad strip of perforated rubber adhesive plaster, and should be applied so as to cover in about the anterior two-thirds of the body. A penny, or a small, flat compress of linen, will be found much more satisfactory than the conical rubber or cork pad which is often recommended.

Trusses for Irreducible Hernia. The application of a truss to this variety of hernia secures the hernia from injury and prevents its further protrusion. Such trusses are secured in the same way as those for reducible hernia, but the pads are made concave or cup-shaped, or may have an air-cushion or water-cushion attached to the pad.

CATHETERS AND BOUGIES.

Catheters are hollow tubes, made either of metal, India-rubber, or other flexible substances.

Sterilization of Catheters and Bougies. To avoid infection of the bladder it is important that catheters and bougies should be thoroughly sterilized before being introduced. Metallic catheters and bougies are best sterilized by boiling. Rubber instruments may be sterilized in the same manner, but repeated boiling destroys them, so that the latter should be carefully washed with soap and water, and then placed in a 1 : 1000 bichloride solution for half an hour, and then rinsed in sterilized water before being introduced.

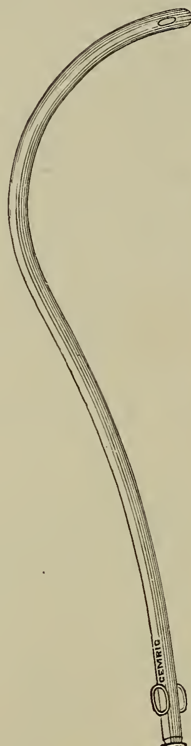
Recent investigations have shown that very satisfactory sterilization of catheters and bougies may be accomplished by exposing them to the vapor of paraform in a closed metallic box (see p. 147).

Infection of the bladder may occur from matter contained in the urethra, so that the urethra should also be sterilized. If it is possible the patient should pass the

Fig. 171.

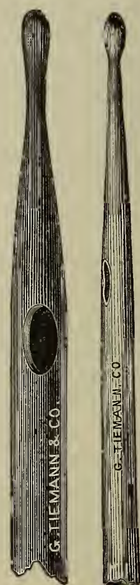
Metallic catheter.

Fig. 172.



Prostatic catheter.

Fig. 173.



French flexible catheters.

Fig. 174.

Mercier's elbowed catheter.

urine to wash out the urethra, and a solution of boric acid or boro-salicylic solutions should be injected before the instrument is passed.

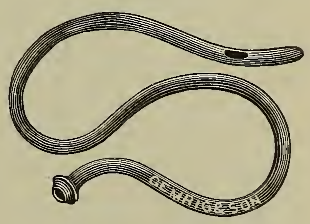
To lubricate the instrument some sterilized substance, such as vaseline, boroglyceride, or olive oil should be employed; any of these substances may be rendered sterile by heat.

Metallic Catheters. These are made of silver, or, if constructed of other metals, they should be plated with silver or nickel, to give them a smooth, bright surface which can easily be kept perfectly clean; and their shape should conform to that of the normal urethra (Fig. 171). The shape of the metallic catheter is sometimes changed to meet certain indications; for instance, the metallic catheter for use in cases of enlarged prostate is longer and has a larger curve than the ordinary instrument (Fig. 172). The metallic female catheter is shorter and has a much smaller curve than the instrument used for the male urethra. A female catheter made of glass is now frequently employed and has the advantage of easy sterilization.

Flexible Catheters. The most commonly used variety of flexible catheter is that known as the English catheter, which is made of linen and shellac, and is provided with a stylet; it can be moulded into any shape desired by dipping it into hot water, which renders it very flexible, and, after moulding it to the proper curve, this can be fixed by immersing it in cold water, which hardens it again.

The French flexible catheters are made of India-rubber, or a combination of this material with other substances. These instruments are conical toward their extremities, and terminate in an olive-shaped point; they are provided with one or two smoothly finished eyes near their vesical extremities (Fig. 173).

FIG. 175.



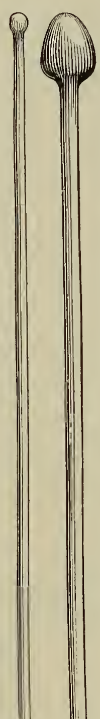
Soft rubber catheter.

Another form of flexible catheter, known as the elbow-catheter or Mercier's catheter (Fig. 174), has an angle or elbow near its vesical extremity; this is often found a satisfactory instrument to use in cases of enlarged prostate.

A variety of flexible catheter made of soft India-rubber is also sometimes employed (Fig. 175).

Catheters and bougies are made according to a certain scale. The English scale runs from 1 to 12; the American from 1 to 20; and the French from 1 to 40.

FIG. 176.



Bulbous or acorn-pointed bougies.

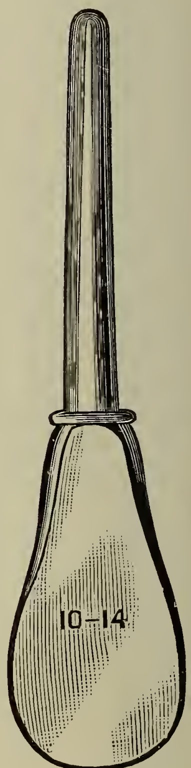
FIG. 177.

Filiform bougies

FIG. 178.

Steel sound.

FIG. 179.



Sound for dilating meatus.

Bougies and Sounds. **Bougies.** These are flexible intruments which correspond in size and shape to the

English and French catheters, and beside there are the acorn-pointed bougie (Fig. 176) and the filiform bougie, which is made of whalebone or of the same material as the ordinary French bougie and catheter. These instruments are of very small size and can often be passed through strictures which will admit no other form of instrument (Fig. 177).

Sounds. These are solid instruments usually made of steel with a smooth surface and plated with nickel; they correspond in size and have the same curve as the metallic catheter; the handle is flattened to allow the operator to grasp them firmly; they are employed in the treatment of strictures by dilatation (Fig. 178). The sound used in dilatating strictures of the meatus is straight and is shorter than the sound employed in the treatment of urethral strictures (Fig. 179). A metallic sound with a larger curve than the ordinary sound is used for exploration of the bladder for calculus or tumor.

Introduction of a Catheter. For the introduction of a catheter the patient may be in the standing, sitting, or recumbent posture, and the latter is the best in most cases; he should rest squarely on his back and have the thighs a little flexed and separated.

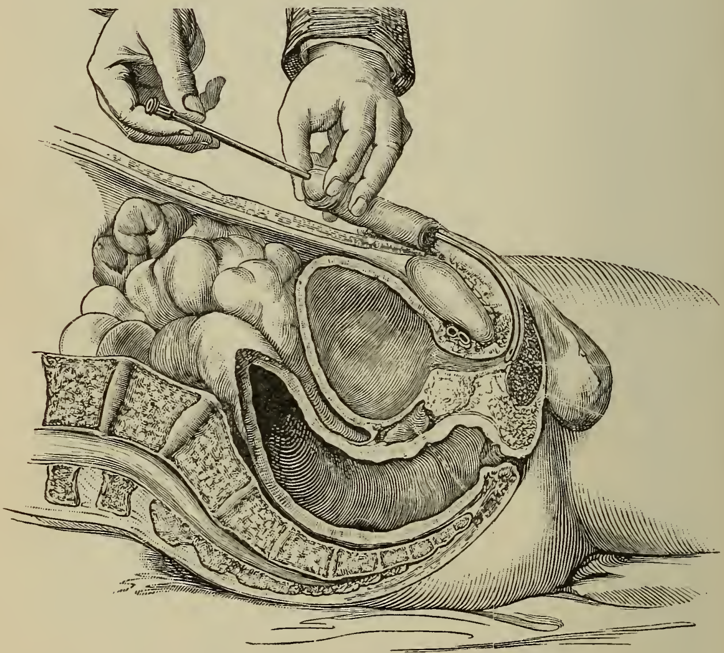
Before passing a metallic catheter the surgeon should see that it has been sterilized, and after warming and oiling it he stands upon the left side of the patient and grasps the penis with the left hand, and turns it over the pubis and introduces the beak of the catheter into the meatus, and gently passes it along the urethra until its point passes beneath the symphysis pubis; at this point the handle is elevated and gently depressed between the thighs, and the beak will pass into the bladder (Fig. 180).

When the prostatic region is reached difficulty is some times experienced in the further passage of the instrument; this may be overcome by introducing the finger into the rectum and guiding the catheter through the prostatic urethra, or if the prostate is found much enlarged, the catheter should be withdrawn, and a prostatic catheter (Fig. 172) should be substituted for it.

The same manipulation is made use of in passing metallic sounds.

Flexible catheters and bougies are passed by grasping the penis and holding it in such a position that it is at a right angle to the axis of the body, and the catheter or bougie is passed into the meatus and carried through the urethra into the bladder by gently pushing the instrument downward.

Fig. 180.



Introduction of a catheter. (Voillemier.)

In this variety of instrument, which has no curve, the surgeon has no means of guiding the point of the instrument, and if an obstruction is met, he should withdraw the instrument slightly and make another attempt; all manipulations should be extremely gentle.

Passing the Female Catheter. It was formerly considered important to pass the female catheter without exposing the patient. At the present time this is rarely done, as it is considered more important to sterilize the vulva and region of the orifice of the urethra to avoid infection of the bladder. After washing the vulva with soap and water, and irrigating it with boric solution or normal salt solution, the orifice of the urethra is exposed, by separating the nymphæ, and the catheter is introduced into the bladder.

Catheterization of the Ureters in the Female. In performing this operation by the direct or Kelly's method, the patient is placed in the dorsal position with the pelvis elevated or in the genu-pectoral position, and the urethra is dilated to admit a cylindrical speculum 12 to 15 millimetres in diameter. With the aid of a head mirror the interior of the bladder can be directly inspected. The opening of the ureter can be exposed by turning the speculum thirty degrees to one side, and is recognized as a small depression, the mucous membrane being of a darker color than elsewhere. A delicate elastic or silver catheter can be introduced into this opening, and by careful manipulation may be passed as far as the pelvis of the kidney. By this procedure unilateral or bilateral disease of the kidneys may be clearly demonstrated, as well as the condition of the ureters themselves. A delicate bougie passed into the ureters may be used to locate the position of the ureters in the operation of hysterectomy. Catheterization of the male ureters can also be practised.

Tying the Male Catheter in the Bladder. When it is desirable to retain a catheter for some time in the male bladder, it is necessary to secure it to prevent its slipping out. Either a metallic or flexible catheter may be employed, but, as a rule, the flexible instrument is the most comfortable to the patient and is to be preferred; there are several methods of securing it in the bladder.

By one method two narrow strips of tape or two or three strong silk ligatures are attached to the rings at the end of a metallic catheter, or are securely fastened around the end of the flexible instrument; these are next brought backward, one on each side of the penis, and the skin is drawn forward and a strip of adhesive plaster half an inch in width is passed over the strings or tapes and carried three or four times around the body of the penis just behind the position of the glans penis. If the skin has been brought well forward before the strips have been applied, the ligatures are tightened as it slips back, and the catheter has not too much play (Fig. 181).

FIG. 181.

Tying in catheter. (BRYANT.)

Another method consists in fastening a strong silk ligature around the catheter just in advance of the meatus; the two ends are next brought backward and tied in a knot behind the corona glandis; the ends are then carried around the penis behind the corona and tied on one side of the frænum; the foreskin is slipped forward and covers the ligatures.

A catheter may also be secured in the bladder by tying the ends of the silk ligatures, which are attached to the instrument in advance of the meatus, to tufts of pubic hair.

A simpler method of securing the catheter is to perforate the free end with a needle armed with a double ligature of silk or hemp; the needle being removed, two loops are made of the proper length, and these are passed through the ends of a T-bandage, which is secured around the waist, the tails being brought up on either side of the scrotum and secured to the body of the bandage passing around the waist.

In the female bladder, when it is desirable to keep the bladder empty, the self-retaining catheter is usually employed, which consists of a catheter with a bulb at its vesical extremity, or an ordinary catheter with silk loops and a T-bandage may be employed in the same manner as in securing a male catheter.

Irrigation of the Bladder. This procedure may be required in the treatment of cystitis, or in sterilizing the bladder, and it is accomplished by passing a flexible catheter with a large eye into the bladder, or a double or two-way catheter may be employed. A syringe, or, better, a rubber bulb holding about a pint, having a nozzle and stopcock (Fig. 182), is filled with warm water, or with any medicated solution which is desired, and it is then attached to the free end of the catheter and the contents are gently injected into the bladder; care should be taken that the bladder is not too much distended. When the desired amount of fluid has been injected, it is allowed to run out of the catheter, and the procedure may be repeated until the solution comes away perfectly clear.

Fig. 182.

Rubber bag with stopcock, for irrigation of the bladder.

The bladder may also be irrigated without using a catheter, the resistance of the compressor muscle of the urethra being overcome by the pressure of a column of water. The patient sits in a chair and a rubber or glass nozzle with a large bulbous tip, which closely fits the meatus, is inserted into it; the nozzle is connected by a rubber tube with a reservoir containing the fluid for irrigation. The reservoir is raised to a height of three to six feet above the patient. He is directed to take deep inspirations, and soon the bladder becomes filled with water, when the nozzle is removed, and the patient empties the bladder naturally. In some cases a little time is required before the column of water overcomes the resistance of the compressor muscle, or its entrance into the bladder may be hastened by making the patient attempt to urinate.

Care should be taken to see that the bladder is perfectly emptied of the solution, and in cases of paralysis of the bladder gentle pressure should be made upon the abdomen over the pubis to accomplish this object. Solutions of boric acid, permanganate of potassium, and weak solutions of carbolic acid and of nitrate of silver are often employed in washing out the bladder in cases of chronic cystitis.

Urethral Injections. In the treatment of urethral inflammations the injection of medicated solutions is generally made use of, and as these injections are usually made by the patient himself, he should be shown or instructed how to employ them. A rubber syringe having a conical nozzle and holding about two or three drachms is the best instrument to employ for this purpose (Fig. 183). The syringe having been filled with the solution, the patient sits upon the edge of a hard chair, with the thighs separated, grasps the syringe between the thumb and middle finger of the right hand, the tip of the index finger resting upon the end of the piston, and inserts its conical end from a quarter to half an inch within the meatus, which is held open by the thumb and finger of the left hand. After the introduction of the nozzle of the syringe the tissues should be drawn tightly around it, the pressure being made laterally so as to narrow the urethral opening instead of broadening it, as is the case when the compression is in an antero-posterior direction. After the fluid has been thrown into the urethra in this manner the syringe is removed, and the patient is instructed to hold the lips of the meatus together for one or two minutes to prevent the escape of the fluid.

Fig. 183.

Shape of nozzle of urethral syringe.

Urethral irrigation may also be practised by means of gravity, a short rubber or glass tube being connected by a rubber tube with a reservoir containing the fluid to be used; the reservoir being placed slightly above the patient.

SUTURES.

A variety of materials are employed for sutures, such as silk, catgut, silver or iron wire, silkworm-gut, kangaroo-tail tendon, and horsehair; the materials most frequently employed at the present time are either catgut, silk, or silkworm-gut, although some surgeons prefer silver wire. Catgut and kangaroo-tail tendon are practically the only substances employed as sutures which are absorbable; the other varieties of suture require removal after their application, although some sutures, such as the silk, when employed in subcutaneous wounds may be cut short, as they are apt to become encysted and produce no trouble. It matters little what variety of material be employed for suturing if the surgeon is careful to see that it is rendered thoroughly aseptic before being brought in contact with the wound.

Sutures of Relaxation. These are sutures which are entered and brought out at some distance from the edges of the wound, and are employed to prevent dangerous tension upon the sutures which approximate the edges of the skin. This form of suture is employed by the use of the *quilled, button,* or *plate* suture.

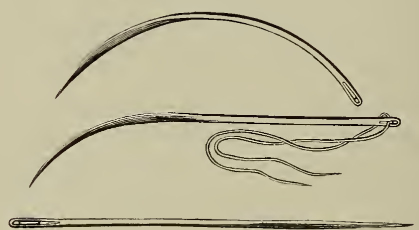
Sutures of Coaptation. These are superficial sutures applied closely together, and include only the skin; they are employed to secure accurate apposition of the cutaneous surface of wounds.

Sutures of Approximation. These are sutures which are applied deeply into the tissue to secure approximation of the deep portions of a wound; this object is accomplished by the use of the *quilled, buried, button,* or *plate* suture.

Secondary Sutures. These sutures are applied when the surfaces of the wounds are covered by granulations, when the primary sutures have failed to secure apposition of the edges of the wound, in cases of secondary hemorrhage where the opening of the wound has been necessitated to turn out the blood-clot and secure the bleeding vessel, and in plastic operations where the primary sutures have failed to secure adhesions of the edges of the flaps. They are also employed with advantage in closing wounds in cases in which it was necessary to pack the wound with antiseptic gauze, or to allow hæmostatic forceps to remain clamped upon bleeding tissues in the wound at the time of operation. The sutures should in such a case be introduced and loosely tied at this time, and when the packing or forceps is removed at the end of two or three days the sutures are tightened so as to secure apposition of the edges of the wound.

Surgical Needles. Needles for surgical use are of different sizes and shapes (Fig. 184); straight needles are the ones most commonly employed, but curved needles

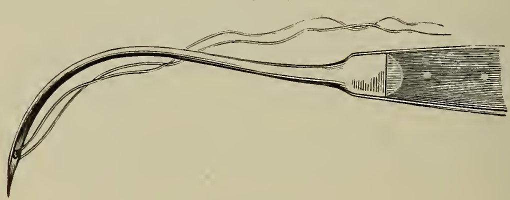
Fig. 184.



Surgical needles.

will be found most convenient for the introduction of sutures in wounds of certain locations. Hagedorn needles, which are flat and have sharp-cutting edges, make a narrow linear wound in the tissues and are useful in some cases. Tubular needles are often employed in introducing

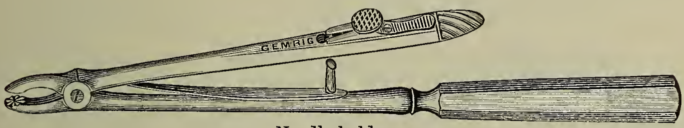
Fig. 185.



Mounted needles.

sutures in wounds in which the use of an ordinary needle is difficult; for instance, in the operation for cleft palate, and for the introduction of sutures in deep wounds, a mounted needle will often be found very useful (Fig. 185). Reverdin's needle, which consists of a handled needle with an eye which is closed with a slide, is useful in passing deep sutures. The needle is first passed through the tissues, then threaded and withdrawn, carrying the suture with it. Needles should be sharp and clean and should be rendered thoroughly aseptic before being used. A needle-holder is often required for the satisfactory introduction of

FIG. 186.



Needle-holder.

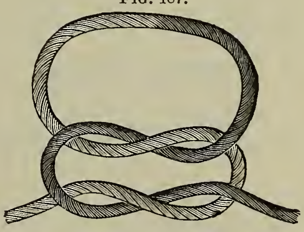
sutures in wounds of certain localities (Fig. 186); if this is not at hand the needle may be held by a pair of dressing forceps or a pair of hæmostatic forceps.

Method of Securing Sutures and Ligatures. Metallic sutures are usually secured by twisting the ends together or by passing the ends through a perforated shot and clamping the shot with a shot-compressor, which securely fixes them.

Sutures and ligatures of catgut, silk, silkworm-gut, kangaroo-tail tendon, or horsehair are secured by tying, and several different knots are employed to secure them.

Reef or Flat Knot. This is one of the best forms of knot to use in securing sutures or ligatures, and it is made by passing one end of the thread over and around the other end, and the knot thus formed is tightened; the ends of the thread are next carried toward each other and the same end is again carried over and around the other, and when the loop is drawn tight we have formed the reef or flat knot (Fig. 187).

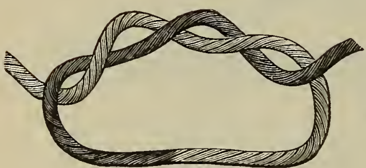
FIG. 187.



Reef or flat knot.

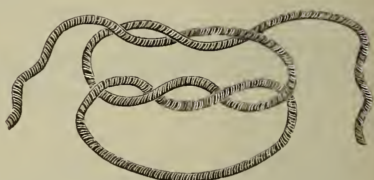
Surgeon's Knot. This knot is formed by carrying one end of the thread twice around the other end (Fig. 188); and after tightening this loop the same end is carried over and around the other end as in the case of the final knot of the reef or flat knot. The surgeon's knot and reef knot combined is one of the best methods of securing sutures or ligatures of catgut or silk, as the first knot is not apt to relax before the second knot is applied (Fig. 189).

FIG. 188.



Surgeon's knot.

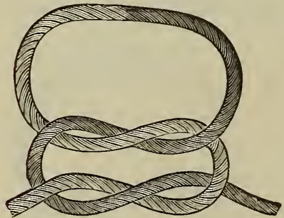
FIG. 189.



Surgeon's knot and reef knot combined.

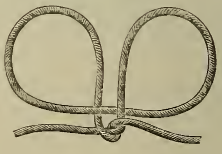
Granny Knot. This method of tying the ligature or suture should not be employed, as the resulting knot is not as secure as the reef knot and is apt to relax; it differs from the latter in the fact that one end of the thread having been carried across and around the other end, the knot is completed by carrying the same end under and around the other end of the thread (Fig. 190).

FIG. 190.



Granny knot.

FIG. 191.



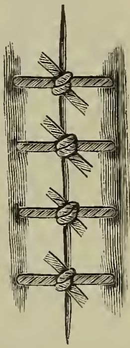
Staffordshire knot.

Staffordshire Knot. This is much used to secure the pedicle in the removal of abdominal tumors, and is applied as follows: A handled-needle armed with a stout silk ligature is passed through the pedicle, and then withdrawn so as to leave a loop on the distal side; this loop is drawn over the tumor and one of the free ends is passed through it so that one end is above while the other end is below the retracted loop (Fig. 191). The ends are then seized and drawn through the pedicle; at the same time the thumb and forefinger are pressed against it until sufficient constriction is made, and the ends are finally secured by tying as in the securing of an ordinary ligature.

Varieties of Sutures.

The Interrupted Suture. This variety of suture which is the one most usually employed in the apposition of wounds, consists of a number of single stitches, each of which is entirely independent of those on either side. In applying this suture the surgeon holds the edge of the wound with the fingers or forceps and thrusts the needle, previously threaded, through the skin three or four lines from the edges of the wound. He then passes the needle from within outward through the tissues of the opposite flap at the same distance from the edge of the wound (Fig. 192). Each stitch is secured as soon as it is passed—by tying if a silk, catgut, or silkworm-gut suture be used, or by twisting if a silver wire suture is employed.

FIG. 192.



Interrupted suture. (PARK).

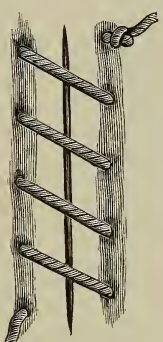
A suture may be used with a needle threaded on each end, in which case both needles are passed from within outward. The sutures may be secured as soon as applied, or they may be left unsecured until a sufficient number have been introduced, and then they may be secured by tying or twisting. Care should be taken to see that they make no tension on the edges of the wound and that they are so introduced as to make the best possible apposition of the parts.

Buried Sutures. In extensive and deep wounds it may be found necessary to introduce both deep and superficial sutures, the former bringing about apposition of the muscles and deep fascia, the superficial layer bringing together the superficial fascia and skin.

Deep or buried sutures are often employed to unite fascia, muscles, or tendons, and the best material for this variety of suture is either catgut, silk, silkworm-gut, or kangaroo-tail tendon.

Continued Suture. This variety of suture is applied in the same manner as the interrupted suture, but the stitches are not cut apart and tied; it is made with silk or catgut and is secured by drawing it double through the last stitch and using the free end to make a knot with the double portion attached to the needle (Fig. 193). This suture is generally employed in intestinal sutures, but also may be employed in bringing about apposition of the edges of wounds in tissues of loose structure.

Fig. 193.



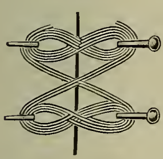
Continued or glover's suture. (Park).

Subcuticular Suture. Halsted has introduced a suture in which the needle is introduced on the under surface of the skin on one side, and brought out just beneath the cut edge; it is then entered in the reverse direction below the epidermic surface opposite; when tied it will lie wholly out of sight. The object of this variety of suture is to avoid infection of the wound by the skin coccus which may be introduced by the suture if passed from without inward. Fine silk or catgut should be used for this variety of suture, which may become encysted, absorbed, or gradually cast off after a few weeks. If employed as a continuous suture the free ends may be tied together and the suture subsequently removed by cutting the loop and drawing out the suture from one end of the wound.

The Twisted or Hare-lip Suture. This is a very useful form of suture where great accuracy and firmness of apposition of the edges of the wound are desired. It is applied by thrusting pins or needles deeply through both lips of the wound, the edges being kept in contact over the wound by figure-of-eight turns with silk or wire (Fig. 194). The ends of the pins should be cut off by pin-cutters after the sutures are applied, or should be protected by pieces of cork or plaster to prevent them from injuring the skin of the patient and causing him pain.

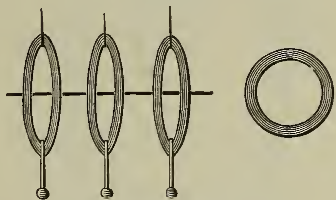
The twisted or hare-lip suture is frequently employed in plastic operations about the face and in other parts of the body where accurate apposition of the flaps is desired.

FIG. 194.



Twisted or hare-lip suture.

FIG. 195.



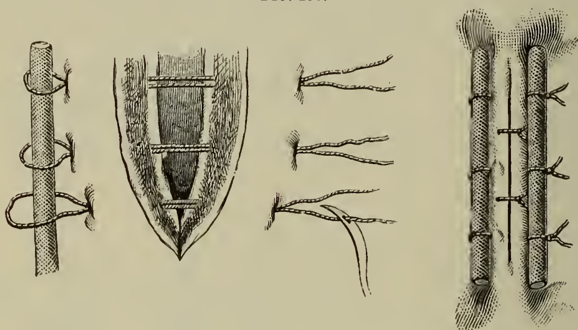
India-rubber suture.

Mattress or Quilt Suture. This suture is applied by carrying the needle through the two flaps and then back again, so that a loop is left on one side and the two ends of the suture project from the opposite flap. This variety of suture may be applied as an interrupted or as a continuous suture; in the latter loops are made through the flaps on each side of the wound.

The India-rubber Suture. This is applied by first passing the pins or needles through the edges of the flaps, and instead of the twisted figure-of-eight suture of silk, delicate rings of India-rubber are employed (Fig. 195).

The Quilled Suture. In making use of this suture a needle armed with a double thread of wire or silk is passed through the tissues as in applying the interrupted suture, but at a greater distance from the edges of the wound. Into the loops on one side of the wound is inserted a quill or piece of a flexible catheter or bougie, and on the opposite side the free ends of the sutures are tied around a similar object after being tightened (Fig. 196). This form of suture makes deep and equable pressure along the whole line of the wound. In applying this suture it may be

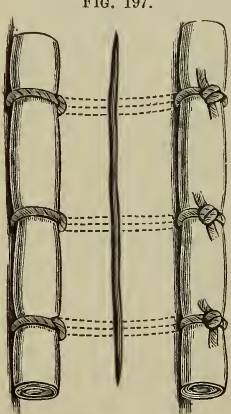
FIG. 196.



The quilled suture. (SMITH.)

found advisable in some cases to introduce a few superficial interrupted sutures along the line of the wound to secure accurate approximation of the skin. Two small rolls of sterilized or antiseptic gauze may be used as a substitute for the quills or pieces of catheter, as shown in Fig. 197.

FIG. 197.

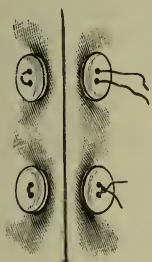


Modified quilled suture. (PARK.)

Button or Plate Suture. This suture is applied by passing a needle armed with a double thread as in the case of the quilled suture, the ends of the suture being passed through the eyes of a button or through perforations in a lead plate before being threaded in the eye of the needle. After the suture prepared in this way has been passed through both sides of the wound, the needle is removed and the free ends of the suture are passed through the eyes of a button or the perforations in a lead plate on the opposite side of the wound, and are tightened and secured

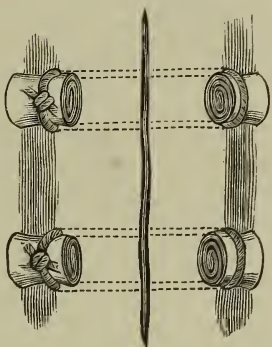
(Fig. 198). In applying this form of sutures, small rolls of antiseptic gauze may be used instead of buttons, as shown in Fig. 199. This form of suture may be employed in deep wounds to accomplish the same purpose as the quilled suture. It allows the cutaneous margins of the wound to remain free from compression, and here, as in the case of

FIG. 198.



Button suture. (SMITH.)

FIG. 199.



Modified plate suture, using gauze pledgets. (PARK.)

the quilled suture, a few interrupted sutures may be introduced between the button or plate sutures to secure accurate apposition of the skin surfaces if desired.

Shotted Sutures. This suture receives its name not from any special method of application, but solely from the way in which it is secured; any of the previously mentioned varieties of sutures may be employed. The material used in applying this suture may be catgut, silver wire, silkworm-gut, silk, or horsehair, and after the suture has been passed the needle is removed, and the ends are passed through a perforated shot; the ends are then drawn upon to bring the edges of the wound in contact, and the shot is pressed down to the skin and clamped by means of a shot-compressor. The suture is then cut off flush with the surface of the shot.

This method of securing sutures is especially useful in closing wounds in the mucous cavities, such as the vagina, rectum, and mouth, where the knot or twist of the wire might cause irritation of the surface or pain to the patient; it is also a useful method of securing sutures in plastic operations; it also facilitates the removal of the sutures, as the shot is not apt to be obscured by the swollen tissue, and is easily seized by forceps when the loop is divided.

Removal of Sutures. Where sutures are buried in the tissues or used to approximate parts in cavities which are subsequently closed, such materials should be used for sutures as will be absorbed in a few days, or will become encysted and remain harmless in the tissues—such as catgut, silkworm-gut, or silk—and it is needless to state that sutures used with this end in view should be rendered perfectly aseptic before being employed.

Catgut sutures, when well prepared and used for sutures in external wounds, usually undergo absorption in from ten to fifteen days; the loop buried in the tissues is absorbed and the knot may be removed from the surface with forceps, or it may come off with the dressings.

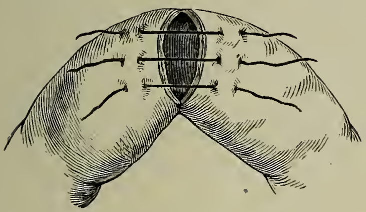
The other substances, such as silk, silkworm-gut, silver wire, and horsehair, are removed by cutting one side of the loop and making traction upon the knot of the suture with forceps, or in the case of the wire suture, after dividing the loop and straightening out one end of it, the wire should be withdrawn in a curved direction.

Sutures which are not causing any irritation should be allowed to remain in position until the wound is solidly healed. The time usually required for their retention in cases of aseptic wounds is from eight to twelve days.

Lembert's Suture. Lembert's suture is used in wounds of the viscera covered by the peritoneum, with the object of bringing in contact the peritoneal surfaces. This form of suture is usually employed in closing wounds of the intestine, bladder, or stomach.

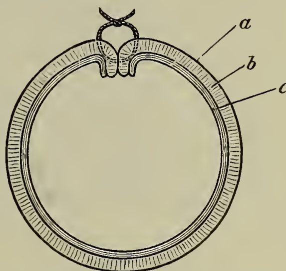
A needle armed with a fine catgut or silk thread is passed, and it is better to employ a round needle, such as the ordinary sewing-needle, in preference to the bayonet-pointed needle, as there results by its use less bleeding from the punctures. The needle is first carried through the peritoneal and muscular coats of the intestine a short distance from the wound, and it is then carried across the wound and passed through the same portions of the intestine a short distance from the edge of the wound on the

FIG. 200.



Lembert's suture. (BRYANT.)

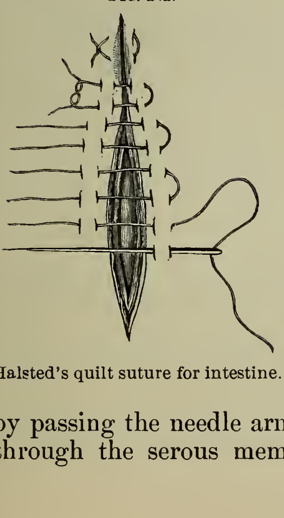
FIG. 201.



Lembert's suture. *a*, serous; *b*, muscular; and, *c*, mucous coat. (SMITH.)

opposite side (Fig. 200), and when the suture is tightened the peritoneal surfaces of the intestine are inverted and brought into contact with each other (Fig. 201); the interrupted or continued suture may be employed in making this form of suture.

FIG. 202.



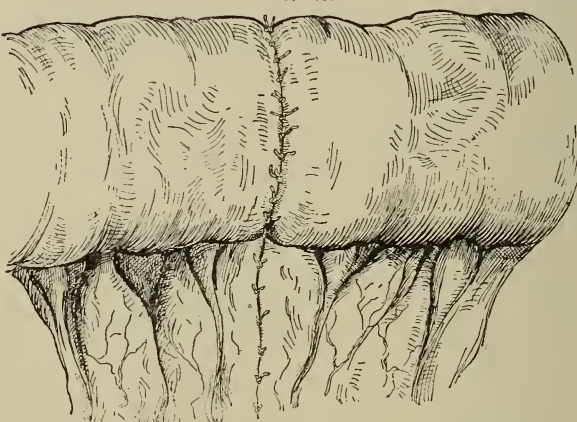
Halsted's quilt suture for intestine.

Halsted's Mattress Quilt Suture. This is a modification of Lembert's suture. The needle penetrates the peritoneal and muscular coats of the gut including a small portion of the submucosa twice on each side of the wound, and is then tied (Fig. 202).

Czerny Suture. This suture is applied in intestinal wounds by passing the needle armed with a catgut or silk thread through the serous membrane on one side of the wound of the intestine and out at the wound surface so as not to include the mucous membrane; the needle is then passed through the wound surface on the opposite side, avoiding the mucous membrane, and brought out through the serous membrane a short distance from the edge of the wound. By this suture the lips of the wound are approximated. For additional security in preventing the escape of the contents of the intestine and to secure approximation of the serous surfaces a few Lembert sutures should be introduced.

Circular Suture of Intestine. After division or resection of the intestine the ends may be united by sutures. Interrupted Lembert sutures are usually employed. The sutures should first be applied at the mesenteric border,

FIG. 203.

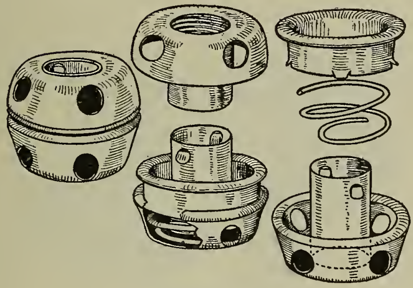


Circular, or end-to-end suture of the intestine. (RICHARDSON.)

and great care should be exercised to make the apposition close at this point. The ends of the bowel should then be brought together by closely applied Lembert sutures. If the mesentery has been divided, it should also be approximated by sutures (Fig. 203).

The Murphy Button. This is a mechanical contrivance which may be employed to secure end-to-end apposition of the divided intestine, or may be used to form a lateral anastomasis between the intestines or hollow viscera.

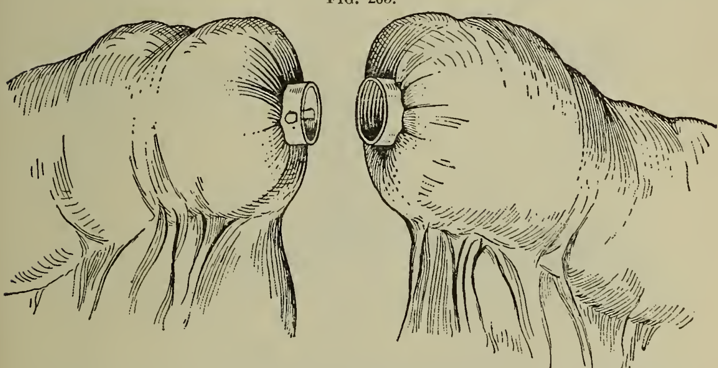
FIG. 204.



The Murphy button.

The construction of the button is shown in Fig. 204. This method of end-to-end approximation or anasto-

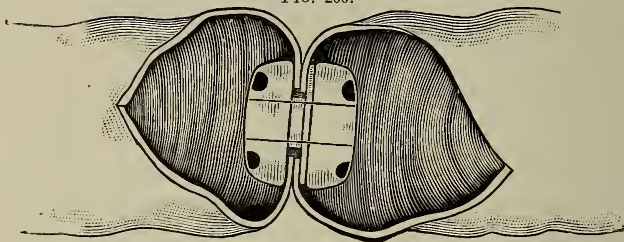
FIG. 205.



The two portions of the Murphy button held in place by purse-string sutures. (RICHARDSON.)

mosis can be accomplished with accuracy and with great rapidity. In employing the button for these purposes the button is separated into its two parts, and each part is slipped into the divided end of the intestine and secured by a purse-string suture, and the parts are approximated by fastening the two portions of the button together (Figs. 205 and 206). Where lateral anastomosis between the intestines, or between the intestines and another hollow

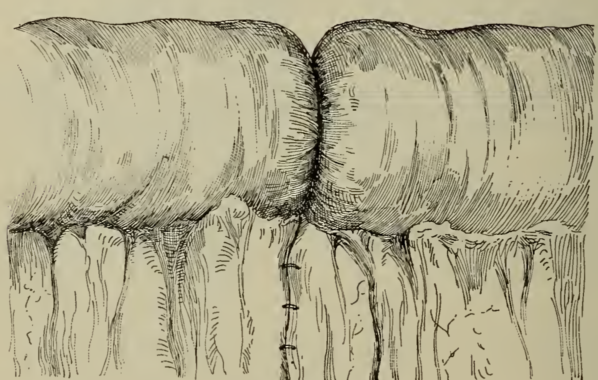
FIG. 206.



End-to-end union of intestine with Murphy's button. (RICHARDSON.)

viscus is desired, an incision is made in each organ, and half of the button is slipped into each opening and secured by a purse-string suture, and the portions of the button are

FIG. 207.



End-to-end approximation, button in position. (RICHARDSON.)

then fastened together. Union of the peritoneal surfaces results, and the button is usually released in from ten to twelve days by sloughing of the included tissues, and it is passed by the anus.

Methods of Intestinal Anastomosis.

Senn's Method. When it is desired to form a permanent orifice between two portions of the gut or other hollow viscera, the ends of the gut are closed and an opening is made in each portion of the gut, into which the perforated bone plates of decalcified bone are slipped, and the walls of the gut surrounding the openings are held in contact with each other by sutures attached to the perforated plates; this is the method devised by Senn. The manner of using the bone plates and sutures is shown in Fig. 208. To accomplish the same purpose rubber rings or perforated plates of rubber have been employed, also rings made from

Fig. 208.

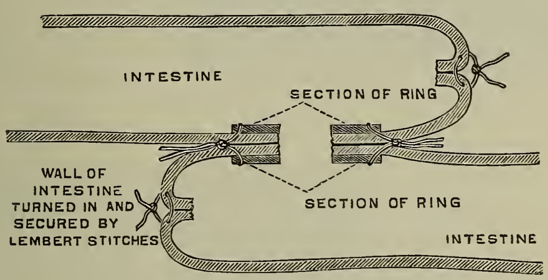
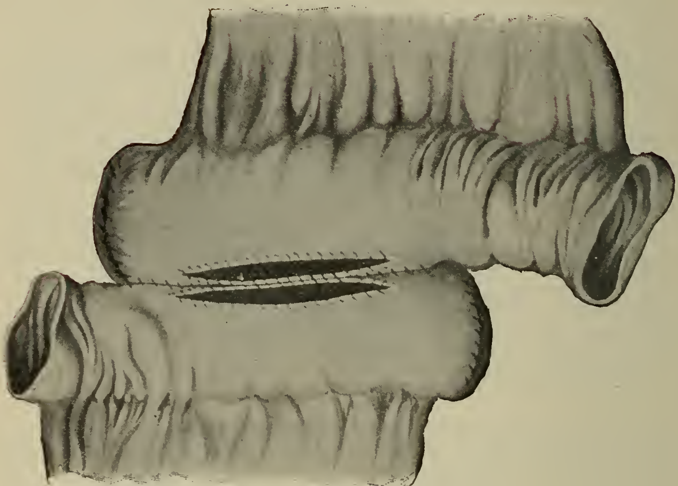


Diagram showing position of bone plates in intestinal anastomosis after resection of the bowel. (Roberts)

catgut, to which the sutures are attached, in the same manner as Senn's plates, and if catgut rings are employed these will be softened and dissolved in a short time so as to be passed without difficulty.

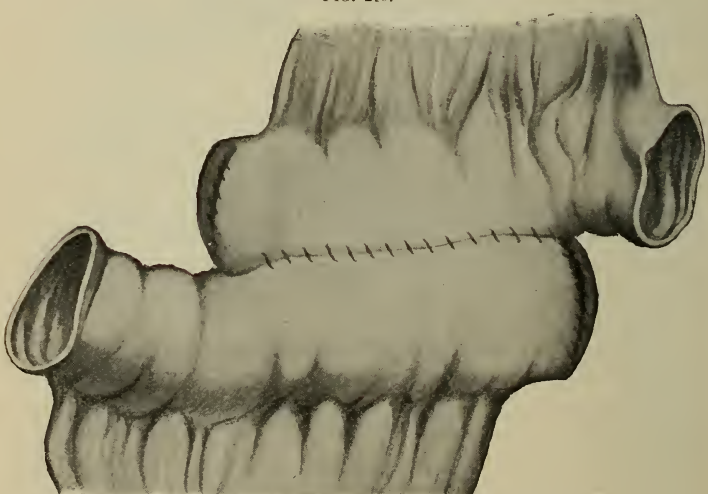
Abbe's Method of Lateral Anastomosis. Portions of the intestinal tract more or less distant, or the intestine and the stomach, may be united by this procedure, thus permitting the contents to pass through the new opening. The bowel upon each side of the constricted portion is manipulated, so that both portions lay side by side, or, in case a portion of the bowel has been removed, the ends

FIG. 209.



Lateral anastomosis. First stage of operation. (RICHARDSON.)

FIG. 210.



Lateral anastomosis; operation completed. (RICHARDSON.)

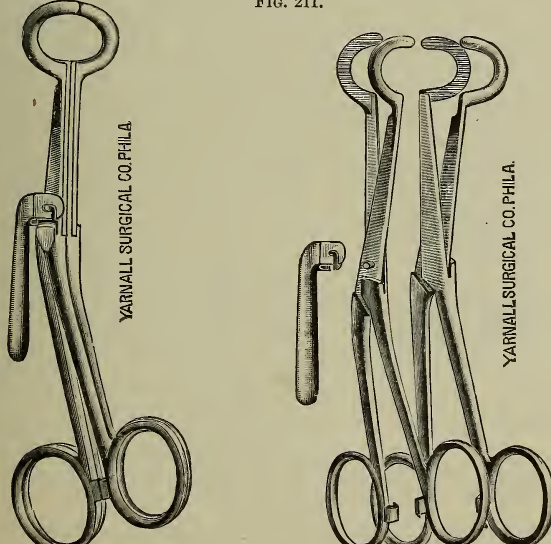
are inverted and closed by Lembert's sutures. The two portions of the bowel are brought side by side, and a longitudinal cut three inches in length, opposite the mesenteric attachment, is made through the coils to be united. The posterior edges of the incision should first be brought together by continuous or interrupted sutures (Fig. 209).

The margins of the incision may be hemmed before uniting them. The anterior edges of the incision are next united by another continuous stitch, and for additional security a second line of interrupted or continuous sutures may be applied (Fig. 210). The time required for the application of the sutures is one disadvantage of this operation.

Intestinal anastomosis by this method may be employed instead of the circular suture in wounds completely dividing the intestine and after resection of the intestine for the removal of growths or for stricture.

Anastomosis or End-to-end Approximation by Laplace's Forceps. Laplace has recently devised a forceps

FIG. 211.



Anastomosis forceps. (LAPLACE).

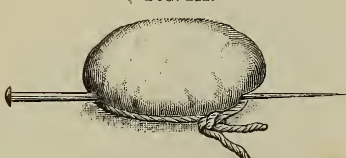
by which end-to-end approximation or lateral anastomosis can be accomplished with great accuracy and rapidity. The forceps are of different sizes, according to the parts to be united, and consist of two parts, which are really hæmostatic forceps curved into a semi-circle on each side and held together by means of a clasp; they open as two rings. They hold together the parts to be united, and serve the same purpose as Senn's bone plates, holding the serous surfaces in contact. The sutures are next introduced at all points except where the forceps penetrate the parts that are sutured. The sutures having been introduced, the forceps are released by loosening the clasp, and withdrawing the forceps, first one half and then the other half, and the small opening is finally closed by one or two sutures. These forceps may be used in end-to-end approximation, lateral anastomosis, or gastro-enterostomy.

Ligatures Used in the Treatment of Vascular Growths.

Various forms of ligatures are used for the strangulation of vascular growths; the material used for ligatures is usually strong silk or hemp thread, catgut, or silver wire.

The Single Ligature with a Pin. This is applied by first inserting a hare-lip pin through the skin near the edge of the growth, passing it under the growth and bringing its point out through the skin at a point opposite the point of entry; a strong silk or hemp ligature is passed under the ends of the pin surrounding the base of the tumor and is drawn tight enough to strangulate the growth, and is secured by two knots (Fig. 212.) If the growth is of considerable size it is better before applying this ligature to introduce a second pin at right angles to the first one, and then secure the ligature under the pins. In applying these forms of liga-

FIG. 212.

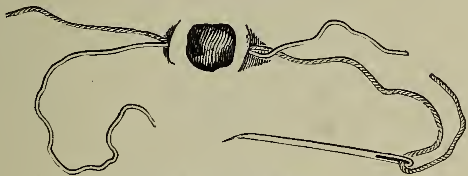


Vascular tumor strangulated with pin and ligature.

ture to healthy skin the patient is saved much pain, and the separation of the mass is hastened, by cutting a groove in the skin with a sharp knife at the point where the ligature is to be applied ; the ligature when tied is buried in the groove thus made.

Double Ligature. This ligature is applied by passing a needle or a needle with a handle, armed with a double

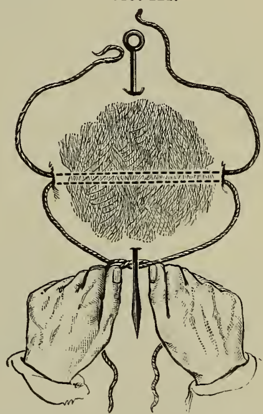
Fig. 213.



Method of applying double ligature. (Roberts.)

ligature, through the skin near the growth, and then passing it under the tumor and bringing it out through the skin at a point directly opposite the point of insertion ; the ligature is then divided and the needle removed. The tumor is strangulated by tying firmly the corresponding ends of the ligature on each side of the tumor, each ligature including one-half of the growth (Fig. 213).

Fig. 214.



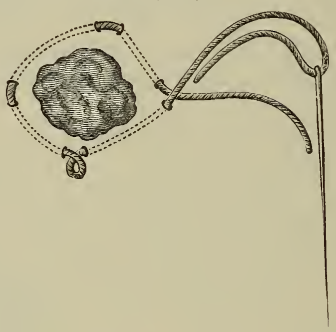
Method of applying double ligature and pin. (Bryant.)

The double ligature may also be applied by first passing a pin under the growth and then passing a needle armed with a double thread under the tumor at right angles to the pin, and after removing the needle the ends of the ligature are tied and the tumor is strangulated in two sections (Fig. 214).

Quadruple Ligature. In applying this ligature two needles carrying a double thread are passed under the growth at right angles to each other, or if the handled needles be used they may be first passed in this manner, and then threaded with double ligatures, which are carried under the growth as they are withdrawn. The needles being removed, the surgeon ties two ends of the ligature together, and repeats this procedure until the growth has been strangulated in four sections.

Subcutaneous Ligature. This is applied by introducing a needle armed with a ligature through the skin near the growth, and carrying it through the subcutaneous tissues around the part to be constricted for a short distance, then bringing it out through the skin. The needle is again introduced through the same puncture, and is again

FIG. 215.



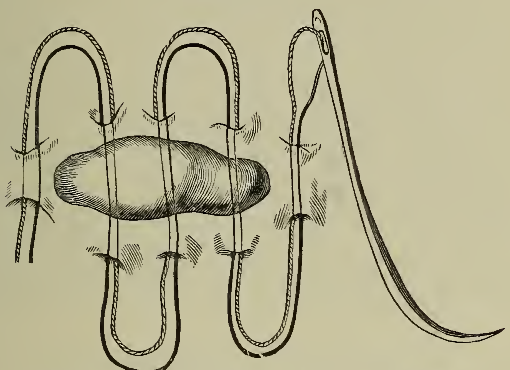
Method of applying subcutaneous ligature. (HOLMES.)

brought out through the skin at some distance from the first point of exit. It is next introduced through this puncture and brought out at a more distant point. In this way the growth is completely encircled by a subcutaneous ligature, which is finally brought out at the point of entrance; the tumor is strangulated by firmly tying together the ends of the ligature (Fig. 215).

If a needle armed with a double ligature is first passed under the growth the ligature is divided, and by passing each end of the divided ligature subcutaneously around the growth it may be strangulated subcutaneously in two sections.

Erichsen's Ligature. This ligature is employed to strangulate tumors of irregular shape in a number of sections. A strong silk or hemp ligature three yards in

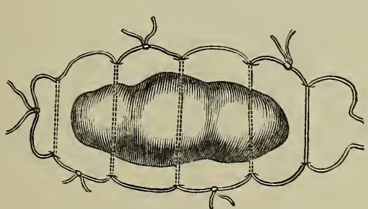
FIG. 216.



Method of applying Erichsen's ligature. (ERICHSEN.)

length, one-half of which is stained black, is carried by a needle as a double ligature under the growth at various points so as to leave a series of loops about nine inches long on each side of the tumor (Fig. 216); the black loops

FIG. 217.



Erichsen's ligature applied.

being cut on one side, the white on the other, the ends are then firmly tied so as to strangulate the growth in sections (Fig. 217).

Elastic Ligatures. Ligatures made of India-rubber varying from half a line to several lines in thickness are often made use of in surgery. They may be employed to strangulate growths such as moles or nævi, or in the treatment of fistulæ, and are especially useful in the treatment of those cases of fistula in ano in which the internal opening into the bowel is situated high up, as the division of such fistulæ by this means is accomplished without hemorrhage and with less risk than by the employment of the knife. In applying elastic ligatures in such cases the ligature, after being passed through the fistula by means of a probe, is carried out through the internal opening; the anus is next well stretched, and the elastic ligature is then firmly tied with two or three knots; the greater the tension made before the ligature is tied the more rapidly will it cut its way out. The smaller sizes of rubber drainage-tubes may be substituted for the solid rubber ligatures.

TREATMENT OF HEMORRHAGE.

The surgeon may be called upon to treat the following varieties of hemorrhage: *arterial*, *venous*, or *capillary*; and these again are classified according to the time of their occurrence, as *primary*—that is, bleeding which occurs at the time the wound is inflicted; *intermediary* or *consecutive*, that which occurs within twenty-four or forty-eight hours after the reception of the injury, which generally takes place during the period of reaction; and *secondary*, which usually results from a septic condition of the wound and takes place after forty-eight hours, and may occur at any time subsequent to this period until the wound is healed. The treatment of hemorrhage is either constitutional or local.

Constitutional Treatment. This consists in keeping the patient in the recumbent posture and avoiding any sudden elevation of the head or arms which might induce fatal syncope. Opium is a valuable remedy and should be freely used. Ergot, gallic acid, acetate of lead, and tincture of iron may also be employed, and stimulants and food should be carefully administered, and in extreme cases auto-transfusion or the transfusion of blood or normal salt solution may be resorted to.

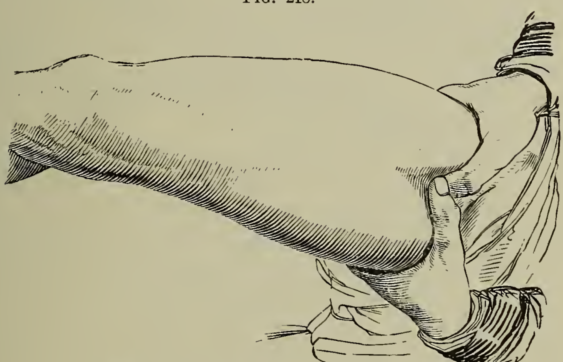
Local Treatment. This consists in the adoption of various local measures to control the bleeding, which may be either temporary or permanent in their action.

Temporary Control of Arterial Hemorrhage.

This may be effected by pressure applied directly to the bleeding vessel in the wound or by pressure applied indirectly to the main artery between the point of its injury and the centre of the circulation, and this pressure may be made by the fingers, *digital compression*, by compresses, or by means of tourniquets.

Digital Compression. This constitutes one of the most valuable means employed in the temporary control of hem-

FIG. 218.



Digital Compression of the femoral artery.

orrhage; the finger is pressed directly upon the bleeding vessel, in the wound, or is used to make pressure upon the artery from which the bleeding arises at some point between the wound and the centre of the circulation (Fig. 218). Control of hemorrhage by digital pressure can only be maintained for a few minutes, for the fingers of the surgeon or assistant soon become tired, so that it is only employed until means are adopted for the permanent arrest of the bleeding. Digital compression of the radial and ulnar arteries may be resorted to for the control of hemorrhage during amputations of the fingers, also of the axillary and femoral arteries in amputations at the shoulder-joint and the hip-joint.

It is also used to control hemorrhage from wounds, either the result of accident or those made by the knife of the surgeon, in which case the finger is placed directly upon the divided vessel, or is employed to hold a sponge or compress firmly in the wound.

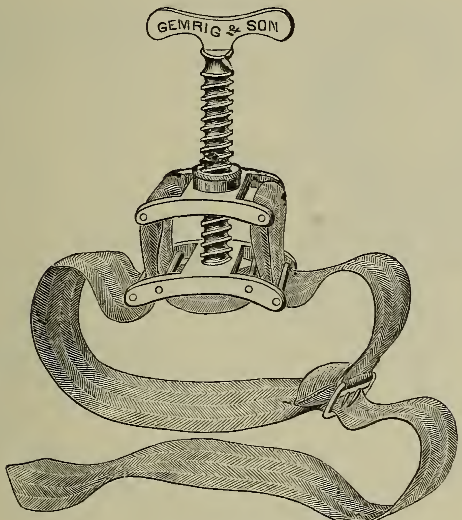
Compresses. By the use of compresses placed directly in the wound or applied to the vessel between the wound and the centre of the circulation, the temporary control of hemorrhage may be very satisfactorily accomplished. The compress which is applied in the wound should be made of antiseptic or aseptic gauze, thereby diminishing the chances of wound-infection.

The compress should be held in position by a bandage firmly applied, and is generally employed only as a temporary expedient until a more permanent means of controlling the bleeding is adopted.

Tourniquets. These instruments, which are employed for the temporary control of hemorrhage from wounds, are of many different kinds.

Petit's Tourniquet. This consists of two metal plates connected by a strong linen or silk strap, with a buckle—the distance between the plates being regulated by a screw (Fig. 219). In applying this tourniquet a compress or roller-bandage is placed directly over the artery to be compressed, and may be held in position by a few turns of the roller bandage. The lower plate of the tourniquet is placed directly over this pad and the strap is tightly secured around the limb to keep the instrument in place. The screw is then turned so as to separate the plates and tighten the strap, thus forcing the compress or pad upon the artery and controlling its circulation. This instrument is very generally employed for the control of hemorrhage in wounds of the extremities, and is especially useful in amputation of these parts, being placed over the main artery some distance above the seat of operation.

FIG. 219.

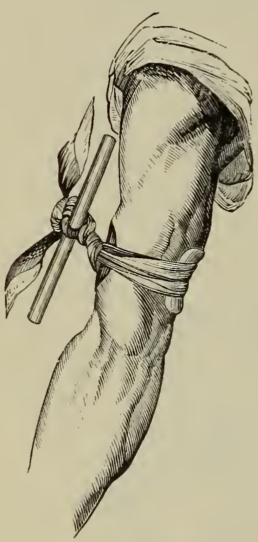


Petit's tourniquet.

The Spanish Windlass. An improvised tourniquet, known as the Spanish windlass, may be employed in cases of emergency; it is prepared by folding a handkerchief or piece of muslin into a cravat and placing a compress or smooth pebble on the body of the cravat; this is placed over the artery to be controlled, and the ends of the handkerchief are tied loosely around the limb; a short stick is passed through this loop, and by twisting the stick the loop is tightened and the compress is forced down upon the artery (Fig. 220).

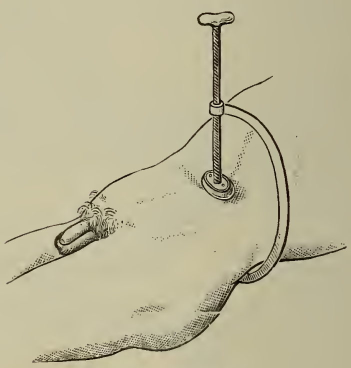
Many other forms of tourniquet have been devised which have the pad and counter-pad arranged to make pressure upon the vessel, such as Lister's aorta compressor (Fig. 221), which is employed in the treatment of aneurism of the iliac vessels and for the control of hemorrhage in amputation at the hip-joint. Signorini's tourniquet (Fig. 222) is constructed upon the same principle, and is frequently employed to control the circulation in the femoral artery in cases of operations on the thigh and leg and

Fig. 220



The Spanish windlass.

Fig. 221.

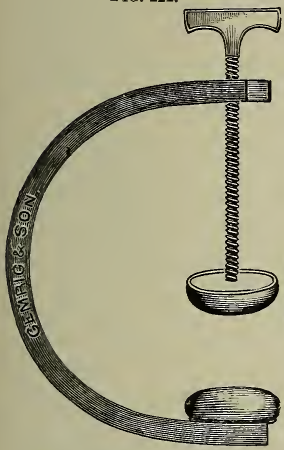


Lister's aorta compressor.

in the treatment of femoral or popliteal aneurism.

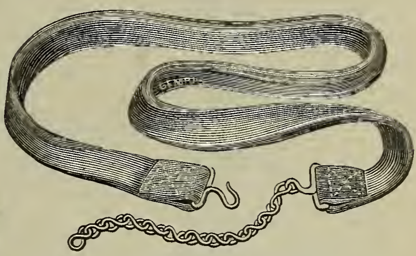
Elastic Constriction. The elastic tube, or strap of Esmarch's apparatus (Fig. 223) may also be employed for the temporary control of arterial hemorrhage, being applied above the wound, and if this is not at hand, any strong rubber cord, or a piece of large-sized drainage-tube may be used as a substitute. In hemorrhage from wounds of the hands and feet, especially in children, and in controlling hemorrhage from wounds of the penis, a piece of drainage-tube, firmly applied above the wound, may be employed with advantage. Care should be observed in applying elastic constriction, for if the elastic tube be applied with great force the subcutaneous tissues may be divided or nerves may be so compressed that their function is destroyed. This tube or strap, although generally employed to control hemorrhage from vessels of the extremities, may be used to control the femoral artery as it crosses the brim of the pelvis, by placing a compress over the artery in this position, and then applying the elastic band to secure it with a figure-of-eight turn, passing it under the thigh, crossing over the pad, and then carrying the ends around the pelvis, and securing them.

Fig. 222.



Signorini's tourniquet.

Fig. 223.

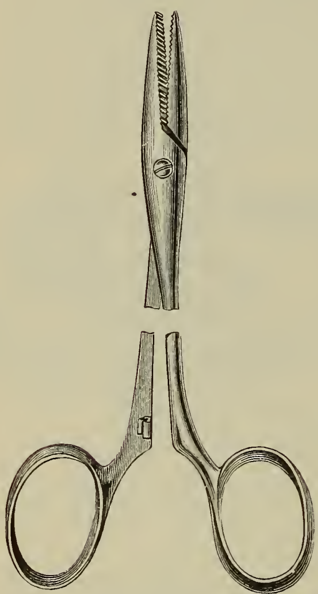


Elastic strap of Esmarch's apparatus.

To make pressure on the axillary artery, a compress should be placed in the axilla, and the middle of the tube placed over this to hold it in position; the ends of the tube are then carried over the shoulder where they are crossed and then carried to the opposite axilla and secured.

Hæmostatic Forceps. The temporary control of arterial hemorrhage by the use of hæmostatic forceps is now very generally employed in surgical operations, and their use has done much to diminish the shock following operations from the loss of blood. The hæmostatic forceps in general use is self-retaining; it is clamped upon the bleeding vessel, and is allowed to remain until the operation is completed, when the vessel is secured permanently by the application of a ligature, and the forceps is removed. The use of these forceps will be found very satisfactory in controlling hemorrhage during the removal of tumors, in cases of amputation, and for the temporary control of bleeding during the operation of tracheotomy they will be found most efficient, as also in abdominal operations, in which their utility was first demonstrated (Fig. 224).

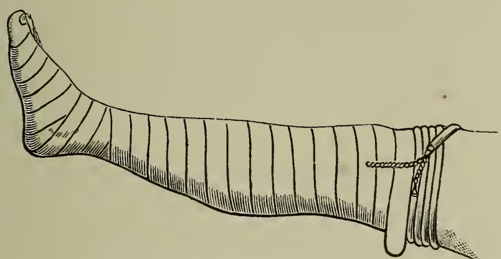
FIG. 224.



Hæmostatic forceps.

Esmarch's Bandage and Tube. This apparatus, which is applied to the limbs to render them bloodless during operations, consists of a rubber bandage two and a half inches in width and three or four yards in length, and a rubber tube two yards in length, to one end of which is attached a chain and to the other a hook, or, better, a rubber strap, one inch in width and one and a half yards in length with a hook and chain. The bandage is applied to the extremity of the limb and is carried up the limb to a point some distance above the seat of proposed operation ; the bandage is applied firmly, each turn overlapping one-fourth of the preceding one, and when the last turn has been made the rubber tube or strap is wound firmly around the limb and secured by fastening the hook into one of the links of the chain (Fig. 225). After securing the tube or strap the rubber bandage is removed from the limb, and if the tube has been firmly enough applied the limb will be found to be blanched, and should be free from blood during the operation. Care should be taken not to apply the tube or strap too tightly in poorly developed limbs, or on parts of the limb where large nerve trunks approach the surface, as they may be subjected to an amount of pressure which will interfere with their functions subsequently. I have knowledge of one case of this nature in which permanent paralysis of the limb followed the use of Esmarch's apparatus; the tube should be applied with just enough firmness to control the circulation.

FIG. 225



Esmarch's bandage and tube applied.

As the strap, when firmly applied, completely cuts off the circulation of the parts below, it should be applied for as short a time as possible, as gangrene has resulted from its prolonged use.

After the removal of the tube or strap there is generally quite free capillary hemorrhage, due to paralysis of the vasomotor nerves from pressure, but this in a short time stops. This apparatus is of the greatest service in controlling hemorrhage at the time of operation, and in amputations and removal of vascular tumors from the limbs will be found most satisfactory. In operations upon bones, such as resection or sequestrotomy, it is especially useful, as it allows the surgeon to have a view of the parts unobscured by hemorrhage. I have found its use most satisfactory in operations for the removal of foreign bodies, such as needles embedded in the hands or feet or extremities.

Permanent Control of Arterial Hemorrhage.

To secure this end the surgeon may resort to the use of position, cold, heat, styptics, pressure, cauterization, ligation, torsion, suture of the artery, or acupressure.

Position. In arterial hemorrhage from wounds of the extremities elevation of the part will be found to materially diminish the amount of bleeding; in hemorrhage from wounds of the arteries of the hand, forearm, foot, or leg, forcible *flexion* of the forearm on the arm or of the leg on the thigh will be found useful in diminishing the force of the blood-current.

Cold. The application of cold by means of a stream of cold water or an ice-bag or pieces of ice will often be found an efficient means of controlling hemorrhage from vessels of small calibre; it is especially applicable to hemorhage from wounds of the vessels of the mouth, nostrils, vagina, or rectum.

Hot Water. Hot water will be found a very efficient means of controlling hemorrhage from small vessels, and it may be used in the form of a hot antiseptic solution. It is of especial value in capillary or parenchymatous hemorrhage, and is employed in the form of a douche or by means of sponges or gauze pads dipped in the hot solution and packed into the wound. The injection of hot water is a most satisfactory method of controlling uterine hemorrhage.

Styptics. These agents are sometimes employed to control capillary bleeding or hemorrhage from small vessels, and although their use is often satisfactory as regards the control of the bleeding, they have the disadvantage of interfering with the primary union in wounds, and since the value of asepsis in wound treatment has been demonstrated they are now very seldom employed. The most valuable styptics which are used are alcohol, alum, oil of turpentine, perchloride of iron, and persulphate of iron or Monsel's solution, acetic acid, vinegar, and antipyrin.

Antipyrin. A solution of antipyrin, 5 per cent., in sterilized water possesses marked styptic action. As it also possesses antiseptic properties and is not toxic, it may be used to control capillary bleeding from the surface of the brain, the intestines and peritoneum, and from bone cavities.

Pressure. For the permanent control of arterial hemorrhage pressure may be applied directly to the bleeding-point or surface by means of a compress of antiseptic gauze or by strips of gauze packed firmly into the cavity from whose surface the bleeding arises.

Compresses are used with the best results where the proximity of a bone gives a firm substance upon which the vessel may be compressed, as is the case in the vessels of the scalp. Pressure applied by means of packing with strips of gauze will be found most efficient in controlling hemorrhage from cavities such as the nose, vagina, or rectum, and in the cavities resulting from the removal of necrosed or carious bone. Pressure may be indirectly applied to an artery by flexing the joint over a compress or by firm bandaging of the limb.

In controlling bleeding from a divided artery in a bony cavity, such as the *inferior dental*, a piece of catgut ligature may be forced into the canal, and will control the bleeding in a most satisfactory manner, or it may be controlled by forcing a small piece of *Horsley's wax* into the opening in the bone; this wax is composed of wax, 7 parts; oil, 2 parts; and carbolic acid, 1 part.

Halsted has introduced a material known as *gut wool*, which is prepared from the same material from which catgut is made. This is cut into fine shreds and is used to control hemorrhage from bone, being pressed into the opening or cavity in the bone from which the bleeding arises.

The troublesome hemorrhage sometimes occurring after the *removal of a tooth* may be controlled by packing the alveolar cavity with a strip of iodoform gauze, or by introducing a wedge-shaped piece of cork and holding it in place by fastening the jaws together by means of a bandage.

Cauterization. The use of cauterization by means of a hot iron is a satisfactory method of arresting hemorrhage. Care should be taken to have the iron only of a dull-red or black heat, as the result desired is not the destruction of the tissues, but the coagulating effect of heat upon them. The form of cautery iron employed will depend upon the size and position of the vessel. Paquelin's cautery is also a satisfactory apparatus to use for the control of hemorrhage.

The control of arterial bleeding by cauterization is often resorted to in operations upon the jaws and in the removal of tumors from the mouth or pharynx or of the tonsils; it is also frequently employed to control hemorrhage in operations upon the uterus and the rectum, and also that resulting from the removal of abdominal tumors, where the application of a ligature is difficult and often impossible.

Torsion. This method of controlling arterial hemorrhage consists in seizing the end of the artery, drawing it slightly out of its sheath and twisting it; it may be accomplished with a single pair of forceps or hæmostatic forceps or by two pairs of forceps. In the latter method the vessel is held by one pair of forceps and is twisted by the second pair.

Torsion of arteries in accidental wounds is quite common, and in many cases controls the hemorrhage until surgical aid is rendered. I have seen the femoral artery in Scarpa's triangle completely controlled in this manner in a case of avulsion of the thigh from a railway injury.

In vessels of moderate size it may be practised with one pair of forceps, and the ordinary double-spring artery forceps (Fig. 226) or hæmostatic forceps will be found satisfactory for such cases. In larger arteries two forceps should be employed, or some of the numerous forms of torsion forceps which have been devised for this purpose.

FIG. 226.

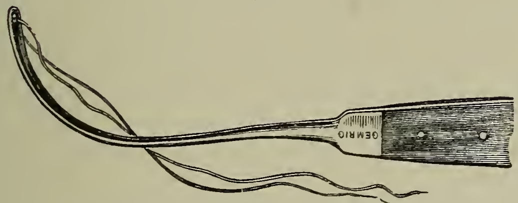
Double-spring artery forceps.

Ligation. The use of the ligature is by far the most generally employed method of controlling arterial hemorrhage. The materials used for ligature are silk, hemp thread, or catgut. Catgut or silk is the material generally employed. The vessel is seized with a pair of artery or hæmostatic forceps or a tenaculum (Fig. 227) and drawn out of its sheath, and a ligature of sterilized catgut or silk is thrown around it and secured by a surgeon's knot, or by a reef knot and a surgeon's knot combined, and when firmly tied the ends of the ligature are cut short in the wound.

Fig. 227.

Tenaculum.

Fig. 228.

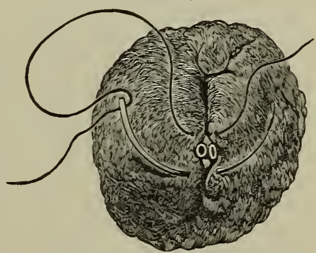


Aneurism needle armed with ligature.

When ligatures are applied to vessels in their continuity they may be threaded into an eyed probe or aneurism needle (Fig. 228) and carried around the vessel and secured.

Deep Sutures. A convenient method of applying a ligature to a bleeding point in a deep wound, or to a vessel in tissues which are of such a nature as not to permit of the isolation of the vessel, is to use a curved needle threaded with a catgut ligature, which is passed deeply into the tissues near the vessel and brought out on the opposite side; the ligature thus placed is then firmly tied, and the ends are cut short in the wound (Fig. 229).

Fig. 229.

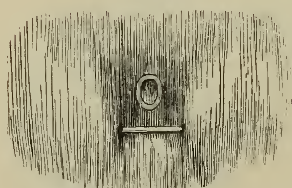


Artery occluded by suture. (Esmarch.)

Suture of Arteries. Murphy has practised experimentally in animals suture of wounded arteries, both in longitudinal and transverse wounds. He recommends in the larger arteries, where more than two-thirds of the circumference has been divided, resection of the injured portion of the vessel, where it can be done without removing more than three-fourths of an inch of the vessel, and invagination of one end into the other, and their fixation by fine silk sutures. In longitudinal wounds the edges may be brought together by fine silk sutures, introduced by means of a fine cambric needle. The sutures should be inserted from one-sixteenth to one-twentieth of an inch apart, and one-sixteenth of an inch from the edges of the wound, and should include only the adventitia and media, not perforating the intima. During the operation the circulation in the vessel should be controlled both above and below the wound by forceps covered with rubber tubing. Where a distinct sheath is present, it should be sutured over the wound, and if this is not present muscle or fascia should be sutured over the closed wound in the vessel.

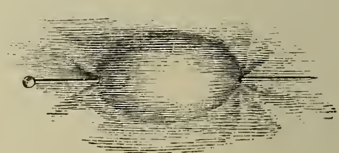
Acupressure. In this method of controlling arterial hemorrhage a needle or pin is used, which is thrust through the tissues in such a way as to compress the artery. In the *first method of acupressure* the surgeon places a finger

FIG. 230.



Acupressure—first method ; raw surface. (ERICHSEN.)

FIG. 231.



Acupressure—first method ; cutaneous surface. (ERICHSEN.)

of his left hand upon the mouth of the bleeding vessel and with his right hand introduces the needle from the cutaneous surface and passes it through the thickness of the flap until its point projects for a couple of lines or so from the surface of the wound a little to the right side of the tube of the vessel. By forcibly inclining the head of the needle toward his right he brings the projecting portion of its point firmly down on the side of the vessel, and after seeing that it occludes the artery he makes it re-enter the flesh as near as possible to the left side of the wound and pushes the needle through the flesh until its point comes out again at the cutaneous surface (Figs. 230 and 231).

There are a number of methods of using the needle or pin in acupressure to produce occlusion of the vessel, but as this method of arresting hemorrhage is not employed at the present time they need not be described.

Rules for Ligating Wounded Arteries. The following rules for the application of ligatures to wounded arteries are laid down by Ashhurst:

1. In cases of primary hemorrhage, no operation should be performed upon an artery, unless it is at the moment actually bleeding. The exception to this rule is in the cases where the vessel is seen to pulsate in the wound or where the wound involves the region of a large artery and the patient has to be transported or may be in a position not to receive surgical aid subsequently if needed; under these circumstances, the vessel should be tied or the wound should be explored to ascertain the fact that no important vessel has been injured.

2. In applying a ligature to a wounded artery, the surgeon should cut down directly upon it at the point from which it bleeds and secure it in the wound. This rule holds good for both primary and secondary hemorrhage.

3. Two ligatures should be applied, one to each end of the artery if it be completely divided, and one on each side of the wound if the latter has not completely severed the coats of the artery. This procedure is adopted for the reason that the arterial anastomosis is so free that the proximal ligature will not always, even temporarily, arrest the bleeding; and if it does accomplish this object at the time, after the collateral circulation is established, bleeding is apt to occur from the distal extremity of the divided vessel. If the coats of the artery are not completely sev-

ered their division should be completed, either before or after the application of the proximal and distal ligatures, thereby favoring the contraction and retraction of the ends of the divided vessel.

Treatment of Venous Hemorrhage.

Bleeding from small veins often stops spontaneously unless there is some pressure upon the wounded veins upon the cardiac side of the wound. It is, however, very satisfactorily controlled by position or by the application of a compress and bandage, or by the use of a ligature; if the divided vein be a large one it is well to secure both ends by ligatures. The free bleeding arising from ruptured varicose veins of the leg is easily controlled by the application of a compress and bandage, while hemorrhage from the larger veins, such as the jugular, should be controlled by the application of ligatures as in the case of wounded arteries.

The Lateral Ligature. The application of the lateral ligature to small wounds of veins of large size, such as the femoral, or to wounds of venous sinuses, has been recommended and employed with good results; this procedure consists in pinching up the wall of the vein so as to include the orifice of the wound and throwing a delicate ligature around it.

Suture of Veins. This procedure has also been employed with success in the case of the larger veins. The bleeding should be controlled by pressure upon the vein upon both sides of the wound, and the wound in the vessel should be closed by fine silk sutures applied closely together by means of a fine cambric needle. The employment of sutures and lateral ligatures in wounds of veins possesses the advantage of controlling the bleeding and at the same time does not cause obliteration of the vessel at the seat of injury.

Actual cautery may also be employed for the control of venous hemorrhage in positions in which its arrest by pressure or the ligature is not feasible.

Compression by means of strips of sterilized gauze is often employed to control venous hemorrhage from cavities.

Treatment of Capillary Hemorrhage.

Capillary or parenchymatous hemorrhage is usually arrested spontaneously by the exposure of the injured surface of the wound to the air, but it is often so profuse that its arrest becomes a matter of importance. To control this form of bleeding, pressure may be applied to the bleeding surface for a short time, and if this fails to arrest it, sponging the surface with dilute alcohol will sometimes prove satisfactory; but the best application to arrest hemorrhage of this nature is hot water, which may be used in the form of a hot bichloride solution or antipyrin solution. Acetic acid and vinegar are also sometimes employed for the same purpose. In cases where the means mentioned above fail to control the bleeding, it may be necessary to pack the wound with strips of antiseptic gauze; this dressing is most serviceable when the hemorrhage comes from the cavities such as result from the removal of tumors or excisions of joints, and for the control of bleeding following the removal of necrosed or carious bone. To control hemorrhage from the mucous cavities, such as the nose, rectum, and vagina, this method of treatment is frequently resorted to.

Treatment of Secondary Hemorrhage.

Secondary hemorrhage following the use of the ligature or other means of controlling bleeding usually results from a septic condition of the wound and is due to a septic arteritis. Since the adoption of the antiseptic and aseptic methods of wound-treatment, it is a much less frequent complication of wounds. The treatment of this complication is both constitutional and local; the *constitutional* treatment consists in the use of those remedies which were mentioned as serviceable in primary hemorrhage, and the drugs upon which the most reliance is to be placed are opium and ergot.

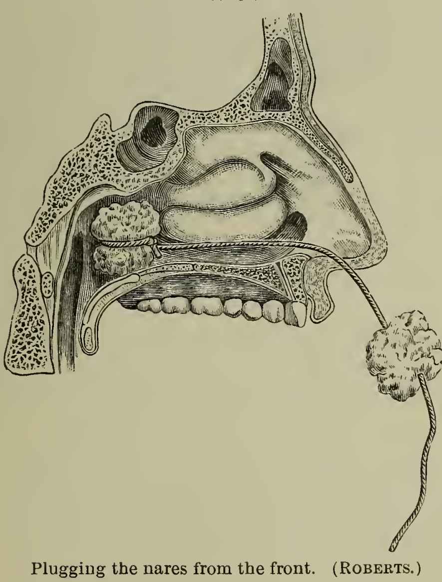
The *local* treatment of this form of hemorrhage consists in the use of the various means of controlling hemorrhage which have been mentioned before, such as the ligature, hot water, pressure, or the actual cautery. If possible, it is well to secure the vessel from which the bleeding arises in the wound; if for any reason this cannot be done, the main artery should be ligated above the wound if the hemorrhage be arterial.

Control of Hemorrhage from Special Parts.

Epistaxis or hemorrhage from the nose may be so profuse as to require surgical interference. To control this form of hemorrhage the application of iced compresses to the surface of the nose may first be made use of, and if this fails to control the bleeding, the surgeon or the patient should grasp the cartilaginous portion of the nose with his thumb and forefinger in such a manner as to keep the nostrils tightly closed, which will prevent the passage of air through the nose and thus permit clots to form, arresting the flow of blood. Bleeding from the nose often arises from the erosion of a small artery low down upon the septum; it can be freely exposed by introducing a nasal speculum, and the bleeding point can be touched with a cautery-iron, avoiding the necessity of plugging the nares. If these simple means fail to arrest the bleeding the nasal cavity or cavities may be packed with strips of antiseptic gauze introduced into the anterior nares, and pushed backward by a director or probe; this will often be found a perfectly satisfactory means of arresting the bleeding. This method may be supplemented by a plug of antiseptic cotton introduced into the posterior nares with the finger. The use of a rubber tampon, consisting of a rubber bag, introduced into the nares in an empty state and afterward inflated, has also been recommended for the control of this variety of hemorrhage.

Another method of controlling hemorrhage from the nose consists in introducing a small piece of sponge or pledget of sterilized gauze, tied to a strong silk ligature, into the anterior nares and pushing it back along the floor of the nose to the posterior nares; a small piece of sponge or gauze about the size of a marble with a hole in the centre is threaded on the ligature and pushed back until it comes in contact with the first piece introduced, and thus by introducing a number of pieces of sponge or gauze in this way the nasal cavity may be completely filled up and the bleeding arrested. Care should be taken to see that the sponge has been rendered aseptic before being introduced, and the nasal cavity should also be washed out with an antiseptic solution before its introduction. The sponges or gauze may be allowed to remain in place for twenty-four to forty-eight hours (Fig. 232).

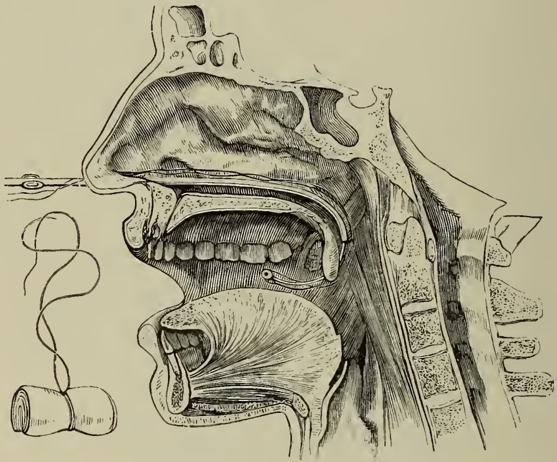
FIG. 232.



Plugging the nares from the front. (ROBERTS.)

Plugging the nares by means of Bellocq's canula is also employed to arrest hemorrhage from the nasal cavities; the canula armed with a strong ligature, is passed along the floor of the nose until it reaches the pharynx, when the spring being protruded, the ligature is seized and brought out of the mouth and secured to a plug of lint or of antiseptic gauze of the required size, and upon withdrawing the instrument the plug is brought into position in the posterior nares and the end of the ligature is allowed to

FIG. 233.



Plugging the nares with Bellocq's canula. (FERGUSSON.)

protrude from the mouth to facilitate its removal (Fig. 233). An ordinary flexible catheter may be employed in place of Bellocq's canula for the introduction of the ligature.

Hemorrhage from the Urethra. In hemorrhage from the urethra, if profuse, the blood will trickle from the meatus, or if efforts at micturition are made the first gush of urine will contain blood, but afterward will be clear, and the last urine will contain a few drops of pure blood.

This variety of bleeding, if it proceeds from the anterior portion of the urethra, may be controlled by the introduction of a catheter and the application of a bandage around the penis, carefully applied so as to make only moderate pressure.

If the bleeding comes from the posterior portion of the urethra, it will often be controlled by the application of cold or pressure to the perineum, or by the introduction of a cold steel bougie, or by the injection of a weak solution of tannic acid or antipyrin.

Hemorrhage from the Bladder. In this variety of hemorrhage the first portion of the urine may be blood-stained and the last portion will contain more blood and clots as the organ contracts, which distinguishes it from hemorrhage from the kidneys, in which the admixture of blood with the urine renders it of a smoky color or dark-red if the bleeding is profuse.

To control bleeding from the bladder a catheter should be introduced and the urine and clots withdrawn; the bladder should next be washed out with a warm or cold boric-acid solution. In severe cases a weak solution of tannic acid, antipyrin or alum may be employed. The application of ice to the perineum and supra-pubic regions may also be employed with advantage.

Hemorrhage from the Rectum. This variety of bleeding may be controlled by the injection of cold or astringent enemata. If the bleeding be profuse a speculum should be introduced, and when the source of the bleeding has been discovered the actual cautery or a ligature should be applied. If this is not feasible the rectum may be plugged with strips of antiseptic gauze, or a piece of a rubber catheter of large calibre may be wrapped with gauze and introduced into the rectum, the end of the catheter being allowed to protrude; by using this tube flatus can escape, and if the bleeding is not controlled blood will escape through the tube, preventing the risk of concealed hemorrhage. If the bleeding arises from hemorrhoids or polypus of the rectum the operative treatment of these conditions should be undertaken to permanently control the bleeding.

TREATMENT OF ABSCESS.

In operations for the evacuation of the contents of abscesses care should be taken to observe every precaution to prevent a new infection of the wound or abscess cavity; the skin over the abscess should be carefully cleaned to make it aseptic, the hands of the surgeon and the instruments to be brought in contact with it should also be aseptic. These precautions should be especially observed in the opening of chronic abscesses when a new variety of infection is liable to be set up if aseptic precautions are not rigidly observed.

Acute Abscess. This variety of abscess should be opened by incision, and this is best done with a straight, narrow, sharp-pointed bistoury; the incision should be deep enough to freely expose the cavity of the abscess, and should be so planned as to be parallel with and not across important structures, and it should also be made at as dependent a portion as possible. Abscesses of the limbs are opened by a longitudinal incision, and those in the region of the anus and breast by an incision radiating from the anus or nipple.

Hilton's Method. In deep-seated abscesses in the region of important structures the method of opening suggested by Mr. Hilton may be employed with advantage; it consists in making a small incision through the skin and cellular tissue; a director is next pushed through the tissues into the abscess cavity, which will be shown to have been reached by the escape of a little pus along the director; a dressing forceps with the blades closed is now pushed along the director into the abscess cavity, and when this has been accomplished the director is withdrawn and the forceps is removed with the blades expanded so as to dilate the wound and allow the pus to escape.

The cavity of the abscess having been emptied of pus, it may be irrigated with a stream of carbolic or bichloride solution, or the irrigation of the abscess cavity may be omitted, and if the cavity is not very large or deep no drainage-tube need be introduced, and a small piece of protective may be placed between the lips of the wound to prevent their adhesion; but if, on the other hand, the cavity is extensive and deeply situated, a rubber drainage-tube or a strip of iodoform gauze should be introduced to the bottom of the cavity to secure free drainage, and if a tube be used, fixed at the surface of the skin by a safety-pin. A gauze dressing, consisting of a number of layers, which has been moistened in carbolic or bichloride solution is next placed over the wound and is covered by a number of layers of dry gauze which are in turn covered by a piece of rubber tissue. The latter may be substituted by a few layers of bichloride cotton, and the dressing is finally secured by a roller-bandage. The dressing is removed at the end of two or three days, the cavity being washed out with one of the antiseptic solutions previously mentioned. The drainage-tube may then be shortened or removed, and the dressings reapplied as at the primary dressing. Under this method of treatment acute abscesses usually heal promptly.

Chronic or Tuberculous Abscess. This variety of abscess, which occurs chiefly in connection with diseases of the bones or joints or of the lymphatic system, is generally tubercular in origin, and may be opened in various ways, the time at which this should be done depending upon the size and situation of the abscess and the amount of constitutional and local disturbance which the patient experiences from its presence.

Aspiration. A tuberculous abscess may be evacuated by means of the aspirator; the pus being withdrawn as far as possible, the puncture is sealed with a small piece of gauze covered with iodoform collodion. Reaccumulation of the pus often takes place, and the aspiration has to be repeated a number of times. The greatest difficulty in the successful removal of the contents of tuberculous abscesses by means of aspiration is the presence of cheesy masses in the pus which occlude the canula and often prevent the complete emptying of the cavity.

Puncture and Injection. These abscesses may also be evacuated by making a puncture through the skin and overlying tissues with a narrow bistoury, the surface having been previously thoroughly washed with soap and water and with a carbolic or bichloride solution; a director is next pushed through this small wound into the cavity of the abscess, and the pus is allowed to escape by stretching the wound by the director; when the cavity is emptied of pus it is washed out with a carbolic or bichloride solution introduced into it by pushing the nozzle of a syringe into the cavity, and this is allowed to escape in the same way as the pus previously did. When the irrigating solution has all escaped the cavity may be injected with an emulsion composed of *iodoform* one part, *glycerin* ten parts; after this has been introduced the small wound is closed by a compress of antiseptic gauze held in place by a compress of bichloride cotton and a bandage or by strips of adhesive plaster. The injection of the iodoform emulsion need not be repeated as long as iodoform continues to be excreted with the urine.

In evacuating tuberculous abscesses by means of the aspirator or by a small puncture, there is absence of shock, and the loss of blood is insignificant, so that these procedures should generally be first employed, and the more radical operation of incision and curetting of the cavity of the abscess, which is accompanied with a certain amount of shock and hemorrhage, should be reserved for those cases in which the less severe operations have failed to be followed by a satisfactory result.

Incision. Tuberculous abscesses are also treated by making a free incision into the abscess cavity with full antiseptic precautions, and after the escape of the purulent matter the walls of the abcess should be thoroughly scraped with a curette, and after the cavity has been freely washed out with a carbolic or bichloride solution large drainage-tubes are introduced and an antiseptic dressing is applied to the wound. The edges of the incision may be brought together by sutures without the introduction of drainage, or the cavity may be packed with iodoform gauze and allowed to heal by granulation. The dressings are removed as soon as they become soaked, and the drainage-tubes are shortened or removed as the discharge diminishes and the cavity contracts.

Diffused Suppuration. This form of suppuration is treated by numerous punctures or incisions, which allow the purulent matter to escape, and where sloughs are present, free incisions may be required to give exit to the necrosed tissues; the introduction of drainage-tubes may also be required. The wounds and the cavities, as far as possible, should be washed out with a carbolic or bichloride solution, and an antiseptic gauze dressing should be applied.

Sinuses. There are suppurating tracts which result from abscesses or wounds; if superficial, they should be laid open freely and their surfaces scraped with a curette and then lightly packed with strips of bichloride or iodoform gauze and should be covered by an antiseptic dressing. If they are too deep to be treated by incision their healing may be facilitated by the injection of stimulating solutions introduced by means of a syringe; the employment of solutions of chloride of zinc, nitrate of silver, and sulphate of copper varying in strength from five to twenty grains to the ounce of water will often prove satisfactory.

SHOCK.

Shock is a condition of physical depression or prostration which often develops after severe injuries or operations. Shock may develop immediately upon or some time after the reception of the injury. Every traumatism is probably followed by a certain amount of shock, and, as a rule, the degree of shock is proportionate to the severity of the injury received. Yet this rule is not without exception; certain classes of injuries are attended with marked shock, and the part of the body sustaining the injury will have an important influence upon the degree of development of shock. Contusions of the viscera, wounds of the testicle, contused and lacerated wounds of the trunk and extremities, if extensive and accompanied by free hemorrhage, are usually followed by marked and often fatal shock. Gunshot wounds causing perforation of important cavities of the body, injuries of the viscera, and shattering of the bones are also well recognized as giving rise to shock in a marked degree. Burns and scalds, if they involve a considerable surface of the body, are attended with severe shock.

A patient suffering from shock presents pallor of the surface, paleness of the lips, dilated pupils, clammy moisture of the skin, muscular debility, occasionally relaxation of the sphincters, frequent, feeble, irregular pulse, subnormal temperature, and feeble, short, sighing respiration; in many cases extreme thirst is a prominent symptom. The senses are often perfectly retained. The temperature is always subnormal, and may vary from a point a little below the normal to a point below 90° F. (32° C.). A depression of temperature below 97° F. (36° C.), if it persists for a few hours, usually indicates a grave condition of shock, and reaction may not occur, although it has been observed in cases where the temperature was as low as 90° F. (32° C.).

Prophylaxis of Shock. Unfortunately, many of the worst cases of shock are due to accidents, and here treatment can be directed only to the condition of shock itself, but the surgeon is often able to diminish to some extent the amount of shock following operations by judicious prophylactic treatment. In patients in whom shock is apt to be markedly developed, as in children or feeble or aged subjects, or in certain classes of operations, he may give the patient stimulants before the operation, and also see that the surface of the body is not unnecessarily exposed to chilling during the operation, that the operaion is not needlessly prolonged, and that as little blood as possible is lost during its performance. The *electro-thermic mattress* may be used with advantage. The previous administration of an ounce of whiskey and the hypodermic injection of from one-twentieth to one-thirtieth of a grain of sulphate of strychnine, and sometimes the use of a small dose of morphine, in feeble and aged patients, will often be followed by good results. A full dose of quinine given an hour or two before the operation is also said to arrest the development of shock.

Treatment. The first indication in the treatment of shock is to establish reaction. The patient should be covered with woollen blankets, the head should be kept low, and dry heat should be applied to the surface of the body by means of hot-water bags, hot bottles, or hot bricks; these should be wrapped in towels to prevent them from coming directly in contact with the surface of the patient's body; neglect of this precaution, which is most important if the patient is unconscious, often produces burns which may be followed by extensive sloughing. If the patient can swallow, he should be given small quantities of whiskey or brandy, with thirty-drop doses of aromatic spirit of ammonia, and, as absorption by the stomach is probably very slow in these cases, stimulants should be administered hypodermically; in our judgment, strychnine is the most valuable stimulant that can be employed. From one-twentieth to one-thirtieth of a grain should, therefore, be injected, and the injection should be repeated every hour or half-hour until several doses have been given. Sulphuric ether, thirty minims, may also be injected into the cellular tissues at intervals, as well as digitalin or tincture of digitalis.

If shock develops during an operation under ether anæsthesia, the use of ether hypodermically is contraindicated. A stimulating enema of whiskey and warm water may be employed. In cases of shock where there is profuse sweating, the use of one-sixtieth of a grain of atropine, repeated as required, is often followed by good results. A large enema of warm saline solution may also be employed. As patients often complain of urgent thirst, it is well to let them take a little black coffee, but not large quantities of water; free indulgence in water does not seem to quench the thirst, and is apt to be followed by vomiting. Intravenous injection of saline solution is likely to be of the most service when the condition has been preceded by the loss of a large quantity of blood. Infusion of saline solution also has been employed with good results.

DRESSING OF WOUNDS.

Incised Wounds. These wounds present the conditions favorable for prompt healing, and they should first be carefully irrigated with a 1 : 2000 bichloride solution, or sterilized water, to remove any blood-clots or foreign bodies, and wiped with a sterilized gauze pledget, and after any hemorrhage which is present is controlled by the use of ligatures, if the wound be an extensive or deep one, provision should be made for drainage by introducing a drainage-tube or a few strands of sterilized catgut at the bottom of the wound, allowing the extremity to project from the most dependent portion of the wound. In superficial incised wounds, after the hemorrhage has been controlled, it is not usually found necessary to make any provision for drainage. If the wound be a deep one, involving the muscles and deep fascia, buried sutures of catgut or silk should be applied to approximate the muscles and fascia, and if important nerves or tendons have been divided their ends should be brought into apposition by sutures of catgut or sterilized silk; the superficial portions of the wound should next be brought together by the introduction of a number of interrupted sutures, catgut, silkworm-gut, silver wire or silk being employed for this purpose; the accurate apposition of the edges of wounds of this variety is secured by the introduction of a number of sutures placed closely together.

After a wound of this variety has been closed the subsequent dressing is accomplished by covering the surface of the wound with a piece of sterilized protective or silver foil a little larger than the wound; over this is placed a pad of antiseptic gauze, composed of ten or twelve layers, which has been soaked in a 1 : 2000 bichloride solution, and over this is laid a pad of dry antiseptic gauze of the same thickness, overlapping the wet gauze by a few inches in all directions; a few layers of bichloride cotton are next applied over the gauze dressings, and the whole dressing is secured in position by the application of an antiseptic gauze bandage. The protective or silver foil may be omitted and the gauze dressing applied directly in contact with the wound. Under this form of dressing prompt healing of incised wounds is the rule, and the wound need not be redressed for a week or ten days unless some indications exist for the change of dressing at an earlier period. At the time of the first dressing the catgut drain or the drainage-tube is usually removed, and if the adhesion of the edges of the wound is firm the sutures may also be removed. An antiseptic or sterilized gauze dressing is usually next applied and allowed to remain in position for a few days longer. Dry sterilized dressings may also be employed.

Lacerated Wounds. These present edges which are torn and not sharply cut, and the vitality of the injured parts is often so seriously impaired that prompt union in this variety of wounds is not, as a rule, to be looked for. Wounds of this nature should first be irrigated with an antiseptic solution, 1 : 2000 bichloride solution, and blood-clots and foreign bodies should be removed. If the wounds be deep, drainage-tubes should be introduced; on the other hand, if they be superficial, or if the edges are not closely approximated, provision for drainage may be omitted. The torn or irregular edges of the wound should next be brought into apposition at a few points, by the introduction of catgut or silkworm-gut sutures, applied not very closely together; and if the edges are discolored and their vitality seems markedly impaired, it is better not to use sutures. If the edges of the wound are so much crushed as to have their vitality destroyed, they may be trimmed away with scissors until a surface possessing fair vitality is secured. The evil results arising from the introduction of sutures into this variety of wounds, with the idea of closely approximating their edges, are so common that the surgeon who dispenses with the use of sutures entirely errs upon the safe side. The use of many sutures in wounds of this nature often causes marked tension in the wound, which is frequently followed by impairment of the vitality of the injured tissues, and sloughing results.

The wound should next be dressed antiseptically, and if it runs a favorable course it need not be redressed for a week or ten days; the time required for the repair of a wound of this nature is longer than that for an incised wound, and more frequent dressing may be required.

In lacerated wounds of the extremities continuous irrigation of the wound by a warm bichloride or carbolic solution, applied as described, is often followed by the most satisfactory results; wounds produced by machinery and railway accidents, in which the vitality of the tissues is much impaired, are particularly favorable cases for this method of treatment, and here the same caution should be exercised as regards the introduction of sutures.

Contused Wounds. This variety of wounds possesses many characteristics in common with lacerated wounds; the edges are bruised and the injury of the subcutaneous tissue is often more extensive than the size of the external wound would lead one to suspect. They are dressed in the same manner as lacerated wounds, and the same objection here exists to the use of sutures as in the latter class of injuries.

Punctured Wounds. These wounds are inflicted by sharp-pointed instruments, and it often happens that a portion of the vulnerating body remains in the wound, as is frequently the case in wounds produced by needles, splinters of wood, metal, or glass, and another complication in this variety of wound is the injury of vessels, giving rise to concealed hemorrhage, or of nerves, resulting in neuritis or neuralgia. Simple punctured wounds should be carefully washed with an antiseptic solution and covered by an antiseptic gauze dressing, and if no complication exists their healing is usually very rapid.

When, however, a foreign body remains in the wound, as often happens in punctured wounds produced by needles and splinters, the punctured wound should be converted into an incised wound, and the body should be searched for and removed if possible, and in doing this in the case of wounds of the extremities the operation is much facilitated by the employment of Esmarch's bandage an strap. The Röntgen or X-rays may be employed with advantage in locating foreign bodies, such as pieces of glass or metal, in punctured wounds. After the removal of the foreign body the wound is treated as an incised wound, and an antiseptic dressing should be applied. When concealed hemorrhage occurs after a punctured wound, the wound should be laid open and the bleeding vessel searched for and ligatured if possible, and the wound should afterward be dressed as an incised wound.

Poisoned Wounds. These wounds are caused by the absorption, by means of a cut or abrasion in the skin, or by the sweat or sebaceous glands, of fluids from a dead body in making dissections, or post-mortem examinations, or in operating upon living subjects, and often result in serious consequences. Infection occurring from a living subject in operating is apt to give rise to a similar specific infection, or a mixed infection may result, whereas infection occurring from dead bodies is usually caused by the bacteria of putrefaction, as infective micro-organisms retain their virulence for a short time only after death. Such wounds, as soon as possible after their reception, should be carefully washed out with a solution of bichloride of mercury, 1 : 2000, or a 30-grain solution of chloride of zinc, and then dressed with an antiseptic dressing. If, however, this precaution is not taken, or the wound has escaped notice, and in a few hours becomes inflamed and painful, and evidences of lymphatic involvement show themselves, the wound should be opened and its surface should be thoroughly washed out with a 30-grain solution of chloride of zinc, and finally with a 1 : 2000 bichloride solution, and it should then be dressed with an antiseptic gauze dressing. Under this method of dressing the poisoned wound is often converted into a healthy one, even after the lymphatic involvement is well marked, and it usually heals promptly without further constitutional disturbance.

Gunshot Wounds. These wounds are produced by small shot, or fragments of shells, and are of the nature of contused and lacerated wounds, and the vulnerating body as well as portions of the clothing are often embedded in the tissues.

The modern small arms ball has much greater velocity than the leaden ball formerly employed; it has great penetrating power, and is more apt to pass through the bones without comminuting them. Primary hemorrhage is also more common in injuries produced by this ball. Within a certain range it also possesses marked explosive action, producing great destruction of the tissues with which it comes in contact, which has been recently explained upon the theory of hydrodynamic pressure or vibratory action. In dressing these wounds any foreign bodies, if they can be located, should be removed, and in the search for and removal of balls from the extremities the application of the Esmarch bandage and strap will be found most useful. The X-rays may also be satisfactorily employed in locating balls or fragments of metal in gunshot wounds. The wound should next be thoroughly washed out with a 1:2000 bichloride solution, and an antiseptic dressing applied as in the case of other contused and lacerated wounds.

Powder Burns. These result from the explosion of powder, and, in addition to the burning and laceration of the tissues, are accompanied by the introduction of grains of unburnt powder into the skin, which, if not removed, leave permanent points of pigmentation. These wounds should first be washed with a 1:2000 bichloride solution, and upon the face, to avoid unsightly pigmentation of the skin, care should be taken to pick out the small masses of powder with a needle or the sharp point of a tenotomy knife. The surface should then be dressed with antiseptic gauze or with lint spread with an ointment of boric acid or an ointment of aristol, consisting of half a drachm or a drachm of aristol to an ounce of vaseline, this dressing being covered by a few layers of bichloride or borated cotton, held in place by a roller-bandage.

Contusions or Bruises. These wounds differ from contused wounds in the fact that the skin is not broken, though in spite of this fact there may exist very extensive laceration of the subcutaneous tissues, accompanied by more or less extravasation of blood from the injured vessels. When not severe enough to require operative treatment they should be dressed by applying over them several layers of lint saturated with lead-water and laudanum, and over this dressing is placed a layer of waxed paper or rubber tissue, and the dressing is secured by a roller bandage.

A solution which I find most satisfactory in the dressing of contusions is as follows: Ammonii chloridi, grs. xx; tr. opii and alcoholis, āā f℥j; aquæ, f℥j.

Several layers of lint saturated with this solution are laid over the contused tissues, and are covered with waxed paper, oiled silk, or rubber tissue.

Extensive collections of blood following contusions often remain in the tissues for some time, but usually are absorbed. If this result does not follow, or an abscess forms, the blood or pus should be removed by aspiration or by incision with full antiseptic precautions.

Brush-burn. This is a form of contused and lacerated wound which is produced by violent friction applied to the surface of the body, and is often produced by coming in contact with rapidly revolving wheels or the belting of machinery, or by the body being rapidly propelled over an uneven surface, or by a rope being rapidly drawn through the closed hands. The injury may vary from a superficial abrasion to the absolute destruction of the skin. The surface of the brush-burn should be cleansed by a stream of sterilized water or 1 : 2000 bichloride solution, and should then be dressed with a powder of acetanilid and boric acid, equal parts, and a sterilized gauze dressing should be applied; if suppuration occurs, a moist bichloride or acetate of aluminum dressing or boric ointment should be applied.

Burns and Scalds. The dressings employed in the treatment of burns and scalds are similar, as the injury to the tissues is practically the same in both classes of injuries. Superficial burns or scalds, in which the effect of the heat has only extended to the superficial layer of the skin, may be treated by the application of lint saturated with a solution of *carbonate of sodium*, a drachm to an ounce of water; this dressing rapidly relieves the pain, and is a satisfactory application in this variety of burns and scalds. In cases in which the effects of heat have extended to the deeper tissues, the affected surface may be dressed with *carron oil*, which is prepared by rubbing together lime-water and linseed oil until a thick creamy paste results; lint is saturated with this mixture and laid over the surface of the burn or scald. This dressing is a comfortable one to the patient, but possesses no antiseptic qualities and soon becomes offensive, and for this reason requires frequent renewal.

The disadvantage met with in the antiseptic method of dressing burns and scalds is the fact that the raw surface presented offers the most favorable conditions for the absorption of the antiseptic substances employed in the dressings, and for this reason the use of bichloride of mercury, carbolic acid, and iodoform is not to be recommended in burns or scalds involving a large extent of surface, on account of the toxic symptoms which may result from their absorption.

In Germany the treatment of extensive burns by continuous immersion of the patient in a hot bath has been followed by good results.

A recent burn or scald, by reason of the heat employed in its production, is practically an aseptic wound, and it may be dressed by covering it with a number of layers of sterilized gauze and cotton, or with powdered boric acid, aristol, or acetanilid, and placing over this a number of layers of borated or salicylated cotton, and holding the dressings in position by a bandage.

If, however, a full antiseptic dressing is employed, the injured surface should first be irrigated with a 1 : 4000 bichloride solution, and then covered with protective or rubber-tissue which has been sterilized, and over this a dressing of bichloride or sterilized gauze and bichloride cotton should be applied.

When blebs are present upon the surface of the burn or scald, they should be opened to allow the serum to escape. If suppuration occurs, or the tissues become necrosed by reason of the severity of the injury, the surface of the burn may be washed with a 1:4000 bichloride solution, and the same dressing should then be applied.

The ulcers resulting from the separation of the dead tissues should be touched with a solution of nitrate of silver, four grains to the ounce of water, and dressed with lint spread with an ointment of boric acid or aristol. In the dressing of extensive burns or scalds of the neck, face, and region of the joints, the possibility of serious deformity from contraction of the tissues in healing should not be lost sight of, and position, splints, and bandages should be employed to prevent, as far as possible, this complication.

Injuries from Electricity. Since the extensive introduction of electricity in the arts, injuries from contact with heavily charged wires are of frequent occurrence. If the current be a strong one, death may be instantaneous, or the patient may be knocked down, become unconscious, and present severe burns at the point of contact, then regain consciousness, and subsequently suffer from numbness in the extremities, traumatic neuroses, and in rare cases true paralysis. If the skin be dry at the time the current is received there will be more burning, less penetration and less shock, and less danger of death. The burns are not painful, but are apt to be followed by extensive sloughing. Alternating currents are more dangerous than continuous currents; a continuous current of one thousand volts is not apt to be followed by serious consequences, whereas an alternating current of the same strength is likely to produce death.

Death from exposure to strong alternating currents is considered by Hedley to be caused by destruction of the tissues or by arrest of respiration producing asphyxia. Exposure to a strong electric current may produce burns or ecchymoses and occasionally wounds; the latter bleed freely and are apt to slough. A burn from electricity presents a dry, blackened surface and is surrounded by an area of pale skin. They are not as painful as ordinary burns, but healing in electric burns is usually slow. Inflammation and suppuration of the tissue usually develop in a few days, and are often followed by the development of an extensive area of moist gangrene, a small burn being followed by extensive and deep destruction of the surrounding tissues.

The treatment of a person who has been exposed to a strong electric current, even if apparently lifeless, consists in practising artificial respiration, Laborde's or Silvester's method being employed ; also friction to the surface of the body and enemata of hot saline solution, and in some cases venesection has been employed with advantage. Hedley records a case of apparent death in a man who received an alternating current of four thousand five hundred volts short-circuited through his body for many minutes, who showed no signs of life for thirty minutes. In this case, after the employment of Laborde's method of artificial respiration for some time, normal respiratory action was restored, and the patient recovered. Artificial respiration should be practised in all cases, and should be continued until it is certain that the patient is dead. At the same time strychnine should be used hypodermically.

The burns should be treated by the application of antiseptic dressings, but these often fail to arrest the sloughing.

DaCosta recommends in the early stage of these burns the use of fomentations of hot saline solution, which facilitates the separation of the sloughs, and in the subsequent dressing of the wounds, peroxide of hydrogen followed by irrigation with saline solution. After the sloughs have been separated dry sterilized dressings should be employed.

Lightning Stroke. In this form of electric injury a person may be struck directly or may be shocked by an induced current, the lightning having struck some object near at hand. A person struck by lightning may die instantaneously or be deprived of consciousness for a time, and may suffer from burns superficial or deep. Upon regaining consciousness the patient may complain of disturbance of vision, and may suffer from paralysis of the nerves of motion or sensation; paralysis of the lower limbs is said to be more common than that of the upper limbs.

The treatment of the stage of shock following lightning stroke consists in the application of external heat, the employment of artificial respiration, and the administration of stimulants. If burns exist upon the surface of the body, they should be treated like burns arising from artificial currents. If paralysis persists some time after recovery from the immediate effects of the shock, the use of galvanism and the administration of strychnine may be followed by good results.

Bedsores. These sores usually occur over the sacrum or hips in patients who are confined to bed for a considerable time, as the result of a long-continued pressure, or in those cases where the vital powers are depressed by adynamic diseases, and are also a frequent and troublesome complication in spinal injuries, in which cases they result from trophic disturbances. Their formation may be prevented in many cases by the use of air cushions or of a water mattress and by keeping the parts exposed to pressure scrupulously clean and frequently bathing them with stimulating lotions, such as alcohol, olive oil, and alcohol equal parts,or soap liniment. The parts should also be protected from pressure by the application of adhesive plaster, or, still better, soap plaster spread upon chamois. When a bedsore has actually formed, and in many cases its formation is very rapid and the slough will be found to involve a large surface of the skin over the sacrum, and to extend down to the bone, we have present a very serious complication, and one which requires most careful treatment.

The dressing of a bedsore before the separation of the slough consists in relieving the part from pressure by the use of an air-cushion placed under the buttocks, and the application of a moist antiseptic dressing until the slough has separated. When the slough has become detached the ulcer remaining should be well irrigated with a 1 : 2000 bichloride solution, and the granulations should be touched with a 5-grain solution of nitrate of silver; and aristol, or boric-acid ointment, spread upon lint, should be applied to the surface of the ulcer, and a piece of soap plaster a little larger than the ulcer should be placed over this dressing, and held in place by broad strips of adhesive plaster. This dressing should be renewed every day or every other day, and means should be adopted to protect the parts from further pressure, and the constitutional condition of the patient should be improved by the administration of a nutritious diet, tonics, and stimulants. The application of the galvanic current has been employed to promote the healing of the ulcer in obstinate cases.

Sprains. Sprains of the joints from twists or other external violence resulting in the stretching or laceration of the ligaments are injuries which require careful dressing.

Sprains may be first treated by the application of cold-water or hot-water dressings for a few hours, or by the application of lead-water and laudanum, the joint being kept at rest by the use of a splint or by confining the patient in the recumbent posture in the case of sprains of the joints of the lower extremities.

After a few days' use of the lead-water and laudanum dressing the swelling usually subsides and the joint may be fixed by the application of a moulded soap-plaster splint or felt splint held in place by a firmly applied roller-bandage, which should be worn for a week or ten days; in ordinary cases after this time the splint may be removed and the patient should be encouraged to use the joint. In cases of severe sprains, on the other hand, the pain and swelling persist for some time, and here the fixation of the joint by a plaster-of-Paris bandage will be found useful for a few weeks.

In the chronic stage of a sprain, after all dressings have been removed, the methodical use of *massage* is often most beneficial; and after the parts have been thoroughly manipulated a flannel bandage should be applied which, by its elasticity, gives a certain amount of support to the parts.

Strapping. The treatment of sprains which I have found the most statisfactory, both in the acute and chronic stage, consists in the use of strapping. Strips of rubber adhesive or adhesive plaster one and a half inches in width are applied around the joint, and are made to extend some distance above and below it, and a gauze bandage is next applied over the straps, and the patient is allowed to use the part as soon as he can do so without discomfort (see page 167).

Sprain-fracture. Under this name Mr. Callender has described an injury which consists in the separation of a ligament or tendon from its point of insertion into a bone, with the detachment of a thin shell of the bone; this injury is apt to occur about the ankle-joint, knee-joint, elbow-joint, and wrist-joint, and the treatment is the same as that of an ordinary fracture in the same locality. This injury is probably much more common than is generally supposed in connection with sprains of the joints, and is, I think, in many cases the cause of tardy restoration of the function of sprained joints, this injury being overlooked and the injury simply being treated as a sprain, and the patient being encouraged to use the part before the union of the bone has been accomplished.

Strains of Muscles and Fascia. These vary in severity from simple stretching of the fibres to absolute rupture and should be treated by putting the parts at rest and by the application of pressure by means of adhesive straps or of a bandage; in strains of the muscles and fascia of the back the use of broad strips of adhesive plaster, applied as in cases of fracture of the ribs, will be found most satisfactory. In the treatment of the latter stages of these injuries the employment of massage will often be followed by good results.

PART III.

FRACTURES.

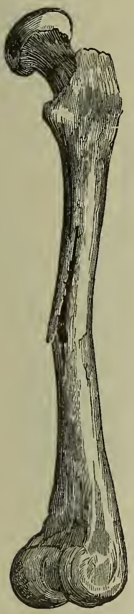
In the following article the author has endeavored to confine himself simply to a description of the varieties of fracture and to their dressing and treatment, and he has tried as far as possible to avoid the multiplication of dressings, being satisfied to describe a few of the methods of dressing most frequently employed. He has also avoided the description of complicated splints and dressings, by the use of which in certain fractures most excellent results are obtained, but has preferred to recommend the employment of simple splints and dressings, which can be obtained by physicians practising in districts remote from large cities, where the services of an instrument-maker cannot be obtained to construct special apparatus for the treatment of these injuries.

VARIETIES OF FRACTURE.

Complete Fracture. This is a fracture in which the line of separation completely traverses the bone, involving the entire thickness of the bone.

Incomplete Fracture. This is a fracture in which there is only a partial separation of the bone-fibres (Fig. 234), under which name is included *partial* or "*green-stick*" *fracture*, in which some of the bone-fibres have given way, while the remaining fibres have been bent by the force and have not been broken (Fig. 235). Fissured, punctured, indented, and perforating fractures are also included in the class of incomplete fractures (Fig. 236).

FIG. 234.



Incomplete fracture of femur.

FIG. 235.

Partial or green-stick fracture of radius.

FIG. 236.

Fissured fracture of the humerus. (GURLT.)

Simple or Closed Fracture. This is a fracture in which there are but two fragments, and the seat of injury in the bone does not communicate with the external air by a wound in the soft parts.

Compound or Open Fracture. This is a fracture in which the seat of injury in the bones communicates with the external air by a wound in the soft parts.

Comminuted Fracture. This is a fracture in which there are more than two fragments, the lines of fracture intercommunicating with each other (Fig. 237).

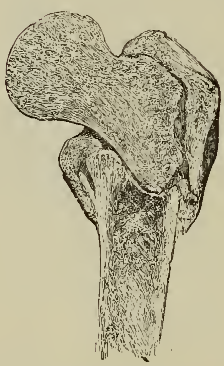
Multiple Fracture. This is a fracture in which a bone is the seat of two or more distinct fractures at different points, the lines of fracture not necessarily communicating with each other.

Complicated Fracture. This is a fracture accompanied by some serious injury of the parts in the region of the

FIG. 237.

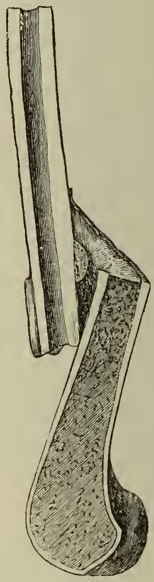
Comminuted fracture of patella.

FIG. 238.



Impacted fracture.

FIG. 239.



Transverse fracture of femur. (GURLT.)

fracture—as, for instance, the laceration of important bloodvessels or nerves, contusion or laceration of the muscles, or dislocation of a neighboring joint.

Impacted Fracture. This is a fracture in which one fragment is driven into and fixed in the other, the impaction taking place at the time of fracture, or being caused by a force subsequently applied (Fig. 238).

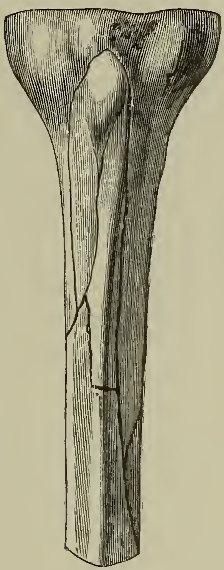
Transverse Fracture. This is a fracture in which the general line of division of the bone is at right angles with the long axis of the bone (Fig. 239). Transverse fractures of the long bones are rarely met with, the line of fracture usually being more or less oblique.

Oblique Fracture. This is a fracture in which the line of separation is oblique to the long axis of the bone. This is one of the most common directions of the line of fracture (Fig. 240).

FIG. 240.

Oblique fracture of humerus.
(STIMSON.)

FIG. 241.



Longitudinal fracture of tibia.
(STIMSON.)

Longitudinal Fracture. This is a fracture in which the line of separation runs in the general direction of the long axis of the bone (Fig. 241). This form of fracture is rare, but is sometimes met with in the long bones as the result of gunshot injury.

Epiphyseal Fracture or Separation. This occurs before complete ossification has taken place between epiphysis and diaphysis, and is rarely seen after the twentieth year of life; the direction of the epiphyseal separation is transverse.

Deformity. The deformity or displacement in fractures is either angular, transverse, longitudinal, or rotary.

Examination of Fractures. In examining a case of fracture to locate the nature and seat of the injury, the clothing should be removed from the part with as little disturbance as possible, and it is better, in most cases, to cut or rip the clothing, rather than to attempt to remove it in the ordinary manner. The surgeon should first inspect the injured part, and, where possible, compare it with its fellow, as in the case of injuries of the extremities; much valuable information is also derived from the patient or his friends as to the manner in which the injury was produced. The part should next be carefully examined by the surgeon; if it be one of the extremities which is injured, it should be gently lifted, firm extension being made at the same time, the surgeon by his touch and by gentle movements seeking to locate the seat of fracture; and he may, by his manipulation, at the same time develop crepitus.

All manipulations should be made with care, and with the greatest gentleness, not only to save the patient from pain, but also to prevent the soft parts in the region of the fracture from being injured by the rough or sharp fragments of the bone. Rough handling of fractures may increase the muscular spasm by the irritation caused by the sharp fragments of the bones, and may also result in the injury of important vessels and nerves, and indeed a simple fracture may readily be converted into a compound one by forcible and injudicious manipulations.

The sooner the examination is made after the fracture has occurred the better, for at this time there is less swelling in the region of the injury, and the surgeon can locate the bony prominences with much more ease, and can often discover the exact seat of the fracture with the least amount of manipulation of the parts. When a case of suspected fracture is not subjected to examination for several days after the reception of the injury, the parts in the region of the supposed fracture are often so much swollen that it is impossible to accurately locate its seat, and in such a case it is often necessary to wait until the swelling has subsided before the position of the fracture can be satisfactorily fixed, the case being treated in the meantime as one of fracture.

Anæsthetics. These may be employed to relieve the patient from pain and to obliterate muscular spasm in the examination of fractures. Their employment is often of the greatest service in the diagnosis of obscure or complicated fractures, especially those in the neighborhood of joints; but the surgeon should remember that all manipulations should be made with the same gentleness as when the examination is conducted without anæsthesia, for there is the same risk of injury to the surrounding structures by the fragments; this precaution is often neglected when an anæsthetic has been given, the surgeon often being inclined to handle the parts more roughly than he otherwise would; such practice cannot be too severely condemned.

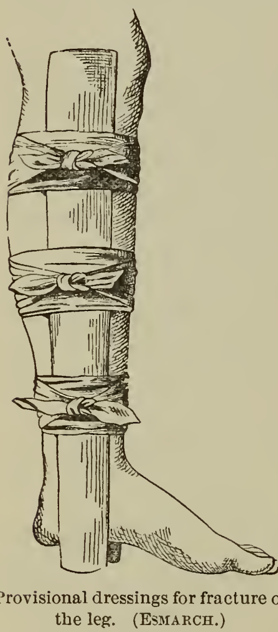
The use of the fluoroscope or of a skiagraph taken by the X-rays has proved a valuable means of locating the existence or location of the fracture in obscure cases.

Provisional Dressings of Fractures. It generally happens that fractures occur at localities more or less distant from the point where the treatment of the fracture is to be conducted, and the transportation of the patient and the temporary dressing of the fracture are, therefore, matters of the first importance. In fractures of the *upper extremity,* if the fracture be simple, the clothing need not be removed, and the arm should be bound to the side by some article of clothing, or supported in a sling made from handkerchiefs or the clothing, and the patient can usually walk or ride for a short distance without much injury to the parts in the region of the fracture or inconvenience to

21

himself. When the bones of the *lower extremities* or the trunk are the parts involved, the transportation of the patient is a matter of more difficulty. When the bones of the *trunk* are involved the part should be surrounded by a binder firmly pinned or tied, made from the clothing or from towels, or sheets, or other strong materials which are at hand. When the bones of the *lower extremity* are involved, if the fracture be a simple one the clothing need not be removed, and the motion of the fragments should be prevented by applying to the sides of the limb, extending above and below the seat of fracture, strips of wood, shingles, pasteboard, bundles of straw, strips of bark taken from trees, or bundles of twigs, these being held in place by handkerchiefs or strips torn from the clothing (Fig. 242). Umbrellas or canes, or broomsticks, applied in the same manner, may be employed, the object of all of these dressings being to secure temporary fixation of the fragments of bone during the transportation of the patient.

Fig. 242.



Provisional dressings for fracture of the leg. (Esmarch.)

If the fragments are not fixed in some way, but are allowed to move about during the transportation of the patient, much damage may result to the soft parts surrounding the fractured bones, and simple fractures may become compound ones by the bones being forced through the skin, the discomfort of the patient at the same time being much increased.

Having applied a dressing to bring about fixation of the fragments, the patient should next be placed upon a broad board or settee; if a mattress cannot be obtained, the fractured limb should be laid upon a mass of clothing, or upon some straw, and he should be placed in a wagon or carried to the point where the subsequent treatment of the fracture is to be conducted.

Reduction or Setting of Fractnres. This should be effected as soon as possible after the occurrence of the injury and as soon as the surgeon is prepared to apply the dressings to keep the parts in their proper position; reduction at an early period is less painful to the patient and is accomplished with more ease to the surgeon than at a later period, when marked swelling and inflammation are present at the seat of fracture. Reduction consists in bringing the fragments, by manipulation, as nearly as possible in their normal position, and it is accomplished by extension and manipulation with the hands, care being taken to use as little force as possible to attain the object. Very little force is required if the surgeon places the part in such a position as to relax the muscles which produce the displacement; when this is accomplished the fragment can usually be pressed into position by the fingers without the application of any considerable force. When the reduction of a fracture has been accomplished the fragments are retained in position by the application of various splints or dressings which serve to prevent their displacement.

Materials and Appliances Used in the Dressing of Fractures.

The Fracture Bed. Many ingenious forms of beds have been devised for the use of patients suffering from fractures of the bones of the trunk and lower extremities, with the object of permitting the patient to have fecal evacuation, without disturbing his position; but a simple bedstead provided with a firm hair mattress is usually more satisfactory than the complicated form of bed.

It will be found more convenient in handling the patient to use a single bed not over thirty-two or thirty-six inches in width, and it is not essential that the mattress be perforated, as a bed-pan can usually be slipped under the patient. The use of an ordinary shallow tin pie-plate covered with a piece of old muslin to receive the fecal evacuations may be substituted for the bed-pan, and will be found in many cases more satisfactory, especially in the case of children suffering from fracture of the lower extremity.

Splints. After the reduction or setting of the fragments in cases of fracture they are usually retained in position until union occurs by the use of splints held in position by means of bandages or strips of muslin. Splints may be made of wood, or of tin, lead, copper, or wire, binder's board, leather, felt, paper, gutta-percha, or plaster-of-Paris.

Wooden Splints. The simplest and best splints are made from wood—white pine, willow, or poplar being the best material to employ for their construction, being sufficiently strong to give fixation to the parts and at the same time being light. Splints made from smooth white pine, willow, or poplar boards from one-eighth to one-fourth of an inch in thickness may be employed in the form of straight or angular splints, and their preparation is a matter of little difficulty.

Wooden splints before being applied to the part should be well padded with cotton, wool, oakum, or hair, and where lateral wooden splints are employed in the treatment of fractures of the lower extremity it is usual to place bandages or junk-bags between the limb and the splint. The carved wooden splints which are sold by the instrument makers are not to be recommended, as a rule, for unless the surgeon has a large number to select from it is rare that a splint can be obtained to accurately fit any individual case.

Binder's Board Splints. Binder's board is an excellent material from which to construct splints; it is first soaked in boiling water, and when sufficiently soft is padded with cotton or a layer of lint and moulded to the part. It may be secured in position by a bandage; as it becomes dry it hardens and retains the shape into which it was moulded.

Undressed Leather Splints. This is a good material from which to construct splints; it is applied by first soaking the leather in boiling water, and after padding it with cotton or lint it is moulded to the part and retained in position by a bandage.

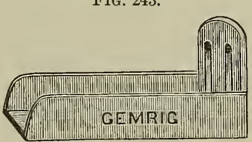
Felt Splints. These are made from wool saturated with gum shellac, pressed into sheets, which is a good material from which to construct splints. This material is prepared for application to the surface by heating it before a fire until it becomes pliable, or by dipping it into boiling water.

Gutta-percha Splints. These are made from sheets of this material, in thickness from one-sixteenth to one-fifth of an inch, and may often be employed with advantage; they are prepared for use by immersing it in hot water, when it becomes soft and can be moulded to the surface. Care should be taken that it is not allowed to become very soft by too long immersion to permit of its being conveniently handled.

Paper Splints. These are made from layers of manilla paper stiffened with starch, and constitute a very fair substitute for some of the varieties of splints previously mentioned.

Plaster-of-Paris, Starch, Chalk and Gum, Silicate of Potassium or Sodium Splints. These may be employed for the construction of splints, either movable or immovable, in the treatment of fractures; their method of preparation and application is described (p. 99 *et seq.*); the plaster-of-Paris dressing is the one which is most generally used at the present time.

FIG. 243.



Fracture-boxwith movable sides.

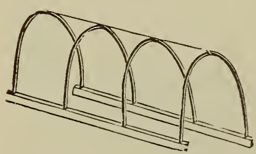
Fracture-box. This is a form of splint used in the treatment of fractures of the lower extremity, and consists of a piece of board eighteen to twenty inches in length, with a foot-board firmly secured at its lower extremity; the sides are secured by hinges which allow them to be raised or lowered (Fig. 243). A fracture-box of greater length is required for the treatment of fractures about the knee-joint.

Bran, Sand, or Junk Bags. These are constructed by taking a piece of unbleached muslin five feet in length and fourteen and one-half inches in width, doubling it and securing the free margins, except at the mouth, by stitches so as to form a bag; the bag is then inverted so that the edges of the seams are brought on the inner surface of the bag. The bags are next filled with dry sand, bran, or hair, or with straw, and the mouth of the bag is closed by stitches or by being tied with a string. Bran bags with splints, or sand bags are frequently employed in the treatment of fractures of the femur.

Bandages. These are made of muslin and are used to retain splints in the treatment of fractures, and are also sometimes applied directly to the injured part before the application of splints to control muscular spasms and limit the amount of swelling; when a bandage is so used it is known as a *primary roller.* The use of the primary roller is sometimes of the greatest service in the dressing of fractures, but its use in inexperienced hands has often been followed by such unfortunate results in the early treatment of fractures, or in cases which are not under constant observation, that I think it is a safe rule of practice to discard entirely the use of the primary roller.

Compresses. These are made from a number of folds of lint, or of cotton or oakum, and are often employed to retain fragments in position or to make localized pressure upon certain points in the treatment of fractures The compresses are held in position by strips of adhesive plaster, by a few turns of a roller-bandage, or by the splints. Compresses are sometimes employed to protect bony prominences of the skeleton from the pressure of the splints, but this purpose is often better effected by the use of small pieces of soap plaster spread on chamois skin fitted over the prominent points.

FIG. 244.



Rack for supporting bed-clothes in fractures of the lower extremity.

Rack or Cradle. This is made of wire or wooden hoops, and is often employed to support the weight of the bedclothes in the treatment of fractures of the lower extremity (Fig. 244).

Evaporating Lotions in Fracture. The employment of evaporating lotions such as lead-water and laudanum, or muriate of ammonia and laudanum, to the skin in the region of fractures is highly recommended by many surgeons, especially in fractures involving or situated near joints. They are here employed to relieve pain, to limit inflammatory swelling, and to hasten the absorption of the blood and serum at the seat of fracture Many surgeons, on the other hand, think that their use causes irritation of the skin and delays the process of repair in the union of the fracture, and so strongly condemn their employment. Personally, I have never seen any bad results arising from their use, and have generally employed them in fractures near or involving the joints, but I do not consider their employment absolutely essential, and when I use them I only do so for two or three days. In cases of fractures accompanied with much pain and swelling, when the surgeon does not wish to use any of the lotions before named, an ointment of ichthyol one part, lanoline three parts, spread on lint and wrapped around the limb, will often prove a satisfactory dressing, or a layer of cotton may be simply wrapped around the part before the application of the splints.

Massage in the Treatment of Fracture. Lucas-Championnière advocates and practises immediate and continuous massage in the treatment of fractures, and holds that by its use pain is diminished, the repair of the bone hastened by the profuse deposit of callus, and the atrophy of muscles and stiffening of joints avoided.

Massage is applied as soon as possible after the fracture has occurred, and consists in manipulations with the thumb, the fingers, or the whole hand. The limb is held by an assistant and extension is made, or it is placed upon a firm pillow or a sand cushion. The manipulations should be made in the direction of the muscular fibres and of the blood-current, and firm pressure should not be made directly over the seat of fracture.

Massage should be practised for from fifteen to twenty minutes daily, and no retention apparatus should be applied in the intervals unless there is marked tendency to displacement of the fragments, when some form of retention apparatus or splint may be used. These manipulations should be continued for some weeks, until union is firm at the seat of fracture. Massage has also been combined with the ambulatory method of treatment of fractures of the lower extremity. This method of treating fractures by massage may be said to be still on trial, sufficient experience not yet having accumulated to prove that it possesses marked advantage over the generally adopted method of treatment by immobilization.

Dressing of Special Fractures.

Fracture of the Nasal Bones. Fractures of the nasal bones are often acompanied with fractures involving the septum, the nasal process of the maxillary bone, and the nasal spine of the frontal bone.

The treatment consists is replacing the fragments, if displacement exists, by manipulation with the fingers over the seat of fracture and by pressure made from within the nostrils by a probe or a steel director. When the displacement is once corrected it is not apt to recur, and in the majority of cases no dressing is required. Before resorting to any manipulation within the nasal cavities the mucous membrane should be thoroughly cocainized to render the operation painless to the patient. When there is a return of the depression of the fragments or displacement of the septum after correcting the deformity by raising the depressed fragment, or bending the septum into place by a director, the parts may be held in position by packing the nasal cavity firmly with a strip of antiseptic gauze.

In lateral displacements of the nasal bones from fracture, after reducing the displacement, a small compress held over the fragment by strips of adhesive plaster will be the only dressing required.

Mason transfixes the nose, after reduction of the fragments, with a stout needle, and steadies the pieces with a strip of plaster crossing the bridge of the nose and fastened to the ends of the needle. The needle is kept in position for eight or ten days (Fig. 245). Roberts, in cases in which there is a displacement of the cartilaginous portion of the nose, after reducing the deformity, holds the parts in position by transfixing them with steel pins.

Fig. 245.

Mason's dressing for fracture of the nasal bones.

Profuse hemorrhage sometimes occurs after fracture of the nasal bones and may require plugging of the nares to control it.

Fractures of the nasal bones are usually quite firmly united in two weeks, and dressings may be dispensed with after this time.

Fractures of the Malar Bone and Zygoma. These fractures are usually the result of direct force; the displacement is upward or backward, and when the zygomatic arch is broken the fragments from pressure upon the masseter muscle or on the tendon of the temporal muscle may interfere with the movements of the lower jaw in mastication. This displacement is corrected by cutting down upon the fragment and elevating it or by passing a tenaculum into the fragment and raising it.

Outward displacements may be corrected by pressure and the application of a compress. The dressing of these fractures after the correction of the deformity consists in the application of a compress of lint over the seat of fracture, held in position by strips of adhesive plaster or a bandage. There is little tendency to recurrence of the deformity after it has been corrected, and union at the seat of fracture is usually firm at the end of three weeks.

Fractures of the Upper Jaw. These fractures may involve the *body*, the *nasal processes*, or the *alveolar processes*. The deformity should be corrected, and if any teeth have been displaced they should be replaced; if there is comminution of the alveolus the teeth in the separate fragments may be fastened together by fine wire to fix the fragments and hold them in place; the teeth of the lower jaw should be brought up in contact with those of the upper jaw, and the jaws should be secured together by the application of a Barton's or a Gibson's bandage (Fig. 246). Inter-dental splints, made of cork, with grooves to fit the teeth, or of gutta-percha, are also employed in the dressing of these fractures. The patient should not be allowed to move the jaw in mastication, and should be nourished by liquid and semi-solid food, which can be taken without removing any teeth to give space for its introduction.

Fig. 246.

Dressing for fracture of the upper jaw.

The bandage should be removed every second or third day, and it should be reapplied in the same manner.

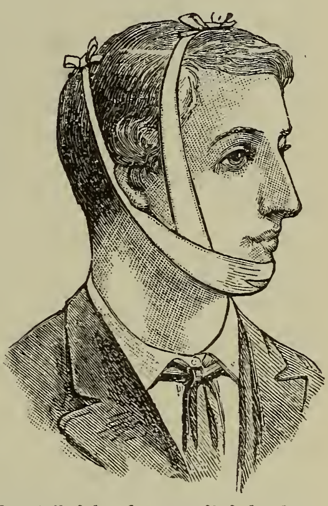
These fractures are usually firmly united at the end of four or five weeks, and dressings may be dispensed with at this time.

Fractures of the Lower Jaw. The lower jaw may be broken at or near the *symphysis*, the most usual seat of fracture being near the mental foramen; it is often broken at two places at once, and the fractures are in many cases

FIG. 247.

Dressing for fracture of the lower jaw.

FIG. 248.



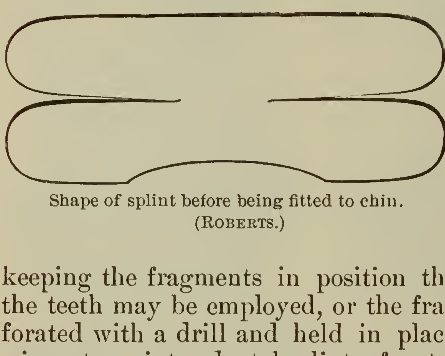
Four-tailed bandage applied for fracture of the lower jaw. (HAMILTON.)

rendered compound by laceration of the mucous membrane, or the injury may consist in a separation of a portion of the *alveolar process* of the bone. The dressing of a fracture of the lower jaw, after reducing the displacement and replacing any loosened or detached teeth, consists in applying a pad of lint under the chin and bringing the jaw up against the upper jaw, holding the compress in place, and securing the jaws firmly in contact by applying a Barton's (Fig. 247), modified Barton's or Gibson's bandage. The bandage should be removed and reapplied at the end of the second or third day, and at like intervals during the course of treatment. The patient should be fed upon a liquid or semi-solid diet, not being allowed to chew any solid food until the union at the seat of fracture has become firm.

A very satisfactory temporary dressing for a fracture of the lower jaw consists in the application of a four-tailed sling (Fig. 248).

Some surgeons prefer to use an external splint moulded from pasteboard or gutta-percha fitted to the chin in the dressing of this fracture (Figs. 249 and 250), this being padded with cotton and held in place by a Barton's, or Gibson's bandage. Where there is much difficulty in

FIG. 249.



Shape of splint before being fitted to chin. (ROBERTS.)

FIG. 250.

Splint moulded to fit chin. (ROBERTS.)

keeping the fragments in position the wiring together of the teeth may be employed, or the fragments may be perforated with a drill and held in place by a strong silver-wire suture; inter-dental splints of metal or gutta-percha are also sometimes used for this purpose. During the course of the treatment of fracture of the jaws the mouth often becomes very offensive from the fermentation of the saliva and discharges, and it is well to use frequently a mouth-wash of chlorate of potash and tincture of myrrh, or boric-acid solution.

The dressings for fracture of the lower jaw are usually applied for four or six weeks, the union usually being quite firm at the end of this time.

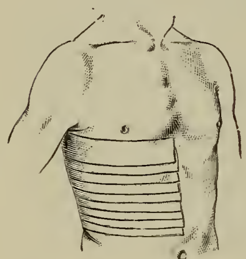
Fracture of the Hyoid Bone. In fracture of the hyoid bone, if displacement exists, its reduction is facilitated by pressure made with the finger in the pharynx.

The treatment consists in enforced quiet and the use of opium if cough is a prominent symptom, and the inflammatory symptoms may require the employment of active local treatment. A dressing may sometimes be employed with advantage, consisting of a splint of pasteboard or leather moulded to the anterior porton of the neck.

Fractures of the Larynx or Trachea. In fractures of the larynx or trachea where there is little displacement and dyspnœa is not marked, the parts should be supported by the application of compresses of lint held in place by strips of adhesive plaster. If, on the other hand, the respiration is embarrassed or there is free expectoration of blood, tracheotomy should be performed, and if the injury be seated in the larynx the displacement of the fragments may be overcome by manipulation with the finger or a director through the tracheal wound, or the larynx may be packed with a strip of antiseptic gauze to control hemorrhage or hold the fragments in position, the patient in the meantime breathing through a tracheotomy-tube secured in the tracheal wound; the packing should be removed in a few days, the tracheotomy-tube being permanently removed as soon as the patient can breathe comfortably through the larynx with the tracheal wound closed. In fracture of the trachea the opening into the trachea should be below or at the seat of injury.

Fractures of the Ribs. Fractures of the ribs are more frequent than fractures of any other bones of the trunk; the ribs most commonly broken are those from the fourth to the tenth; the most common seat of fracture is near the junction of the costal cartilages or at the angle. The dressing of fractures of the ribs is best accomplished by enveloping the side of the chest on which the rib or ribs are broken with broad straps of adhesive or rubber plaster. The adhesive straps should be two and a half inches in width and long enough to extend from the spine to the middle of the sternum. The straps are warmed and the first strap is firmly applied at the base of the chest, extending from the spine to the mid-sternal line; a number of ascending straps are applied in this way, each strap overlapping the preceding one by about one-third of its width until half the chest is covered in (Fig. 251). This dressing usually gives the patient much comfort, and the straps need not be renewed until they become slightly loosened, usually at the end of a week or ten days; they should then be renewed in the same manner.

Fig. 251.



Adhesive plaster dressing for fracture of the ribs. (Hamilton.)

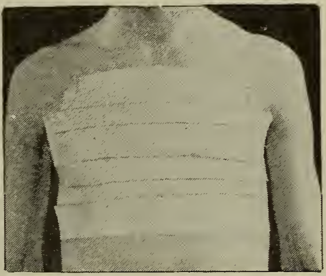
The dressings for fractures of the ribs are usually dispensed with at the end of three or four weeks, as repair of the fracture is generally well advanced by this time.

A satisfactory temporary dressing for fractures of the ribs consists in surrounding the chest by a broad binder of stout linen or muslin; indeed, some surgeons prefer to employ this dressing during the course of treatment, but, as a rule, I think it is not as good a dressing as the adhesive plaster dressing, as the former confines the movements of both sides of the chest.

Fractures of the Costal Cartilages. These fractures often take place at the junction of the cartilages with the ribs or in the body of the cartilages, and the union of the fracture usually takes place by the production of a mass of bone at the seat of fracture. The dressing for fractures of the costal cartilages consists in the application of strips of adhesive plaster applied in the same manner as for fracture of the ribs, and the dressings should be retained for about the same time.

Fractures of the Sternum. Fractures of the sternum are rare injuries, but diastasis of the bones of the sternum is a more common accident. The dressing for either variety of injury is the same, and consists in the application of a compress over the seat of fracture held in place by a broad bandage, or, better, by strips of adhesive plaster (Fig. 252), applied so as to cover and fix the anterior portion of the chest, covering the entire length of the sternum. This dressing should be retained for at least four weeks, being renewed if it becomes loose at the end of a week or ten days.

FIG. 252.



Adhesive plaster dressing for fracture of the sternum.

Fractures of the Pelvis. These fractures may involve the *ilium*, *ischium*, *pubis*, or *sacrum*, and are often serious injuries from implication of the pelvic viscera. The reduction of the displacement should be first accomplished as far as possible by external manipulation, together with internal manipulation by the fingers introduced into the rectum, or into the vagina in the female. The patient should be placed upon a firm bed on his back, with the knees slightly flexed over a pillow, and the parts should be kept at rest by surrounding the pelvis with broad straps of adhesive plaster or a stout muslin binder, or by a firmly applied padded pelvic belt. The hip-joints should be kept at rest by the application of pasteboard splints or by sand-bags. The dressings should be retained for a period of at least six weeks.

When these fractures are complicated by injury of the pelvic viscera various operative procedures may be required, which will compel the surgeon to modify the method of dressing.

Fractures of the Sacrum and Coccyx. The dressing of fractures of the *sacrum*, after effecting reduction of the fragments as far as possible by pressure from within the rectum, consists in the application of broad adhesive straps around the pelvis, and the patient should be kept at rest in bed.

When the *coccyx* only is fractured, after reduction of the displacement, which may sometimes be accomplished by manipulation with the finger in the rectum, the patient should be confined to bed and the bowels should be kept at rest by the use of opium by suppository. The patient should be kept at rest for two or three weeks.

Fractures of the Vertebræ. Fractures of the vertebræ are always most serious injuries, not only from the injuries of the bones themselves, but also from the damage to the spinal cord, membranes, and nerves, which often accompanies them.

In transporting, or turning in bed, a patient suffering from fracture of the vertebræ, great care should be exercised, for rough or sudden motions might cause a displacement of the fragments which might, by injury of, or pressure upon, the spinal cord, rapidly prove fatal.

In the *treatment* of fractures of the spine, if the deformity is marked, efforts should be made to reduce it by extension and counter-extension, and the result may be successful, especially if the fracture be associated with a dislocation of the vertebræ. In some cases the use of permanent extension by means of weights attached to the legs, shoulders, and chest by adhesive plaster and bandages has been successful in reducing the deformity.

The patient should be placed upon his back upon a bed with a hair mattress, or, better, if it can be obtained, a water-bed, which consists of a rubber mattress filled with water, which distributes the weight of the patient's body evenly over the surface. Whatever form of bed be used, the greatest care should be exercised to keep the patient absolutely clean, and the parts of the body or limbs which are exposed to pressure should be frequently bathed with alcohol or soap liniment; and to distribute the pressure, small pads should be placed under the parts and changed at intervals. These precautions are necessary to prevent, if possible, the formation of extensive bedsores, which are a frequent and troublesome complication of these injuries.

The *bowels* should be carefully watched, and, if constipation is present, it should be relieved by the use of enemata; and, as it is not desirable to lift the patient to slip a bed-pan under him, the discharges can be received in a flat tin plate pushed under the thighs and buttocks, or on pads of oakum or old muslin.

The care of the *bladder* is also a matter of the greatest importance; the retention which at first exists should be relieved by the use of a flexible catheter carefully sterilized and introduced with great gentleness, and when incontinence supervenes the catheter should also be used at intervals; the employment of a soft instrument, if used with care, is not apt to produce any injury to the urethra or bladder.

The employment of a plaster-of-Paris jacket has been followed, in some cases, by good results, and it may be applied early in the case, or it may be used after the patient has been kept in the recumbent posture for some weeks; by its use it is often possible to get the patient out of bed and allow him to sit in a chair.

In fractures involving the *cervical verterbræ*, care should be exercised in lifting or moving the head, and it is often of advantage in these cases to apply short sand-bags to the sides of the neck and head, to give additional fixation to the parts while the patient is in the recumbent posture, or, if he is allowed to get out of bed, to apply a moulded leather or pasteboard splint to the neck, shoulders, and back of the head for the same purpose.

The course of treatment in cases of fractures of the vertebræ, if the patient does not succumb to the injury in a few days or weeks, often extends over many months, and recovery is often more or less incomplete as regards the function of the parts below the seat of fracture.

Fracture of the Skull. The treatment of fractures of the skull, whether simple or compound, depends largely upon the nature of the injury and the condition of the cranial contents. In simple fractures unaccompanied with cerebral symptoms no special dressing is required, but in compound fractures where loose fragments are present, these should be removed; and if there is no depression of the fragments, and if no cerebral symptoms are present, the wound should be drained, carefully closed and dressed antiseptically, the dressings being held in place by a recurrent bandage of the head.

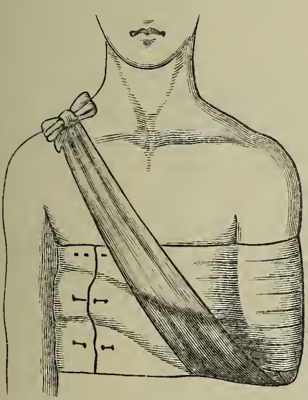
The patient should be put to bed, and the use of an ice-cap to the head is often of service. The diet should be restricted, while calomel and opium or bromide of potassium should be administered; it is well to keep the patient for a few weeks in a quiet and darkened room. Where cerebral symptoms are present, either in simple or compound fractures, and trephining is resorted to, the dressing of the wound is similar, and the same general treatment should be adopted In all cases of fracture of the skull, whether subjected to operative treatment or not, it is well to keep the patient at rest in bed for three or four weeks, and he should be cautioned to avoid excesses afterward, and should not resume active work for some months.

Fractures of the Clavicle. Fractures of the clavicle may be complete or incomplete, and in the latter variety of injury the deformity is not usually very marked. The indications for treatment in complete fractures of the clavicle are to relax the sterno-cleido-mastoid muscle, to prevent the weight of the arm on the injured side from dragging down the outer fragment of the clavicle, and, by fixing the scapula, to carry the attached external fragment outward and forward. A large variety of dressings have been devised and used to accomplish these objects.

Dressing by Position. The treatment of fractures of the clavicle by position is accomplished by placing the patient in bed on his back upon a firm mattress with a low pillow under his head, and the arm on the side of injury should be fastened to the side of the chest by a few circular turns of a bandage passing around the arm and chest; the deformity is usually very satisfactorily reduced upon the patient assuming this position, and after three weeks' rest in this position the union is generally sufficiently firm to allow the patient to get out of bed and be about with the arm bound to the side or carried in a sling or with a Velpeau bandage applied, without any recurrence of the deformity.

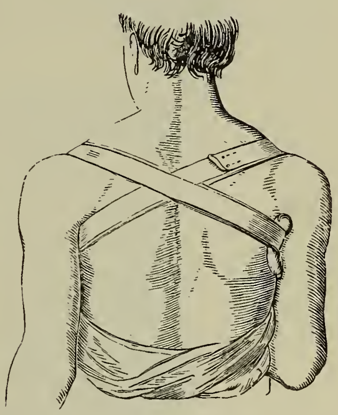
Temporary Dressing. A satisfactory temporary dressing for fractures of the clavicle consists in the application of a four-tailed bandage; the bandage is made from a piece of muslin two yards in length and fourteen inches in width; a hole is cut in its centre about four inches from its margin, to receive the point of the elbow; the bandage is then split into four tails in the line of the hole and to within six inches of it; the body of the bandage should be applied so that the point of the elbow rests in the hole, and a folded towel being placed in the axilla, the lower tails should be carried, one anteriorly, the other posteriorly, diagonally across the chest and back, to the neck on the side opposite the seat of fracture, and secured; the

FIG. 253.



Four-tailed bandage for fracture of the clavicle. (STIMSON.)

FIG. 254.



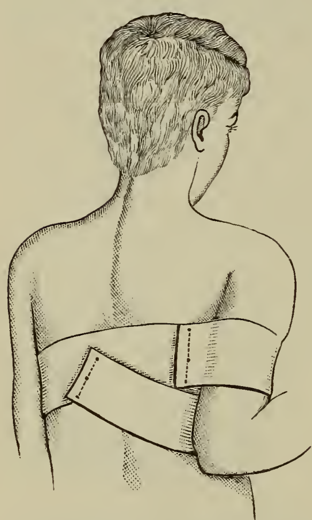
Posterior figure-of-eight dressing for fracture of the clavicle. (HAMILTON.)

remaining tails are next carried around the lower part of the chest and secured so as to fix the arm to the side of the body (Fig. 253).

In some cases the deformity is corrected by the application of a posterior figure-of-eight bandage, the forearm on the side of injury being carried in a sling (Fig. 254).

Sayre's Dressing. This consists of two strips of adhesive plaster three and a half inches wide and two yards in length. The first strip is looped around the arm just below the axillary margin, and is pinned or sewed with the loop sufficiently open not to constrict the arm. The arm is then drawn downward and backward until the clavicular portion of the pectoralis major muscle is put sufficiently upon the stretch to overcome the action of the sterno-cleido-mastoid muscle, and in this way draws the sternal fragment of the clavicle down to its place. The

FIG. 255.



Sayre's dressing for fracture of the clavicle. First strip applied.

FIG. 256.

Sayre's dressing for fracture of the clavicle. Second strip applied.

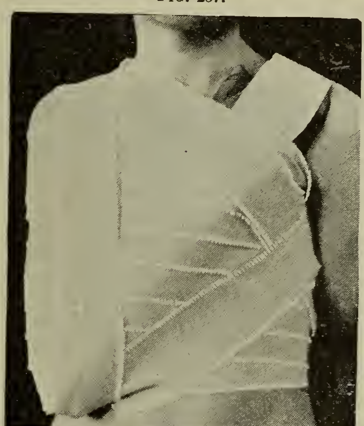
strip of plaster is then carried completely around the body and pinned or stitched to itself on the back (Fig. 255). The second strip is next applied, commencing upon the front of the shoulder of the sound side; thence it is carried over the top of the shoulder diagonally across the back, under the elbow, diagonally across the front of the chest to the point of starting, where it is secured by pinning or sewing. A slit is made in this strip to receive the point of the elbow. Before the elbow is secured by the plaster it should be pressed well forward and inward (Fig. 256).

Velpeau's Dressing. This may also be used in the treatment of fractures of the clavicle (Fig. 258). A compress may also be secured by the vertical turns of this bandage over the seat of fracture if needed. The application of the bandage is described (p. 62).

In any form of dressing in which the arm is held against the side of the chest it is well to apply a folded towel or piece of lint between the arm and chest to prevent the surfaces from becoming excoriated.

Modified Velpeau's Dressing. A modified form of Velpeau's dressing for fracture of the clavicle is applied as follows: A soft towel or piece of lint is placed against the side of the body and over the front of the chest, and held

FIG. 257.



Modified Velpeau dressing for fracture of the right clavicle.

in position by a strip of adhesive plaster; the arm is next placed in the Velpeau position, a good-sized pad of lint is next applied over the scapula, and this is held in place by a broad strip of adhesive plaster two and a half inches in width and one and a half yards in length; this strip is continued downward and forward so as to pass over the point of the elbow, and is carried diagonally across the chest to the shoulder of the opposite side, and is secured, a slit being cut in it to receive the point of the elbow; a compress of lint is next placed over the seat of fracture and held in place by a strip of adhesive plaster; an additional strip of plaster is next carried from the spine around the arm and chest and secured on the opposite side of the chest; circular turns of a roller bandage are then passed around the chest, including the arm from below upward until the arm is securely fixed to the body, and the dressing is finished by making one or two turns of the third roller of Desault (Fig. 257). Or the turns of the third roller of Desault may be applied first, and the dressing may be finished by circular turns of a roller passing around the arm and chest, extending from the elbow to the shoulder.

Fracture of Clavicle in Children. In the treatment of fractures of the clavicle in children the Velpeau or modified Velpeau dressing will be found to be the most satisfactory dressing to employ, and as these patients are particularly apt to disarrange their dressings it is well to render the dressing additionally secure by applying a few broad strips of adhesive plaster over the turns of the roller bandage, the strips following the turns of the bandage.

The removal of dressings and their reapplication will depend upon the comfort of the patient and the manner in which they keep their position. As a rule, in fractures of the clavicle the dressings are removed at the end of the second or third day, the parts are inspected, and the skin is sponged off with dilute alcohol; the dressings are then reapplied, and if the patient is comfortable and the parts are in good position, the dressings are made at less frequent intervals until union is completed at the seat of fracture.

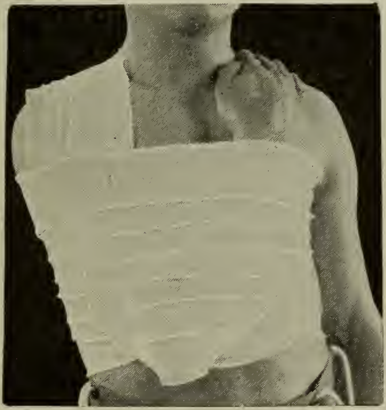
Union in cases of fracture of the clavicle is generally quite firm at the end of four or five weeks, and at this time the dressings may be removed, and the patient should carry the arm of the affected side in a sling for several weeks, and should not undertake any work requiring forcible movements of the arm until eight or ten weeks have elapsed from the receipt of the injury.

The time required for union in fractures of the clavicle in children is somewhat shorter; the dressings may be removed at the end of three weeks.

Fractures of the Scapula. Fractures of the scapula may involve the *body*, *neck*, *acromion* or *coracoid* process of the bone. Fractures of this bone are quite rare.

Fracture of the Body of the Scapula. In dressing this fracture, if deformity is present, it is reduced by manipulation, and compresses of lint are placed above and below the seat of fracture and held in place by adhesive strips; the arm is next fixed to the side of the body by spiral turns of a roller bandage passing around the arm and chest, and the forearm is supported in a sling.

Fig. 258.



Velpeau dressing for fracture of the scapula.

Fracture of the Neck, Acromion or Coracoid Process of the Scapula. These fractures may be dressed by placing a pad of lint or a folded towel in the axilla and binding the arm to the body by spiral turns of a roller bandage passing around the arm and chest, and supporting the forearm in a sling. Or these fractures of the scapula may be dressed by first placing a pad of lint or a folded towel in the axilla and then securing the arm in the Velpeau position by the application of a Velpeau bandage (Fig. 258). In fractures of the acromion or coracoid processes the union is usually fibrous. In the treatment of fractures of the scapula the dressing should be retained for about four weeks.

Fractures of the Humerus. Fractures of the humerus may involve the *upper extremity*, the *shaft* or the *lower extremity* of the bone

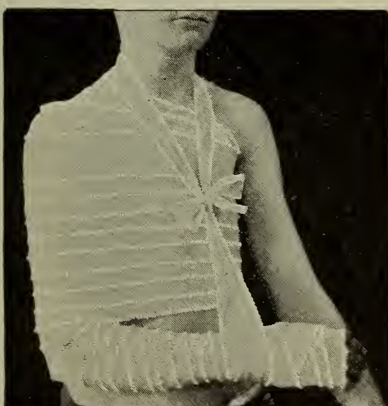
Fractures of the Upper Extremity of the Humerus. These include fractures of the head and anatomical neck of the bone, fractures through the tuberosities, fractures through the surgical neck of the humerus, and epiphyseal fracture or disjunction of the upper epiphysis of the humerus.

FIG. 259.

Moulded splint for shoulder and arm.

The most satisfactory dressing for all fractures of the humerus above the upper third of the bone is applied as follows: A primary roller should be evenly applied from the tip of the fingers to the seat of the fracture, the arm being flexed at the elbow before the bandage is carried above this point, to prevent the dangerous constriction which might result if the bandage were applied with the arm in the straight position, and it were afterward flexed at the elbow. A folded towel or a thin pad of lint should next be placed in the axilla and over the outer surface of the chest, to furnish a firm basis of support for the humerus and also to prevent excoriation from the contact of the skin surfaces. A splint of pasteboard, felt, or leather (Fig. 259) is next moulded to the shoulder and arm; this should be long enough to extend some distance below the seat of fracture and wide enough to cover in about one-half of the circumference of the arm, and is padded with cotton and fitted to the shoulder and arm. The splint and arm are next secured to the side of the body by spiral turns of a roller bandage including the arm and chest in its turns and applied from the elbow to the top of the shoulder. The forearm is carried in a narrow sling suspended from the neck (Fig. 260). This dressing should be removed at the end of twenty-four or forty-eight hours, and after the parts have been inspected and sponged over

FIG. 260.



Dressing for fracture of the upper extremity of the humerus.

with alcohol, the dressings should be reapplied in the same manner, and if the patient is comfortable they need not be disturbed again for three or four days, subsequent dressings being made at the same intervals. Union in fractures of the upper extremity of the humerus, except in *intracapsular* fracture, in which bony union is the exception, is usually quite firm at the end of five or six weeks, and the dressings can be dispensed with at this time.

Separation of the Upper Epiphysis of the Humerus. This accident is not uncommon in patients under eighteen years of age, and resembles in many respects fracture of the neck of the humerus. There is usually a marked projection of the upper extremity of the lower fragment in front of the shoulder (Fig. 261). The dressing for separation of the upper epiphysis of the humerus is similar to that

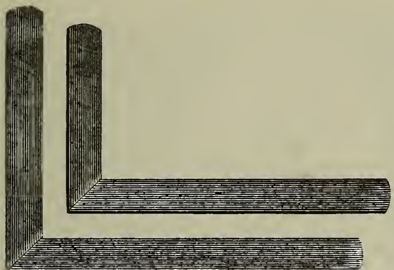
FIG. 261.

Separation of upper epiphysis of the humerus.

employed in fracture of the neck of the humerus (Fig. 260). The functional result following this injury is usually very good.

Fracture of the Shaft of the Humerus. The dressing consists in the application of a primary roller from the tips of the fingers to the seat of fracture; a short, well-padded, wooden splint extending from the axilla to a point a little above the internal condyle is next placed on the inner surface of the arm and against the chest; a moulded pasteboard or felt splint, fitted to the shoulder and outer side of the arm and extending a short distance below the seat of fracture, is padded with cotton and applied to the shoulder and arm. The splints are held in position by the turns of a bandage, and the arm is secured to the body by spiral turns of a roller bandage carried around the chest and arm, and the forearm is carried in a sling suspended from the neck. The dressing is much the same as that for fracture of the upper part of the humerus, with the addition of the short internal splint.

FIG. 262.



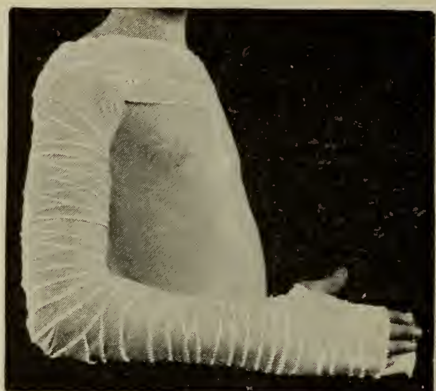
Internal angular splints.

Fracture of the shaft of the humerus may also be dressed by first applying a primary roller and then placing the forearm and arm upon a well-padded internal angular splint (Fig. 262). Care should be taken to see that the end of the splint extends only to the axilla and does not press upon the brachial vein. A pasteboard or felt moulded splint is next applied to the shoulder and outer side of the arm, which should be long enough to extend below the seat of fracture. The splints are held in position by turns of a roller bandage beginning at the fingers and carried up to the shoulder, and finished with a few spica-of-the-shoulder turns (Fig. 263). The arm is supported by a sling applied at the wrist, and sometimes for additional security the arm is bound to the side of the body by spiral turns of a bandage carried around the arm and chest. The after-treatment of these fractures as regards the removal and renewal of the dressings is the same as in cases of fracture of the upper portion of the humerus.

In fractures of the shaft of the humerus the dressings should be retained for five or six weeks.

Fracture of the Lower Extremity of the Humerus. These include fractures at the *base of the condyles*, *splitting fractures* between the *condyles* or those of the *internal* or *external condyle*, and *epiphyseal fracture* or *disjunction* of the lower epiphyis of the humerus.

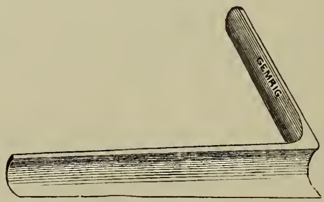
FIG. 263.



Dressing for fracture of the shaft of the humerus with internal angular splint and external splint of binder's board.

In dressing fractures of the lower extremity of the humerus, if a primary roller is employed it should be car-

FIG. 264.



Anterior angular splint.

ried up only to the elbow. The displacement is reduced by extension and manipulation, and before applying any splint it is well in many cases to apply over the region of the fracture several folds of lint saturated with lead-water and laudanum, and to cover this dressing with waxed paper or rubber-tissue to diminish as far as possible the swelling, which is very marked after these injuries. The use of this lotion may be omitted, and a layer of cotton may be placed around the joint in its place. An anterior angular splint (Fig. 264) well padded with cotton or oakum is next applied and held in position by the turns of a roller bandage applied from the fingers to the upper

FIG. 265.

Dressing for fracture of the lower extremity of the humerus with anterior angular splint.

portion of the splint (Fig. 265). These fractures may also be dressed with a well-padded internal angular splint, this splint being substituted by an anterior angular splint at the end of ten days or two weeks.

Some surgeons prefer to dress fractures of the condyles of the humerus with the arm in the *extended* position upon a straight anterior splint, or with short, narrow pasteboard splints applied around the joint, as favoring more accurate coaptation of the fragments. If this position is employed a straight wooden splint is applied to the anterior surface of the arm and forearm, or moulded splints of pasteboard may be used, and after the union is moderately firm, at the end of two weeks, the elbow should be flexed and kept in this position during the remaining time of the treatment.

Treatment by Acute Flexion (Jones's Method). In this dressing of fractures of the condyles of the humerus, the forearm is placed in a position of acute flexion at the elbow, and the hand of the injured arm is brought up and is supported by a sling carried around the neck (Fig. 266). The flexion of the forearm on the arm may also be secured by passing broad strips of adhesive plaster around the arm

Fig. 266.

Dressing for fracture of condyles of humerus in acute flexion.

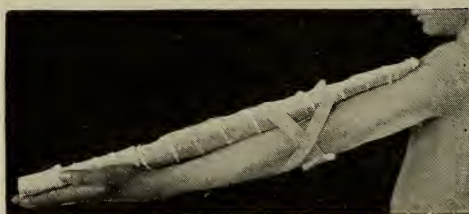
and forearm. This dressing is applied for three or four weeks and then removed and the arm gradually extended. It is held that by this method of dressing better motion is obtained, and the tendency to gunstock deformity is diminished.

When fractures of the lower extremity of the humerus involve the elbow-joint a certain amount of impairment of joint-motion is apt to occur either from anchylosis or from displacement of the fragments, giving rise to what is known as gunstock deformity, which in many cases it is impossible to completely reduce, so that flexion and extension of the joint are restricted. Bearing these facts in mind, it is well to make passive motion in these cases as early as the second or third week. It is well to explain to the patient or his friends that impairment of joint-motion may result in these fractures in spite of the greatest skill and care in the treatment. In a case of fracture in the region of the condyles of the humerus the dressings should be removed in twenty-four hours, and it should be redressed in the same manner, and if the swelling does not increase and the dressing is comfortable to the patient it should afterward be dressed at less frequent intervals; the union is generally quite firm at the end of four weeks, and the splint may be removed at this time. Fractures of the condyles of the humerus are very common in children, and epiphyseal disjunctions of the lower epiphysis of the humerus are also met with; the dressing of these injuries in this class of patients is similar to that described for fractures of the condyles of the humerus.

Fracture of the Olecranon Process of the Ulna. Fracture of the olecranon may consist in simply a separation of the cortical layer of bone over the summit of the process to which the triceps is principally attached, or the line of fracture may pass through the sigmoid fossa.

Fractures of the olecranon are dressed with the arm slightly flexed at the elbow, or with it completely extended; the former position is possibly a little less irksome to the patient. The separation of the fragment by the action of the triceps muscle is usually not very marked; but, if the displacement is considerable, it may in a measure be overcome by the use of a compress above the fragment, over which figure-of-eight strips of adhesive plaster are fastened to draw it down into position (Fig. 267). The ends of the strip are then attached to a well-padded straight splint which should be long enough to extend from the upper third of the arm to the ends of the fingers, which is secured in position by the turns of a roller carried from the fingers to the upper extremity of the splint, with figure-of-eight turns at the elbow to reinforce the action of the strips of plaster (Fig. 268).

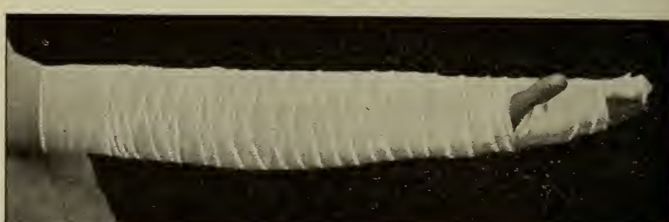
FIG. 267.



Adhesive strap applied to draw fragment downward.

This fracture may also be dressed by first applying a primary roller up to the elbow, and then placing the arm upon a well-padded anterior obtuse-angled splint, or a straight splint with a good-sized pad of lint or oakum

FIG. 268.



Fracture of olecranon dressed in the extended position.

fastened at a point corresponding to the position of the flexure of the elbow. When either of these splints is placed upon the arm a position of moderate flexion is obtained. A compress of lint is next placed above the fragment, if there is a displacement, and one or two narrow strips of adhesive plaster are fastened over this and passed obliquely downward and attached to the splint on either side. The splint is then securely fastened to the arm by the turns of a roller bandage applied from the fingers to the upper end of the splint.

The dressings in a case of fracture of the olecranon should be removed at the end of twenty-four or thirty-six hours, or sooner if there is evidence of swelling of the tissues in the region of the fracture, and they should be reapplied in the same manner. If the dressing is comfortable to the patient, and there is no evidence of swelling, the subsequent dressings should be made at less frequent intervals; the dressings are usually retained in this fracture for five or six weeks. Passive motion should not be made until this time, as flexion of the elbow tends to separate the fragments, unless union has taken place. The union of a fracture of the olecranon is, in most cases fibrous, but in a few instances bony union has been observed.

Fracture of the Coronoid Process of the Ulna. Fracture of the coronoid process is rarely met with, and its dressing is accomplished by placing the arm in a flexed position and applying a well-padded internal right-angled splint, or a posterior right-angled splint, and securing it to the arm by the turns of a roller-bandage. A moulded pasteboard or leather gutter may be substituted for the angular splint. The dressings should be changed at intervals, and after their removal, at the end of three or four weeks, passive motion should be practised.

Fractures of the Head and Neck of the Radius. These fractures are also quite rare, and, when met with, should be dressed, after reducing the fragments by manipulation, by flexing the elbow and keeping it in this position by the application of a well-padded anterior right-angled splint, the splint being firmly secured in position by the turns of a roller bandage applied from the tips of the fingers to the upper end of the splint (Fig. 265). The splint should be changed at intervals, and should not be permanently removed for four weeks, at which time passive motion, consisting in flexion and extension at the elbow and pronation and supination of the forearm, should be made.

An internal angular splint applied to the inner surface of the forearm and arm may also be used in the treatment of these fractures (Fig. 262).

Fractures of Both Bones of the Forearm. These fractures are often met with as the result of direct or indirect violence, and after reducing the displacement, which is always marked when both bones are broken, and is not so marked when one bone only is broken, by making extension from the hand and by manipulation, the forearm is placed in the supine position or in a position between pronation and supination. The supine position is, as a rule, to be preferred in any fracture of the radius, as the upper fragment is supinated by the action of the biceps and supinator brevis muscles, and, therefore, unless the lower fragment be placed in the supine position, union with rotary deformity will almost inevitably ensue.

Two straight wooden splints, well padded, a little wider than the forearm, are employed. The anterior splint

FIG. 269.

Dressing for fracture of both bones of the forearm.

should be long enough to extend from the elbow to the tips of the fingers, and the posterior splint should extend from the elbow to the wrist. A primary roller should never be applied to the forearm in dressing these fractures, as its application diminishes the interosseous space, and its use has been followed by gangrene of the hand and forearm. In applying the anterior splint to the palmar surface of the forearm and hand, care should be taken to see that the upper end of the splint does not press upon the brachial artery and basilic vein at the elbow when the forearm is flexed; the posterior splint is next applied from the elbow to the wrist, and the splints are held in position by the turns of a bandage carried from the fingers to the elbow (Fig. 269).

In dressing this fracture a posterior splint equal in length to the anterior splint may be used in place of the short posterior splint extending from the elbow to the wrist.

In fracture either of the shaft of the radius or of the ulna alone, the deformity is usually not so marked as when both bones are broken at the same time, the unbroken bone acting as a splint; the dressing for these fractures is the same as for fracture of both bones of the forearm.

The dressing should be removed in twenty-four or thirty-six hours, and after inspecting the parts and sponging them with dilute alcohol the splints should be replaced in the same manner and secured. The dressings should be removed and renewed at intervals of two or three days for two weeks at least, and after this time the dressings should be made at less frequent intervals. The time required for union in these fractures is usually five or six weeks, and the splints should be retained for this time.

In children *incomplete* or *green-stick* fractures of the bones of the forearm are very common : their dressing, after reducing the deformity, which consists in bending the bones back into place, often converting the incomplete fracture into a complete one, is accomplished in the same manner as described above. In these patients there is a great tendency to displace the splints or rather to draw the forearm out of the splints, and to prevent this I often employ an anterior angular splint, in place of the straight anterior one, the upper portion of which, being fastened to the arm, prevents the child from dragging the arm out of the dressings.

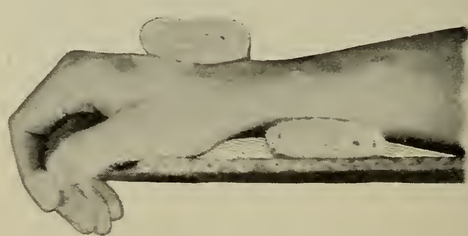
Fracture of the Lower End of the Radius. The most common fracture of the radius is one situated from one-half of an inch to one and one-half inches above the lower articular surface of the bone (Colles's fracture), the line of fracture being more or less transverse, although it may in some cases be slightly oblique; the characteristic deformity in this fracture is represented in Fig. 270.

Fig. 270.

Fracture of the radius near its lower extremity.

The most important point in the treatment of this fracture is to effect complete reduction before the application of any splint; this is done by making extension from the hand, and, at the same time, by over-extending and then flexing the wrist and by manipulation, the deformity can usually be completely reduced. The arm should then be brought

Fig. 271.

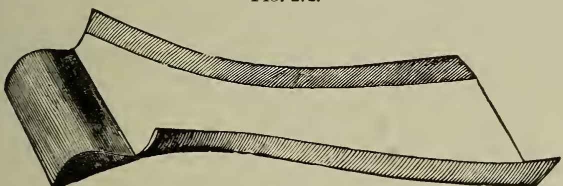


Position oı compress in Colles's fracture.

into the position of supination, and a firm compress of lint is next placed over the lower end of the upper fragment on the palmar surface of the forearm; a second compress is then placed over the upper end of the lower fragment (Fig. 271), and a well-padded Bond's splint (Fig. 272) is applied to the palmar surface of the arm and held in place by the turns of a roller bandage (Fig. 273).

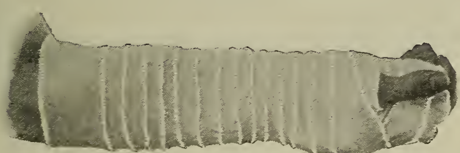
Many surgeons treat this fracture with the hand in a position between pronation and supination, the thumb pointing upward. A substitute for Bond's splint may be

Fig. 272.



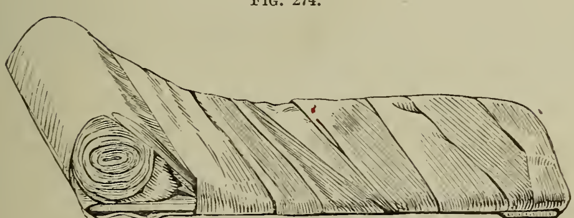
Bond's splint.

Fig. 273.



Dressing for fracture of the lower end of the radius.

Fig. 274.

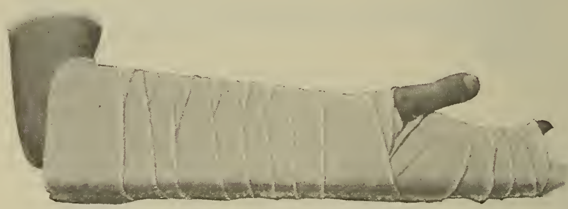


Substitute for Bond's splint.

prepared by fastening a roller bandage obliquely upon a straight wooden splint as suggested by Dr. Hays (Fig. 274).

Another method of treating Colles's fracture after the reduction of deformity consists in placing upon the dorsal surface of the forearm a padded straight splint, extending from the elbow to the tips of the fingers, and a short, straight splint upon the palmar surface of the arm, extending from the elbow to the wrist. These splints are held in position by a bandage, and the forearm carried in a sling with the hand inclined to the ulnar side (Fig. 275). The hand should be bandaged to the posterior splint for about seven days and then set free. The posterior splint should be left

Fig. 275.



Dressing for Colles's fracture with long posterior and short anterior splint.

long for another week; at the end of this time it should be shortened so as to extend only to the wrist-joint, and the patient should be encouraged to use the fingers and make motions of the wrist. At the end of three weeks both splints should be removed, and the patient should carry the forearm in a sling for a few weeks longer and be encouraged to use the hand.

The most important point in the treatment of this fracture is the complete reduction of the deformity at the first dressing, and if this has been satisfactorily done almost any splint may be used with a good result, and, indeed, some surgeons use no splint, applying only a compress over the seat of fracture, held in place by a strip of plaster, the arm being carried in a sling.

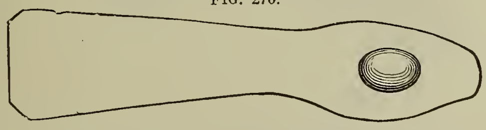
The after-treatment of these fractures consists in removing the splint and compresses after twenty-four or thirty-six hours and in sponging the surface of the skin with dilute alcohol, and the compresses and splint should then be reapplied in the same manner; the fracture should be dressed every second or third day for the first two weeks, and after this time it should be dressed at less frequent intervals. Union is usually quite firm at the end of four weeks, and the splint should be dispensed with at this time. A certain amount of stiffness of the wrist and fingers is apt to follow this fracture, which is usually soon overcome by passive motion and physiological use of the parts.

In *children* epiphyseal separations or fractures of the lower epiphysis of the radius are often met with, and their treatment is similar to that described above; a Bond splint with compresses or two straight splints with compresses being the most satisfactory dressing to employ in this injury, the dressings being retained for three weeks.

Fractures of the Carpal Bones. These fractures are usually compound or open fractures, and are so frequently associated with extensive laceration of the arm and hand that operative measures have to be resorted to; but if such is not the case they are dressed, when compound, with an antiseptic dressing, and the hand and forearm are supported upon a well-padded palmar splint held in place by a roller bandage; more or less impairment in the motion of the wrist is apt to follow these fractures. The dressings should be retained for three or four weeks, and after their removal passive motion should be employed to overcome as far as possible the joint-stiffness resulting.

Fractures of the Metacarpal Bones. These fractures are often met with as the result of direct or indirect force

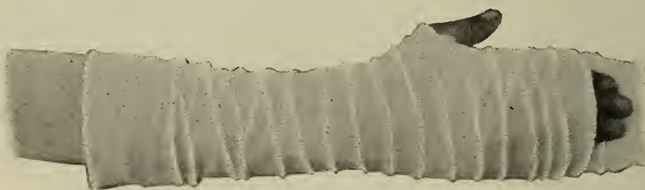
FIG. 276.



Agnew's splint for fracture of the metacarpal bones.

applied to the metacarpal bones. The treatment of fractures of the metacarpal bones consists in first reducing the deformity, which is usually an angular one, the projection of the angle being toward the back of the hand; this is reduced by pressure with the fingers, and the hand and forearm should then be placed upon a palmar splint (Fig. 276) with a pad of oakum or cotton under the palm; a compress of lint is next placed over the seat of fracture, and the hand and forearm are bound to the splint by the

Fig. 277.

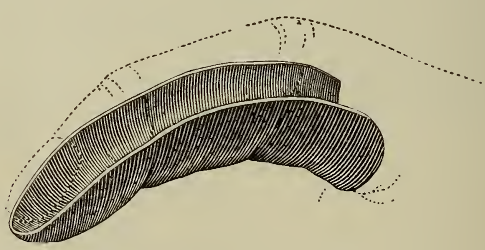


Dressing for fracture of the metacarpal bones.

turns of a roller bandage (Fig. 277). At the end of three weeks union at the seat of fracture is usually quite firm, and the splint should be dispensed with at this time.

Fractures of the Phalanges. The treatment of fractures of the phalanges consists in reducing the displacement by extension and manipulation, and in placing the

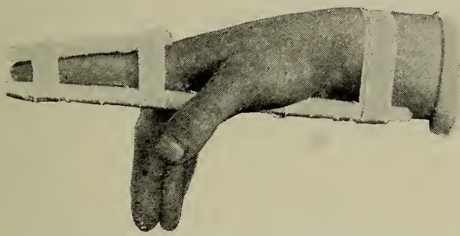
Fig. 278.



Gutta-percha splint for fracture of phalanx. (Hamilton.)

finger in a moulded gutta-percha or pasteboard splint (Fig. 278), and securing the splint in position by the turns of a roller bandage. When the proximal phalanx is fractured a narrow, padded, wooden splint extending from the end of the finger to the wrist should be applied upon the palmar surface of the finger and hand, and a short dorsal splint should also be used; if there is a tendency to lateral displacement short lateral splints should also be employed, and the splints should be held in place by strips of plaster or by a roller bandage (Fig. 279).

Fig. 279.



Dressing for racture of phalanx with anterior and posterior splints.

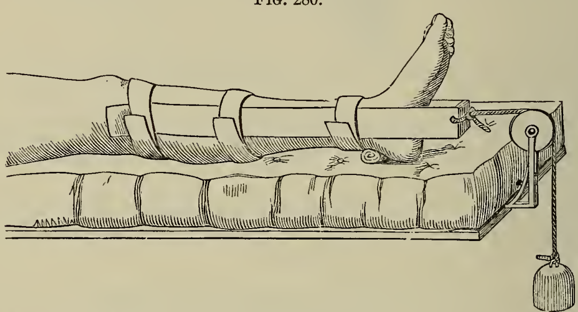
Union in fractures of the phalanges is usually quite firm at the end of three weeks, and the splints can be dispensed with at that time.

Fractures of the Femur. These may involve the *neck, great trochanter*, and *upper end of the shaft*, the *shaft*, or the *lower extremity* of the bone.

Fractures of the Upper Extremity of the Femur. In dressing these fractures the patient should be placed in bed upon a firm mattress, and an extension apparatus made from adhesive plaster should be applied to the leg, extending as far as the knee-joint. The extension apparatus is constructed by taking a piece of adhesive plaster two and a half inches in width and long enough to extend from the outer side of the knee to four inches below the sole of the foot, and from this point back to the inner side of the knee; in the centre of this strip is placed a block of wood, two and a half inches wide and four inches in length, with a perforation in its centre; the block and the inner surface of the strip on each side are next faced with a similar strip of adhesive plaster to a point about an inch above each malleolus; a few straps are next wound around the wooden block to fix the previously applied straps; the strip of plaster is next warmed and applied to the sides of the leg and held in position by three strips of adhesive plaster carried around the leg at intervals (Figs. 280), and the plaster is made additionally secure by the application of a roller bandage applied to the foot and leg and carried up to the knee.

Through the perforation in the block or stirrup is fastened a cord which passes over a pulley attached to the bed, and to this cord is attached the extending weight. The extension apparatus being applied, lateral support is given to the leg and thigh by sand-bags applied on either side; the outer sand-bag should extend from the foot to

Fig. 280.

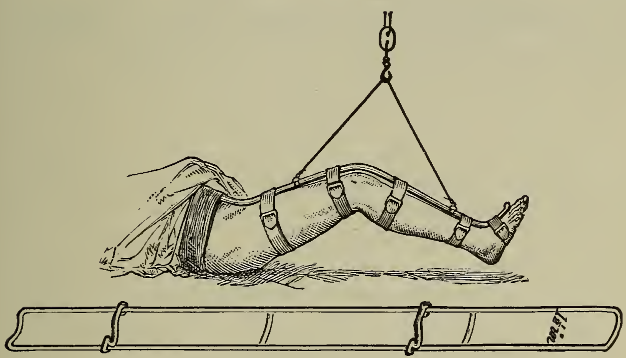


Adhesive plaster extension apparatus applied to limb. (Ashhurst.)

the axilla, and the inner one from the foot to the groin. A weight of five or ten pounds is attached to the extending cord, and the lower feet of the bed should be raised on blocks a few inches high to prevent the patient from slipping down in bed; a pad of oakum or cotton should also be placed under the tendo-Achillis to relieve the heel from pressure. This dressing is kept in place for from four to six weeks, and if union has occurred the patient is kept in bed for a few weeks longer and is then allowed to be about, using crutches. In the majority of cases of fracture of the neck of the femur fibrous union only takes place, and after employing the dressing before described for six weeks the patient is allowed to get up and go about on crutches. It often happens that the subjects in whom these fractures occur are old and feeble, and if it is found that restraint in bed with the dressings here described is not well borne, under such circumstances they should be discarded and the patient should be allowed to sit up in bed with the limb resting on a pillow, or to get into a chair, the treatment of the local condition having to be disregarded, attention being given to the patient's constitutional condition.

In fractures of the neck of the femur and of the upper part of the shaft of the bone the anterior wire splint of

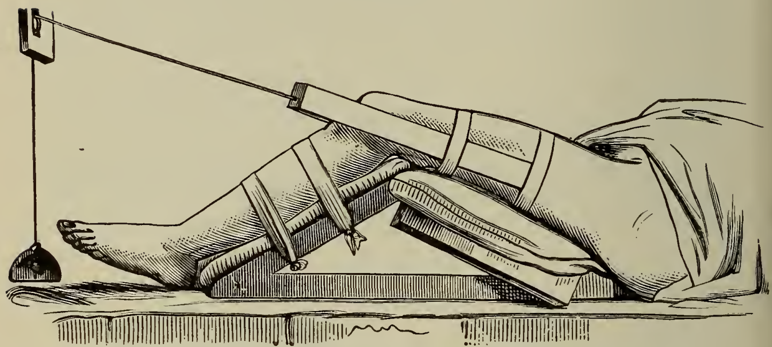
FIG. 281.



Smith's anterior splint for fracture of the femur.

Prof. N. R. Smith is sometimes used with advantage; the limb being swung from the splint the patient is able to move in bed without causing him pain or disturbing the fragments (Fig. 281). In fractures in the upper portion of the femur where there is marked tilting forward of the upper fragment Prof. Agnew employed extension made from the thigh and placed the limb upon a double inclined plane, maintaining this position during the treatment of the case (Fig. 282). With the same object in view, in place of the double inclined plane a double inclined fracture-box may be employed (Fig. 283), extension being made from the thigh by means of adhesive plaster strips applied above the knee, to which a weight is attached.

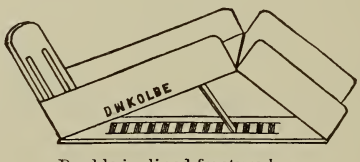
FIG. 282.



Dressing for fracture of the femur with extension upon an inclined plane. (AGNEW.)

Fracture of the Shaft of the Femur. In the treatment of fractures of the shaft of the femur the dressings are applied to diminish as far as possible the shortening and to prevent angular or rotary displacement of the fragments. In dressing these fractures the patient should be placed

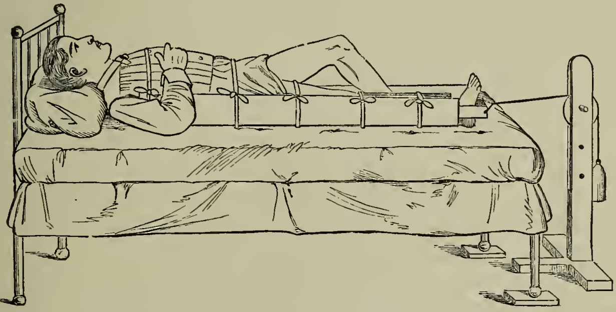
FIG. 283.



Double inclined fracture-box.

upon a fracture-bed or an ordinary bed with a firm hair mattress; an extension apparatus of adhesive plaster is applied and extension is made by a weight attached to this as previously described. Lateral support is given to the limb by the application of two wooden splints—the outer or long one extending from the axilla to the foot, the inner or short one extending from the groin to the foot. The splints at their upper extremity should be about six inches in width and at their lower extremity about three and a half inches. The splints are wrapped in a splint cloth which extends from the foot to the groin, and after this has been placed under the limb the splints are fixed in their proper positions, the short one to the inner side, the long one to the outer side of the limb. Between the limb and the splints are interposed bran-bags : the outer bag should be long enough to extend from the axilla to the foot, the inner one from the groin to the foot. The splints and bran-bags are held in place by five or six strips of bandage passing under the limb and body and around the splints and bran-bags at intervals. The heel is saved from pressure by placing a wad of oakum or cotton under the tendo-Achillis, and after the splints have been brought into place the strips of bandage are firmly tied to secure them, and a weight of ten or twelve pounds is attached to the extending cord. The foot of the bed is raised to prevent the patient from slipping downward and to allow the

FIG. 284.



Dressing for fracture of the shaft of the femur with lateral splints and bran-bags. (ASHHURST.)

weight of the body to act as a counter-extending force. After the application of the dressings the thigh should be slightly abducted. During the after treatment of these fractures the surgeon should see that the splints and bran-bags are kept firmly in place and that the foot does not roll outward; this is accomplished by untying the strips and readjusting the bags and then bringing up the splints and securing them in position by fastening the strips (Fig. 284). The extension apparatus usually does not require renewal during the course of treatment. The extension apparatus and splints are kept in place for four or six weeks, and at this time union at the seat of fracture is usually quite firm, so that they may be removed, and the fracture is then supported by moulded pasteboard splints or by the application of a plaster-of-Paris splint for several weeks longer, and at the end of eight weeks it is safe to allow the patient to be up and around on crutches.

Many surgeons, in fracture of the shaft of the femur, prefer to use a *long external sand-bag* and a shorter *internal one* in place of the corresponding long and short splints and bran-bags, and if care is observed to see that the sand-bags are kept accurately in contact with the limb and body, excellent results may be obtained by this form of dressing. After considerable experience with both methods of furnishing lateral support in the dressing of fractures of the shaft of the femur, I am well satisfied that angular deformity is less likely to result where the splints and bran-bags are employed.

The plaster-of-Paris dressing, including the foot, leg, thigh, and pelvis, is employed by some surgeons in the early treatment of fracture of the shaft of the femur, the limb being kept well extended until the plaster has thoroughly set. In applying this dressing the patient should be placed upon the pelvic supporter (see p. 94).

Fracture of the Lower End of the Femur. The fractures met with in this portion of the femur are supra-condyloid fractures, those in which one condyle is separated from the other, or comminuted fractures in which both condyles are separated; epiphyseal disjunctions of the lower end of the femur, met with in young subjects, may also be classed with fractures at this portion of the bone.

The dressing of supra-condyloid fractures, if there is shortening, should be similar to that employed in fractures of the shaft of the femur, consisting in the application of an extension apparatus and bran-bags and splints or sand-bags to give lateral support; if, however, there is no marked shortening the dressing employed should be the same as that applied in fractures involving one or both condyles or epiphyseal separations.

The dressing employed in fracture of one or both condyles or in epiphyseal disjunction of the lower end of the femur consists in placing the limb in a long fracture-box extending from the foot to the upper third of the thigh, the box being well padded with a soft pillow, or a well-padded posterior splint, or a moulded pasteboard or felt gutter may be employed; if either of these dressings is employed, the splint or gutter should be long enough to extend from the lower part of the leg to the upper part of the thigh.

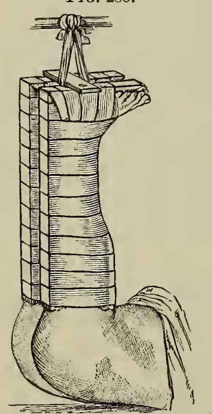
At the end of two weeks it is well to place the limb in a plaster-of-Paris dressing extending from the foot to the upper part of the thigh. This dressing should be retained for four weeks, and at the end of this time the dressing should be removed, and if the union is sufficiently firm to allow the patient to go about on crutches, a fresh plaster-of-Paris splint should be applied extending from the middle of the leg to the middle of the thigh, or lateral splints of pasteboard may be substituted for the plaster dressing.

A certain amount of permanent impairment of the joint motion is apt to follow fractures involving one condyle or both condyles of the femur.

Fracture of the Shaft of the Femur in Children. The treatment of these fractures in infants by extension by a weight and pulley and lateral splints is often unsatisfactory on account of the difficulty in keeping the patient quiet upon his back, and from the soiling of the dressings by the feces and the urine. In children two years of age and over I have never found much trouble in employing extension and lateral support by splints and bran-bags or sand-bags, and in these cases I make additional fixation at the seat of fracture, and guard against displacement of the fragments by the child sitting up in bed when not watched, by carefully moulding external and internal pasteboard or felt splints to the thigh, and holding them in place by the turns of a bandage. I have employed this form of dressing even in children under two years of age with the most satisfactory results.

In cases of fracture of the femur in children from a few months to a year or eighteen months of age, in whom it is difficult to obtain quietude, or who have to be moved to give them nourishment if they are taking the breast, the dressing which I have found most satisfactory consists in first applying a roller bandage from the foot to the groin, and then moulding to the outer half of the foot, leg, thigh, and also to half of the pelvis, a pasteboard or felt splint which is well padded with cotton, and held in position by the turns of a bandage carried from the foot to the pelvis and finished with circular turns about the pelvis. The splint should be so moulded as to include a little more than one-half of the circumference of the thigh and leg. If this splint becomes soiled it is easily replaced by a fresh one, and its removal and renewal are much easier than that of the plaster-of-Paris splint which is recommended by some surgeons in these cases.

FIG. 285.



Fracture of the femur treated by vertical extension. (BRYANT.)

In young children fractures of the femur are often *incomplete* or *green-stick fractures;* and even when complete, the shortening is usually not marked, as the line of fracture is apt to be transverse, the periosteum often not being completely ruptured, which tends to hold the fragments in position.

In green-stick fractures the deformity should be reduced by manipulation, even if it is necessary to convert the incomplete fracture into a complete one to accomplish this object.

Mr. Bryant recommends that fractures of the femur in young children be treated in the *vertical* position; the injured limb, together with the sound one, is flexed at a right angle to the pelvis and fixed with a light splint, and attached to a cradle or bar above the bed (Fig. 285).

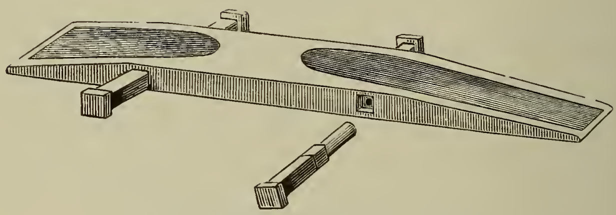
If the plaster-of-Paris dressing is used, the limb should be first enveloped from the foot to the pelvis with a flannel bandage, and extension should be made while the plaster-of-Paris bandage is being applied, and should be kept up until the bandage has become fixed. The plaster bandage should extend from the toes to the pelvis, and it is well to fix the hip-joint by carrying several turns of the bandage about the pelvis. To prevent the splint from absorbing the discharges and becoming offensive, the upper portion of it may be coated with shellac.

The time required for union in fractures of the femur in children is about four weeks, and the dressings may be removed at this time; but the child should not be allowed to use the limb for several weeks after this period.

Ambulatory Treatment of Fractures of the Femur. In this method of treatment in fractures of the femur the injured limb is strongly extended, and a flannel roller is applied to the leg, thigh, and pelvis. A plaster-of-Paris bandage is then applied from the toes to the pelvis, and is made to include the pelvis by spica and circular turns. It should be well padded in the perineum, and the inner portion of the bandage should fit well in the region of the tuberosity of the ischium. The plaster dressing should be so applied that upon the patient standing upon the limb the weight is supported by the plaster cast resting upon the tuberosity of the ischium and the expanded portion of the ilium. A Taylor hip-splint, reinforced by plaster bandages and the use of crutches, with a high shoe on the sound foot, may be used in the ambulatory treatment of fractures of the femur.

Fractures of the Patella. The dressing of fractures of the patella consists, first, in the application of a roller bandage from the toes to the upper part of the leg; a well-padded posterior wooden splint long enough to extend from the middle of the leg to the middle of the thigh, or an Agnew splint, which is provided with pegs for the attachment of strips of adhesive plaster (Fig. 286), is next placed under the limb. A small compress of lint is next placed above the upper fragment, and a similar compress is placed below

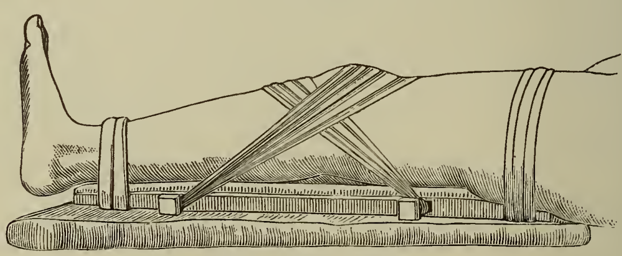
Fig. 286.



Agnew's splint for fracture of the patella.

the lower fragment; a strip of adhesive plaster one and a half inches in width and twenty-four inches in length has its middle portion applied over the compress, and its ends are then brought obliquely downward and fastened to the splint, or to the pegs if Agnew's splint be used; this may be reinforced by a second or third strip. The object of

Fig. 287.



Agnew's splint applied.

these strips is to bring the upper fragment down in contact with the lower fragment. A strip of plaster with the ends passing in the opposite direction is next placed over the lower compress, and the ends are fastened to the splint or pegs; this strip serves only to steady the lower fragment, as it cannot be drawn upward to meet the upper fragment by reason of the inextensibility of its ligamentous attachment (Fig. 287). If the Agnew splint is employed the strips of plaster may be tightened by turning the pegs to which they are fastened without removing the splint.

The splint is next firmly fixed in contact with the limb by the turns of a roller bandage extending from the lower to the upper end of the splint. The limb should next be placed upon an inclined plane or in a long fracture-box, with its foot elevated to relax the quadriceps femoris muscle. This dressing should be removed and reapplied in a few days, as the dressings become loose as the swelling about the seat of injury subsides, and after this disappears the dressings require renewal at less frequent intervals; and usually at the end of three weeks the splint may be removed and a plaster-of-Paris bandage may be applied, extending from the middle of the leg to the middle of the thigh. At the end of six weeks the patient may be allowed to walk upon the limb, the knee-joint being fixed with a plaster-of-Paris or pasteboard splint.

It is well, after removal of the splints, for the patient to wear for some months a laced muslin knee-supporter, which gives some support to the knee-joint.

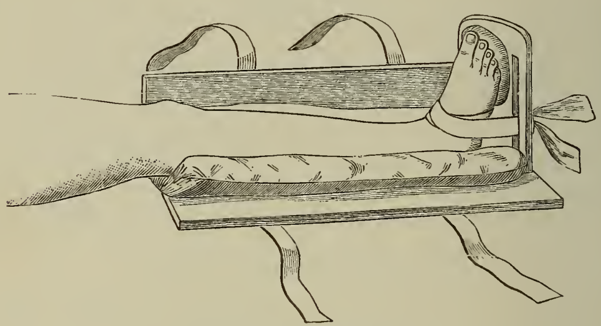
The union in fractures of the patella is usually fibrous, although in rare cases bony union has occurred.

A great variety of splints have been devised and used in the treatment of fractures of the patella, the main object of which is to fix the knee-joint and bring the fragments as nearly as possible in apposition. Malgaigne's hooks, or Levis's modification of the same, are employed by some surgeons to secure close apposition of the fragments. The method of treatment in fractures of the patella, which consists in exposing the fragments by an incision and drilling and suturing them with catgut or silver-wire sutures, is also employed at the present time, the strictest antiseptic precautions being taken to prevent infection of the wound. In cases of rupture of the fibrous union after fracture of the patella, which is not an uncommon accident, the treatment of the case should be the same as that for a recent fracture of the patella.

Fractures of the Bones of the Leg. In fractures of both bones of the leg the displacement is usually very marked. When one bone only is broken, the sound bone, acting as a splint, prevents much deformity, except in case of fracture at the lower end of the fibula, when the foot inclines to the injured side.

The dressing of fractures of both bones of the leg, or of fracture of the tibia or fibula alone, except in cases where the lower portion of the fibula is the seat of injury, is best accomplished by the use of a fracture-box. The

FIG. 288.

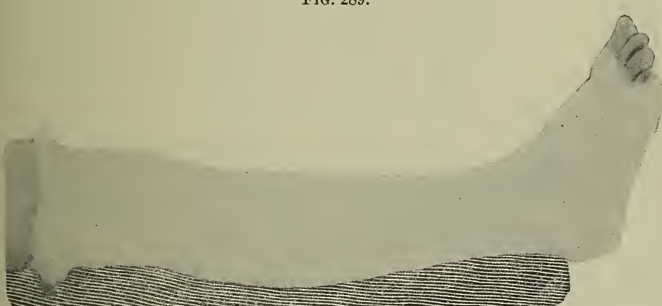


Application of the fracture-box.

displacement being overcome as far as possible by extension and manipulation, the leg is placed in a fracture-box, which is prepared for the reception of the limb by having the sides let down and having a soft pillow laid in it; the foot is next secured to the footboard by a loop of bandage passed around the foot, the ends being tied after passing through the slots in the footboard; a pad of oakum or cotton is placed under the tendo-Achillis, to relieve the heel from pressure, and a similar pad is placed between the sole of the foot and the footboard (Fig. 288). The sides of the box are then brought up and secured by two or three strips of bandage tied around the box. In using a fracture-box in the treatment of fractures of the bones of the leg the surgeon should see that the foot is kept well down to the footboard and is at a right angle with the leg, that there is no eversion of the knee, and that the pillow is full enough to make equable pressure upon the leg when the sides of the box are secured, and that the heel is not subjected to undue pressure—the use of a pad of oakum or cotton under the tendo-Achillis being employed to prevent this complication. Where there is a tendency to tilting upward of the lower end of the upper fragment the lower fragment can be brought in line with this by raising the foot by a mass of oakum or cotton placed under the tendo-Achillis and heel, and so overcoming the deformity. In some cases division of the tendo-Achillis may be required before this deformity can be corrected.

The subsequent dressings of the case are conducted by letting down the sides of the box and correcting any dis-

FIG. 289.



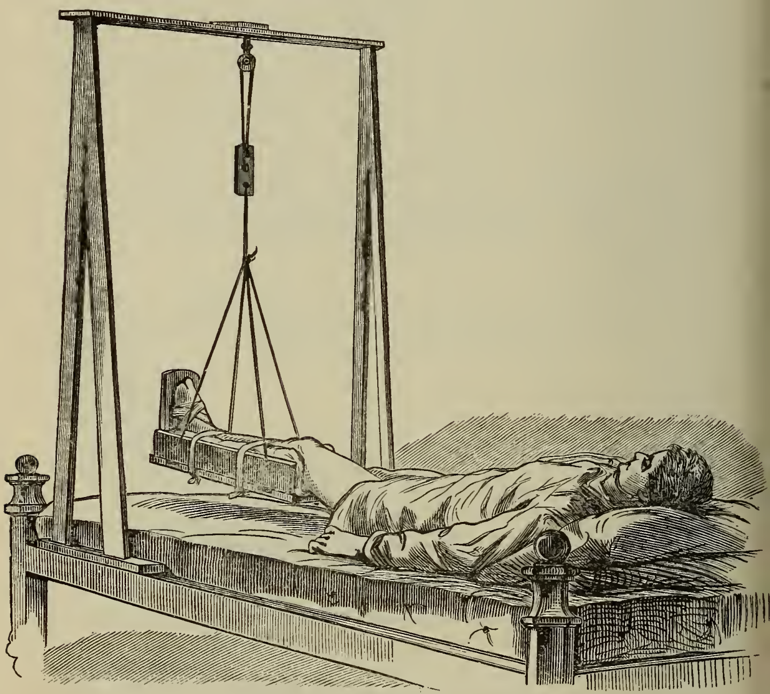
Plaster bandage applied to fracture of the leg.

placement, if present, by adjusting the limb and pads in their proper position, and again bringing up the sides of the box and securing them. At the end of two weeks the fracture-box may be removed and a plaster-of-Paris dressing may be applied to the limb, which will allow the patient more freedom of movement in bed, or permit of his sitting up without disturbing the fragments (Fig. 289).

Union in fracture of the bones of the leg is usually quite firm in six weeks, but the patient should not be allowed to put his weight upon the limb in walking for at least eight weeks.

If the patient is restless, and finds his position with the fracture-box resting upon the bed irksome, the fracture-box may be swung from a frame fastened over the bed (Fig. 290).

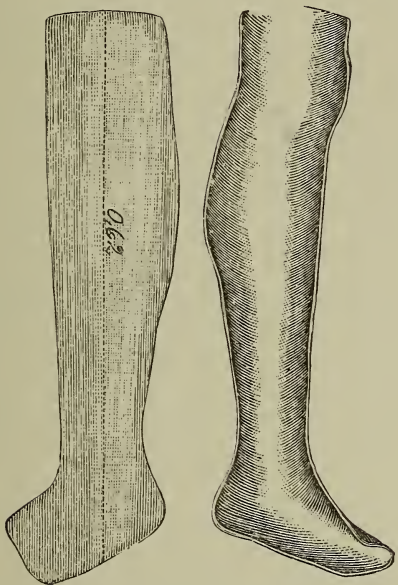
Fig. 290.



Fracture-box suspended. (Agnew.)

The application of a plaster-of-Paris dressing as a primary dressing—the ordinary plaster-of-Paris bandage or the Bavarian dressing being applied—in fractures of the bones of the leg is adopted by some surgeons, and, if employed, the case should be under constant supervision for a few days, so that the dressing can be removed if a dangerous amount of swelling takes place. Moulded splints of felt or pasteboard are also sometimes applied in the treatment of these cases (Fig. 291).

FIG. 291.



Moulded binder's board splints for fracture of the leg.

Ambulatory Treatment of Fractures of the Bones of the Leg. The application of a dressing for the ambulatory treatment in fractures of the bones of the leg is as follows: The fracture should be reduced and the skin of the leg carefully washed with soap and water; a flannel bandage is then applied from the toes to a point just above the knee. This bandage holds to the sole of the foot a number of layers of cotton wadding, which, when moderately compressed, makes a pad three-quarters of an inch in thickness. A plaster-of-Paris bandage is applied to the foot and leg, and extends above the knee, and care should be taken to apply additional turns about the sole of the foot and ankle, to give it greater strength at these points. The turns of the bandage should also be firmly applied about the expanded head of the tibia.

In the ambulatory method of treatment, the patient, as soon as the bandage has become firm, is allowed to walk about, first with crutches or a cane, and finally bearing his weight upon the injured limb.

In patients suffering with *delirium tremens*, or in *maniacal* patients, the use of a fracture-box in the treatment of fractures of the bones of the leg is often not satisfactory, on account of the difficulty in restraining the movements of the patient and the consequent displacement of the fragments. In such cases it is well to apply a few strips of binder's board, well padded with cotton, to the limb, extending above and below the seat of the fracture, holding them in place by a few turns of a roller, and then to wrap the limb and foot in a soft pillow, and hold this in place by the turns of a roller bandage applied with moderate firmness. This dressing allows the patient to move the limb without serious disturbance of the fragments, and, after the patient recovers from his attack, the leg may be placed in the fracture-box or in a plaster-of-Paris dressing.

In fractures of the bones of the leg *in young children* the same difficulty is often experienced in keeping them quiet, and for this reason a fracture-box cannot be used with satisfaction. In dressing these cases, two lateral splints of pasteboard, moulded to the foot and leg and well padded with cotton, may often be employed with the best results. The splints should not be wide enough to meet on the anterior or posterior surface of the leg or foot. The splints, after being carefully adjusted, are held in place by the turns of a roller bandage; and, after these splints have been applied for two weeks, and all swelling has subsided at the seat of fracture, a plaster-of-Paris bandage may be substituted for them, which should be worn for three weeks; at the expiration of this time union is usually firm enough to dispense with all dressings.

Fractures of the Fibula. In fractures of the fibula, with the exception of that fracture occurring at the lower end of the bone, the deformity is not marked, and they are usually dressed with a fracture-box applied as in the dressing of fractures of both bones of the leg, and at the end of two weeks a plaster-of-Paris dressing should be applied, and the patient may be allowed to get out of bed and move about on crutches. The union in a fracture of the fibula is usually quite firm at the end of five weeks, and all dressings may be dispensed with at that time.

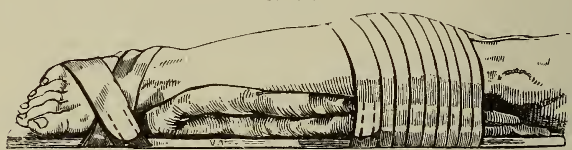
Fracture of the Lower End of the Fibula (Pott's Fracture). This fracture usually occurs in the lower fifth of the bone, and is often associated with a laceration of the internal lateral ligament of the ankle-joint or a sprain-fracture of the internal malleolus, and is usually accompanied by marked eversion of the foot.

In this fracture, after reducing the displacement by extension and manipulation, the limb should be placed in a fracture-box provided with a soft pillow, the foot should be secured to the footboard, and a pad of oakum or cotton should be placed under the tendo-Achillis; before bringing up the sides of the box and securing them, two firm compresses of lint or oakum should be placed in contact with the leg and foot, one just above the inner malleolus, the other just below the outer malleolus. The sides of the box are next brought up and secured, and by the pressure of these compresses the foot is brought into an inverted position and the deformity is corrected.

The after-dressing of this fracture consists in letting down the sides of the box, and in inspecting the parts to see that the foot is kept in the proper position, and care should be taken to see that undue pressure is not made upon the skin by the compresses, which might result in ulceration; this may be avoided by sponging the skin with alcohol and changing the positions of the compresses slightly at each dressing. At the expiration of ten days the fracture-box and compresses may be removed and the limb may be put up in a plaster-of-Paris dressing, including the foot and leg, up to the knee. The patient may then be allowed to go about on crutches, and at the end of five weeks all dressings may be dispensed with.

This fracture is also dressed by means of *Dupuytren's splint,* which consists of a straight wooden splint long enough to extend from the condyles of the femur to the end of the toes; this splint is provided with padding, the thickest part of which, several inches in thickness, should rest upon the skin just above the inner malleolus when the splint is applied to the inner side of the leg. The splint is secured in position by the turns of a roller applied

Fig. 292.



Dupuytren's splint applied.

over the foot and at the upper part of the leg (Fig. 292). After using this dressing for a few days, if the displacement is satisfactorily corrected, the splint may be removed and the leg may be placed in a fracture-box or in a plaster-of-Paris dressing.

Fractures of the Tarsal Bones. The *calcaneum* and *astragalus* are the tarsal bones most frequently fractured. The dressing of fractures of the *calcaneum,* after reducing the displacement, which is not usually marked unless the posterior portion of the bone is involved, by manipulation, consists in placing the leg and foot in a fracture-box, and care should be taken to see that the foot is kept at a right angle to the leg. When the fracture involves the posterior portion of the bone, and there is displacement by the action of the muscles inserted into the fragment, the leg should be flexed upon the thigh and the foot should be extended; this position may be maintained by applying a well-padded curved splint to the anterior portion of the leg and foot and securing it in position by a bandage.

Fractures of the *astragalus,* after reducing any deformity which is present by extension and manipulation, are dressed by placing the foot and leg in a fracture-box, care being taken to see that the foot is kept at a right angle to the leg. This precaution is important, as anchylosis not infrequently occurs after this fracture, and if the foot is in the proper position it is much more useful to the patient.

As soon as the swelling, which is usually very marked after fracture of the calcaneum or astragalus, subsides, the foot and leg should be put up in a plaster-of-Paris bandage. The amount of tension and the inability to reduce the displacement in cases of fracture of the astragalus may be indications for excision of the fractured bone. The time required for union in fractures of the tarsal bones is from five to six weeks.

Fractures of the Metatarsal Bones. These fractures are dressed by placing the foot upon a well-padded plantar splint, and using compresses to hold the fragments in place if there is much displacement, the splint and compresses being held in position by a bandage; or they may be treated by placing the foot and leg in a fracture-box, the footboard of the box acting as a plantar splint; the plaster-of-Paris dressing may also be used in these cases. The time required for union in fracture of the metatarsal bones is from three to four weeks.

Fractures of the Phalanges of the Toes. These fractures are often compound and attended with so much laceration of the soft parts that immediate amputation is required; when, however, the fractures are simple, or in compound fractures where amputation is not required, the dressing consists in applying a plantar splint of wood or binder's board, extending beyond the toes and securing it in position by the turns of a roller bandage. When a single toe only is broken a moulded splint of gutta-percha or binder's board may be applied, and a portion of the splint should extend some distance upon the sole of the foot, to fix the proximal joint, and also to give the toe a firm point of fixation; the moulded splint should be held in position by a narrow roller bandage or by strips of adhesive plaster. The time required for union in fractures of the phalanges of the toes is about three weeks.

Dressing of Compound or Open Fractures.

In the dressing of compound or open fractures the same dressings and splints which are generally used in the treatment of simple or closed fractures may be employed; the wound in the soft parts requires a special dressing, and this should be so arranged as to secure free drainage and promote its prompt healing. In some cases of compound fracture the treatment of the injuries of the soft parts demands attention first, and in such cases the injury to the bones is for a time disregarded, care being taken to see that the fragments are kept quiet, so as to prevent further damage to the soft parts until the wound is in such a condition that the proper manipulation to reduce the displacement and fix the fragments by splints and suitable dressings can be undertaken without interfering with the repair of the wound.

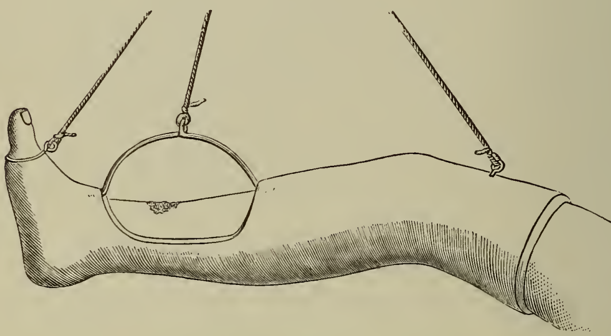
In the dressing of compound or open fractures the skin surrounding the wound should be first carefully cleansed, and the wound should next be thoroughly irrigated with a 1 : 2000 bichloride solution, and any foreign bodies or loose fragments of bone should be removed, and if there is hemorrhage it should be controlled by securing the bleeding vessels with ligatures. The reduction of the displacement should next be accomplished by making extension and by manipulation; if the fragments project from the wound before this can be satisfactorily accomplished, it may be necessary to enlarge the wound and to resect one or both ends of the fractured bones, and in some cases it may be necessary to drill the ends of the fragments and introduce a strong wire or catgut suture, or a metallic nail, screw, or plate, to hold them in their proper positions. After reduction of the displacement the wound should again be thoroughly irrigated with the antiseptic solution, and after making provision for drainage by the introduction of a drainage-tube or tubes, counter-openings being made to secure free drainage if necessary, sterilized or antiseptic gauze dressings should be applied.

The wound, if a small one, need not be closed with sutures; but if extensive, a few catgut, silk, or silkworm-gut sutures may be applied to bring the edges of the wound into apposition, care being taken to avoid making undue tension; if the soft parts have been much lacerated or contused, it is better to introduce no sutures. If the limb is much swollen and the wound is a small one, free division of the deep fascia to relieve tension and secure drainage is often followed by good results. A final irrigation of the wound through the drainage-tube is next made, and the wound is covered by a bichloride gauze dressing and covered by a number of layers of bichloride cotton, the whole dressing being held in position by a gauze bandage applied with moderate firmness.

The reduction of the fragments and the dressing of the wound having been accomplished as has been described, the splints appropriate for a similar fracture, if it were a simple or closed one, are next applied. If the surgeon has been able to render the wound aseptic, and has applied an antiseptic dressing, the compound fracture is often soon converted into a simple one by the prompt healing of the wound, and the patient may exhibit no more constitutional disturbance than he would have with a similar simple or closed fracture. The redressing of a compound fracture dressed in this way need not be made for a week or ten days, unless there is a rise in the patient's temperature or the dressings become soaked with discharges from the wound, or they become uncomfortable to the patient by reason of swelling of the soft parts in the region of the wound. When the redressing of the fracture becomes necessary the dressings are removed, and the drainage-tubes may be removed if no longer needed; the wound being redressed with an antiseptic dressing, the splints are reapplied, and, after the wound is healed, the subsequent dressing of the fracture should be the same as that of a simple fracture. The time required for union in a compound fracture is usually much longer than in a corresponding simple fracture.

Plaster-of-Paris Dressing. This may be used as a primary dressing in compound fractures; the displacement being reduced and the wound being dressed with an antiseptic gauze dressing, a plaster-of-Paris bandage is applied to the parts so as to firmly fix the fragments; the joints on either side of the fracture should be fixed by the bandage, and the parts should be held in position until the plaster has set firmly. After the plaster has become firm a fenestrum

Fig. 293.



Fenestrated plaster dressing for compound fracture of the leg. (Stimson.)

should be made over the position of the wound, so that it can be inspected or dressed through this when necessary. The ends of a piece of stout wire, bent into a semicircle, may be incorporated in the turns of the plaster bandage above and below the position of the fenestrum, to give it additional strength after the removal of a portion of the bandage to make the fenestrum (Fig. 293).

If the plaster-of-Paris dressing is applied as a primary dressing in compound fractures the case should be carefully watched for a few days, and if much swelling occurs at the seat of fracture its removal and renewal are indicated;

profuse discharge of serum may also soak the dressings and bandage so that its renewal is necessitated. Some surgeons, therefore, prefer to defer the application of the plaster-of-Paris dressing in compound fractures for a few weeks until the swelling has diminished and the wound is nearly or quite healed; the wound being covered with an antiseptic dressing, the plaster bandage is applied and a fenestrum is made over the position of the wound if required.

Binder's Board or Felt Splints. These may also be employed in the dressing of compound fractures, being moulded to the parts after an antiseptic dressing has been applied to the wound, and held in position by the turns of a roller bandage.

The principal advantage in the use of these splints is the ease with which they can be removed and reapplied if frequent dressings of the fracture are necessary for any reason. They may be used during the entire course of treatment, or, after a few weeks, when the swelling has diminished at the seat of fracture and the wound is well advanced toward repair, they may be discarded and a plaster-of-Paris dressing substituted. In compound fractures of the bones of the leg, after reducing the displacement and applying an antiseptic dressing to the wound, I usually apply moulded binder's board splints to either side of the leg, including the foot, and place the leg in a fracture-box for additional security, and after a few weeks I discard the binder's board splints and apply a plaster-of-Paris dressing.

A method of dressing compound fractures which has been introduced by Mr. Treves consists in rendering the skin in the region of the wound aseptic and removing any foreign bodies from the wound, then rendering it as far as possible aseptic; *iodoform* is then dusted thickly over the wound at intervals, and, mixing with the blood and serum from the wound, is allowed to dry, forming an antiseptic scab, the wound being exposed to the air, and the fragments are retained in position by splints or by a fracture-box.

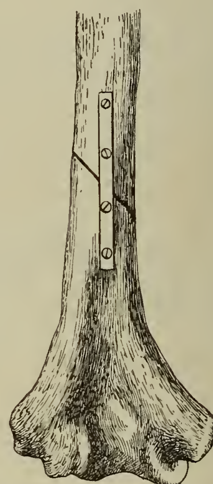
Ununited Fractures. This condition usually arises from local causes, such as imperfect coaptation of the fragments, the interposition of muscular tissue, fascia, tendon, or nerve, or a portion of devitalized bone between the fragments. The ends of the bones may be rounded, or may be united by fibrous tissue, or there may be an attempt at the formation of a false-joint, the end of one fragment being rounded off and the other cupped to re-receive it.

The treatment of ununited fracture consists in exposing the ends of the bones by incision, with full antiseptic pre-

Fig. 294.

Fragments in ununited fracture secured by silver wire.

Fig. 295.



Fragments in ununited fracture secured by silver splint.

cautions, and removing the ends of the bones to secure a healthy surface, and then fixing the fragments securely together by drilling them and introducing one or more heavy silver-wire sutures (Fig. 294). In some cases the shape of the fragments is such that the bones can be sawed so as to form a mortise, and the fragments can then be fixed by the introduction of one or more steel or silver screws. Another method of fixation is by a steel or silver splint secured to the fragments by iron or silver screws (Fig. 295). After the fixation of the fragments has been accomplished, the wound should be closed and an antiseptic dressing applied, and additional fixation is furnished by the application of a plaster-of-Paris dressing.

PART IV.

DISLOCATIONS.

Dislocation. This is the displacement of the articular surfaces of the bones which enter into the formation of a joint.

Dislocations may be *complete, partial, simple, compound,* and *complicated,* and they are also known as *recent* and *old* dislocations.

Complete Dislocation. This is a dislocation in which no portions of the articular surfaces of the bones remain in contact with each other.

Partial Dislocation. This is a dislocation in which portions of the articular surfaces of the bones still remain in contact with each other.

Simple Dislocation. This is a dislocation in which there exists displacement in the relation of the articular surfaces of the bones with little injury to the soft parts adjacent to the joint, and the displaced ends of the bones do not communicate with the air by a wound in the soft parts.

Compound Dislocation. This is a dislocation in which there exists displacement of the articular surfaces of the bones which communicate with the air through a wound in the soft parts.

Complicated Dislocation. This is a dislocation in which, in addition to the displacement of the articular surfaces of the bones, there exists a fracture, or a laceration of important bloodvessels, nerves, or muscles in proximity to the dislocation.

Recent Dislocation. This is a dislocation in which the displacement of the articulating surfaces of the bones has existed for such a period that time has not been afforded for inflammatory changes to take place in the articular surfaces of the bones or in the adjacent tissues which would seriously interfere with their reduction.

Old Dislocation. This is a dislocation in which the displacement of the articulating surfaces of the bones has existed for some time, and in this variety of dislocation the displaced bones often form firm adhesions to the surrounding tissues, and the articulating surfaces often undergo changes.

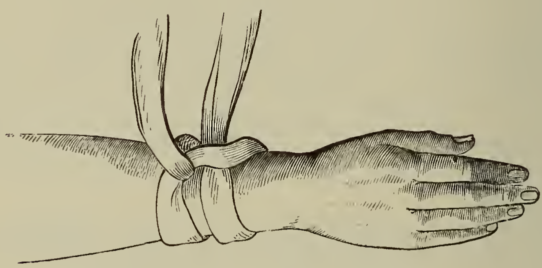
Treatment of Dislocations. The first indication in the treatment of dislocations is to return the displaced articular surfaces of the bones to their normal position and to retain them in this position by the use of suitable dressings. The return of the articular surfaces of the bones to their normal position or *the reduction* of the dislocation is accomplished by manipulation, extension, and counter-extension. The reduction of dislocations should be attempted as soon as possible after they have occurred.

The principal obstacles to the reduction of dislocations are muscular resistance and the anatomical peculiarities of the joints. The former is best overcome by the use of an *anæsthetic* given to the point where complete muscular relaxation is produced. The resistance offered by the changed relations of the articular surfaces and the ligaments is to be overcome by the surgeon making such manipulations, founded upon his knowledge of the anatomy of the parts, as will make the ligaments, muscles, and bones assist in the reduction of the dislocation.

In recent dislocations, by the use of extension and manipulation, especially if an anæsthetic be employed, the reduction is usually accomplished without the use of much force; but in old dislocations, where absolute muscular shortening has taken place, the use of extending bands is often required, and in securing these bands to the limb the clove-hitch knot is useful (Fig. 296).

The treatment of dislocations after reduction consists in placing the joint at complete rest by the application of suitable splints and bandages, and in treating any inflammatory complications, if they arise, by the application of

Fig. 296.



Clove-hitch knot applied. (Erichsen.)

evaporating lotions, and in a week or two after the injured ligaments have been repaired, passive motion should be resorted to for restoring the function of the joint.

Special Dislocations.

Dislocations of the Vertebræ. Dislocations of the *lumbar* and *dorsal vertebræ,* as simple dislocations, are extremely rare accidents; they are occasionally met with, but are more often associated with fractures of the vertebræ in these regions; their occurrence in the cervical vertebræ is more common. The treatment of dislocations of the vertebræ, whether complicated with fracture or not, consists in attempting reduction by making extension and counter-extension with manipulation, and by this means, in many cases, the luxations can be reduced. If, however, the efforts at reduction are unsuccessful, permanent extension should be applied by means of a weight-extension apparatus from both legs and from the shoulders and head. The after-treatment consists in keeping the patient at rest upon his back in bed upon a firm mattress, and if the cervical vertebræ have been involved, the head and neck should be supported by short sand-bags; and in case of the vertebræ below this point, the application of a plaster-of-Paris jacket may be used to give support and fixation to the parts. The general management of the case as regards complications is similar to that in cases of fracture of the vertebræ.

Dislocations of the Coccyx. These are reduced by manipulations with the finger in the rectum and external manipulation at the same time. The only after-treatment required is rest in bed for a few days and the administration of opium to keep the bowels quiet.

Fig. 297.

Bilateral dislocation of the jaw. (Ashhurst.)

Dislocations of the Lower Jaw. These dislocations may consist in the displacement of one or both condyles of the lower jaw from the glenoid fossæ, constituting the unilateral or bilateral dislocation of the jaw; the latter is the more common form of dislocation of the jaw met with, and the deformity resulting is shown in Fig. 297.

The *reduction* of a dislocation of the lower jaw is accomplished as follows: The surgeon placing his thumbs, well protected by strips of bandage or a towel, on the molar teeth or behind them, presses the angles of the jaw downward while he elevates the chin with his fingers, and by this manipulation the condyles of the jaw usually slip back into place with a snap (Fig. 298). After reduction of the

FIG. 298.

Method of reducing dislocation of the lower jaw. (HAMILTON.)

dislocation the jaw should be fixed for a week or ten days by the application of a Barton's bandage or a four-tailed sling.

Dislocation of the Hyoid Bone. A few cases of dislocations of the hyoid bone have been recorded; the treatment consists in throwing back the head as far as possible, to place the muscles of the neck upon the stretch, depressing the lower jaw, and pressing the luxated bone into position.

Dislocations of the Ribs. The ribs may be dislocated at their vertebral articulations or at the junction with the costal cartilages. The treatment of these dislocations consists in reducing the displacement by manipulation and pressure and then in fixing the chest to secure immobility of the ribs by strapping the affected side with strips of adhesive plaster, the same dressing being applied as in cases of fracture of the ribs, the dressing being retained for three or four weeks.

Dislocations of the Sternum. Dislocation or diastasis of the sternum may occur at the junction of the manubrium and gladiolus or at the junction of the ensiform cartilage and gladiolus. The *reduction* is effected by extension of the chest by bending the dorsal spine over a firm cushion placed under the back and by pressure upon the projecting bone; when the displaced bone has been reduced a compress should be placed over the seat of injury, and held in place by broad strips of adhesive plaster, or by a bandage to keep the parts at rest. The dressing should be retained for three or four weeks.

In the few examples of dislocations of the ensiform cartilage which have been reported, the displacement of the cartilage has in some cases given rise to persistent vomiting, which was relieved by reduction of the displacement; it is, however, almost impossible to keep the fragment in place after reduction.

Dislocations of the Pelvis. Dislocations or diastasis of the bones of the pelvis may occur at the pubic or sacro-iliac symphyses.

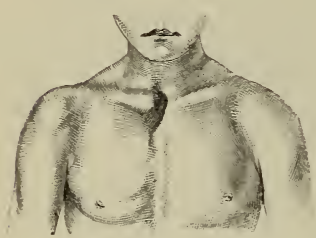
These are generally serious injuries, as they are apt to be complicated by lesions of the pelvic viscera.

The *reduction* of these dislocations is effected by pressure and manipulation, and after reduction the parts should be supported by a compress held in place by a stout binder or by broad strips of adhesive plaster, the patient being kept quiet in bed and the pelvis being supported by means of sand-bags. The dressings should be retained for from four to six weeks.

Dislocations of the Clavicle. Dislocations of the clavicle may occur either at the sternal or acromial end, and the latter injury some writers describe as a dislocation of the scapula, following the general rule that the distal bone is the one dislocated.

Dislocations of the Sternal End of the Clavicle These may occur in a forward, backward, or upward direction, and the displacement is generally well marked (Fig. 299). The *reduction* of this dislocation is effected by placing the knee against the spine, and drawing the shoulders outward and backward and pressing the displaced end of the clavicle into place. The reduction is generally easy, but it is often difficult to keep the end of the bone in its proper position. To accomplish this a compress should be placed over the end of the bone, and this should be secured in place by broad strips of adhesive plaster; the shoulders should be brought well backward and secured by a posterior

FIG. 299.



Dislocation of sternal end of clavicle forward. (BRYANT.)

FIG. 300.

Dislocation of clavicle at acromial end. (BRYANT.)

figure-of-eight bandage of the chest, and the arm of the injured side should be fastened to the side of the chest by spiral turns of a bandage. In some cases, in addition to the compress over the end of the bone, securing the arm of the injured side in the Velpeau position will be found all that is necessary to retain the bone in position.

Dislocation of the Acromial End of the Clavicle. This may be upward, downward, or backward (Fig. 300). The reduction is effected by manipulation of the arm and scapula and by pressure over the displaced end of the clavicle. The displacement is usually reduced without much trouble, but it is often a matter of difficulty to keep the end of the bone in its proper place.

The dressing consists in placing a compress over the acromial end of the clavicle and holding it in place by broad strips of adhesive plaster; the arm should at the same time be fixed in the Velpeau position.

Stimson's dressing consists in applying a long strip of adhesive plaster three inches wide, the centre being placed over the flexed elbow and its ends carried up in front of and behind the arm, crossing over the end of the clavicle and being secured on the front and back of the chest respectively, while the bone is held in place by pressure upon the clavicle and the elbow. For additional security the forearm may be supported in a sling and the arm bound to the side of the chest.

The dressings after reduction of dislocations of the clavicle should be kept in place for at least three weeks. Although in many cases a certain amount of deformity persists, the disability resulting from the injury is not often marked.

Dislocations of the Scapula. Dislocation of the acromion process of the scapula from the outer end of the clavicle, which has been described under dislocations of the acromial end of the clavicle, is classed by some writers as a scapular dislocation.

Dislocation or Projection of the Inferior Angle of the Scapula. This is caused by the escape of the inferior angle of the scapula from under the latissimus dorsi muscle or is due to relaxation of this muscle and of the serratus magnus, sometimes described as a dislocation of the inferior angle of the scapula. The *reduction* of this deformity consists in the employment of manipulation and pressure to overcome the displacement, and the use of a compress held in place by broad strips of adhesive plaster to secure the bone in its proper position.

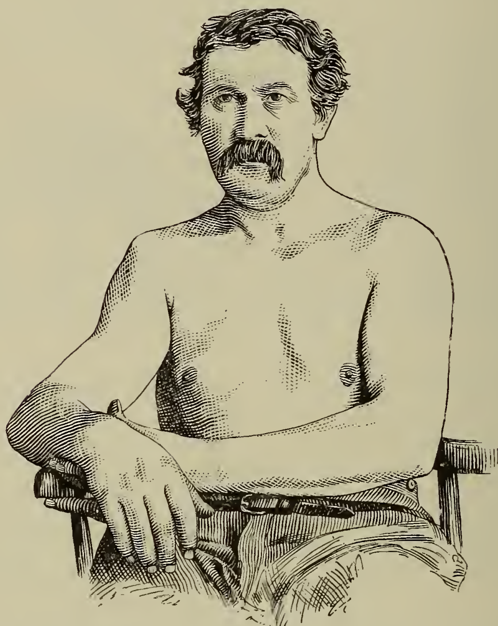
Dislocations of the Shoulder. The head of the humerus may be dislocated *downward, forward,* or *backward.*

Subglenoid Dislocation of the Head of the Humerus. In this variety of dislocation the head of the bone rests in the axilla (Fig. 301).

Subcoracoid Dislocation of the Head of the Humerus. In this variety of dislocation the head of the humerus rests beneath the coracoid process of the scapula (Fig. 302).

Subclavicular Dislocation of the Head of the Humerus. This may be considered an aggravated form of the latter variety of dislocation; the head of the humerus in this dislocation rests beneath the clavicle.

FIG. 301.



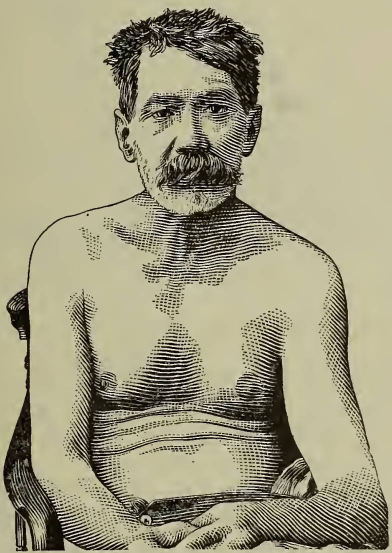
Subglenoid dislocation of the head of the humerus. (STIMSON.)

Subspinous Dislocation of the Head of the Humerus. In this variety of dislocation the head of the humerus rests beneath the spine of the scapula (Fig. 303).

Reduction of dislocations of the humerus is effected by manipulation, by extension and counter-extension, and by a combination of these methods.

Manipulation in the reduction of *subglenoid dislocation* of the humerus is practised with the patient in the recumbent posture by first flexing the forearm upon the arm to relax the long head of the biceps muscle; the elbow is next seized and abducted so as to bring it to the side of the patient's head, thus relaxing the deltoid and supraspinous muscles; the surgeon or an assistant next places

FIG. 302.



Subcoracoid dislocation of the head of the humerus. (STIMSON.)

his hand upon the head of the humerus in the axilla, and, as the arm is drawn outward to a right angle with the body by the other hand, he pushes the head of the bone into the glenoid cavity.

In the reduction of *subcoracoid* and *subclavicular* dislocations the manipulations are the same, except that the arm is to be rotated outward before being carried downward.

In the reduction of *subspinous* dislocations after the arm has been abducted, it should be rotated inward and direct pressure should be made upon the head of the bone as the arm is adducted.

Fig. 303.

Subspinous dislocation of the head of the humerus. (Erichsen.)

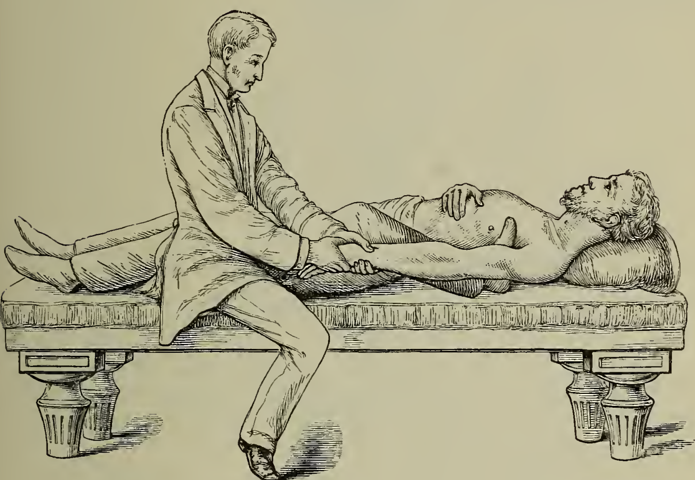
Reduction may also be effected by extension and counter-extension, as in Cooper's method, where extension is made from the arm downward and counter-extension is made by the heel in the axilla (Fig. 304).

Kocher's method of reduction of dislocations of the shoulder consists in flexing the elbow at a right angle and pressing it closely against the side, the forearm at the same time being turned as far as possible away from the trunk. While the external rotation is being maintained the elbow is carried well forward and upward, and the arm is then rotated inward and the elbow is lowered.

Mothe's Method. Reduction by this method may also be accomplished by extension made upward, the scapula being fixed by the foot or hand placed over the acromion process (Fig. 305).

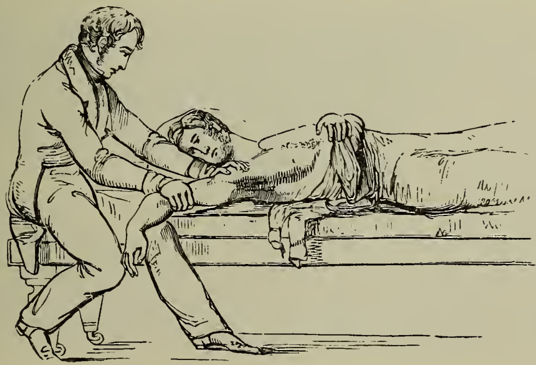
After reduction of dislocations of the head of the humerus the arm should be bound to the side of the body by the turns of a spiral bandage of the chest, or should be held against the side by the application of a Velpeau's bandage; this dressing should be removed at intervals of a few days, and after ten days or two weeks all dressings

FIG. 304.



Reduction of dislocation of the humerus by heel in the axilla. (ERICHSEN.)

FIG. 305.



Reduction of dislocation of the humerus by extension upward.

should be dispensed with, passive motion should be employed, and the patient allowed to move the arm.

Dislocations of the Elbow. Dislocations of the bones of the forearm at the elbow may be either *backward, forward*, or *lateral*. The backward dislocation is the most common form (Fig. 306).

FIG. 306.

Dislocation of both bones of the forearm backward. (LISTON.)

The *reduction* of *backward dislocations* is effected by making traction upon the forearm and at the same time making pressure upon the lower end of the humerus as the forearm is flexed upon the arm.

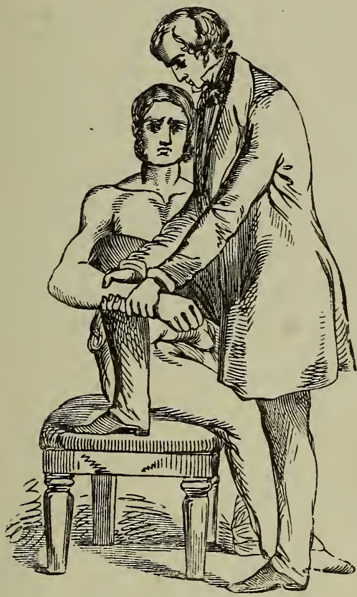
Or the reduction may be accomplished by bending the arm slowly and forcibly over the knee placed upon the inner surface of the elbow, so as to press upon the radius and ulna, separating them from the humerus and freeing the coronoid process from its abnormal position (Fig. 307).

Lateral dislocations of the bones of the forearm at the elbow are reduced by making extension from the forearm, and at the same time making direct pressure on the displaced bones and counter-pressure on the lower end of the humerus.

Forward dislocations of the bones of the forearm at the elbow are reduced by making forced flexion at the elbow, together with extension and counter-extension, or by making forced extension of the forearm at the elbow, pressing the humerus backwards, and suddenly flexing the forearm.

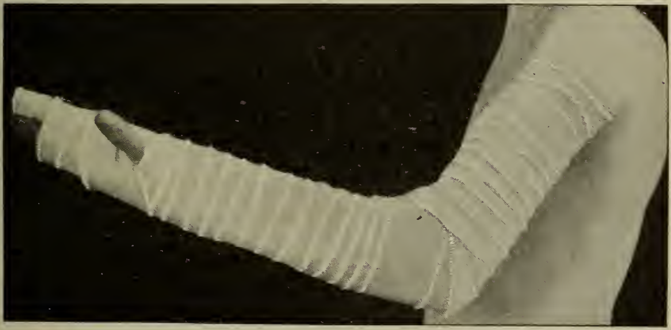
The dressing, after the reduction of dislocations at the elbow, consists in the application of a well-padded ante-

FIG. 307.



Reduction with the knee in the bend of the elbow. (HAMILTON.)

FIG. 308.



Dressing after reduction of dislocation of the elbow.

rior right-angled or slightly obtuse-angled splint, to keep the forearm in a flexed position—the dressing being practically the same as that for fractures of the lower end of the humerus, with an anterior angular splint (Fig. 308). This dressing should be retained for two or three weeks, being removed at intervals of several days; after the removal of the splint passive motion should be practised, to prevent stiffness of the elbow-joint.

Dislocations of the Head of the Radius. The head of the radius may be displaced *forward, outward*, or *backward*, the forward dislocation being the most frequent (Fig. 309). The *reduction* of these dislocations is effected

FIG. 309.

Dislocation of the head of the radius forward. (LISTON.)

by making extension from the forearm and counter-extension from the lower end of the humerus, and at the same time the head of the bone is pressed into its proper position. The dressing after reduction of the displacements consists in the application of a compress over the head of the bone, and the arm and forearm should be placed upon a well-padded anterior angular splint, which is secured by a roller bandage. The dressing is similar to that employed after reduction of dislocations of the bones of the forearm at the elbow. Difficulty is sometimes experienced in keeping the head of the bone in position after reduction, so that the use of a compress in addition to the use of the splint is often required. The arm should be kept upon the splint for three weeks, being redressed at intervals.

Dislocation of the Upper End of the Ulna. The upper end of the ulna may be displaced backward, the olecranon projecting beyond the condyles of the humerus, while the head of the radius occupies its normal position.

The *reduction* of this displacement is effected in the same manner as that of both bones of the forearm backward, and the dressing after reduction is similar to that employed when both bones have been displaced.

Dislocations of the Wrist. Dislocations of the carpus from the bones of the forearm may be *forward* (Fig. 310) or *backward* (Fig. 311). The *reduction* in either variety

FIG. 310.

Dislocation of the carpus forward. (HAMILTON.)

FIG. 311.

Dislocation of the carpus backward. (HAMILTON.)

of displacement is effected by extension from the hand and by pressure. After reduction of the displacement, which does not tend to recur, the hand and the forearm should be placed upon a well-padded straight splint applied to the palmar surface of the hand and forearm. The splint should be retained for ten days or two weeks.

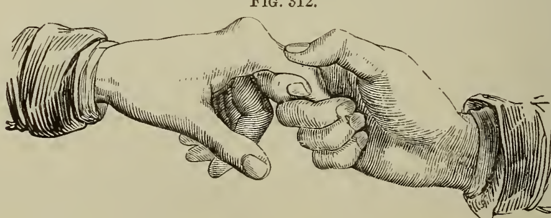
The lower end of the ulna may be dislocated from the radius *forward, backward,* or *inward.* The reduction of these displacements is effected by fixing the radius and pushing the ulna back into place. The dressing after reduction consists in placing the wrist-joint at rest by the application of well-padded anterior and posterior straight splints. The splints should be retained for three or four weeks, dressings being made at intervals of two or three days.

Dislocations of the Bones of the Carpus. The displacement of the individual bones of the carpus occasionally takes place, the *os magnum,* the *semilunar,* and *pisiform* being the bones most usually displaced, although other bones of the carpus are sometimes dislocated. *Reduction* is effected by means of extension and pressure, and the part should afterward be dressed with a palmar splint and compresses.

Dislocations of the Metacarpal Bones. The metacarpal bones may be dislocated from the carpus; the bones most commonly displaced are those of the thumb and of the index and middle fingers; the latter are usually displaced backward, while the metacarpal bone of the thumb may go either backward or forward.

Reduction is effected by extension and pressure. The dressing after reduction consists in the application of a palmar splint to the hand and forearm and a compress over the displaced bone. The dressings should be retained for two weeks.

FIG. 312.

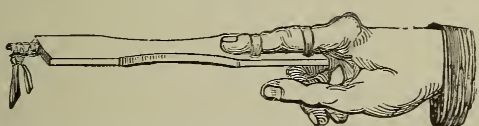


Backward dislocation of phalanx. Reduction by extension. (HAMILTON.)

Dislocations of the Fingers. Dislocations of the phalanges of the fingers usually take place at the metacarpo-phalangeal junction, but sometimes occur at the inter-phalangeal joints. The *reduction* is usually easily effected by extension (Fig. 312), or by pushing the phalanx back until it stands perpendicularly upon the metacarpal bone, when by strong pressure upon its base, from behind forward, it is readily carried by flexion into its natural position.

Where difficulty is experienced in making extension in the reduction of these dislocations, the ingenious apparatus

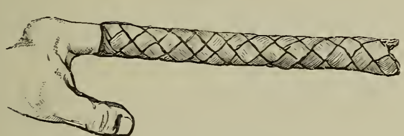
FIG. 313.



Levis's apparatus for dislocation of the phalanges applied.

of the late Dr. Levis (Fig. 313), or the "Indian puzzle" apparatus (Fig. 314), may be employed with success.

FIG. 314.

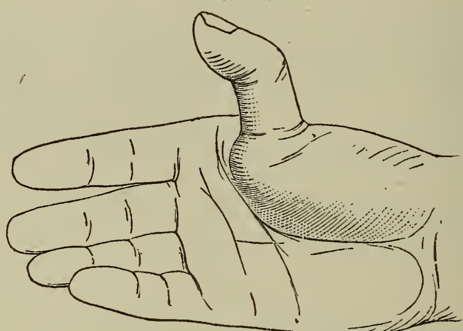


Extension by Indian puzzle. (BRYANT.)

In *dislocations of the proximal phalanx of the thumb backward* (Fig. 315) great difficulty in reduction is often experienced from the head of the metacarpal bone slipping between the two heads of the short flexor muscle, or between the lateral ligaments. The interposition of the external sesamoid bone is considered by some surgeons to be the cause of difficulty in the reduction of this displacement.

In this dislocation *reduction* is effected by firmly pressing the metacarpal bone of the thumb strongly toward the palm of the hand to relax the two portions of the short flexor muscle. The thumb is next extended upon the wrist until its tip points to the elbow. An assistant next places his finger behind the proximal phalanx to prevent its slipping backward, and by bringing the thumb down to the flexed position the bone slips into place. It sometimes happens that all efforts at reduction fail, and in such cases it may be necessary to divide one head of the short flexor muscle subcutaneously or through an open wound before the displacement can be relieved.

Fig. 315.



Dislocation of proximal phalanx of thumb backward. (Farabeuf.)

The dressing of dislocations of the phalanges after reduction consists in the application of splints of wood, or moulded splints of binder's board, or gutta-percha, to fix the joint, which should be retained for ten days or two weeks.

Dislocations of the Hip. The head of the femur is most frequently dislocated backward, downward, or upward, although it may assume other positions in exceptional cases.

Posterior or Backward Dislocations of the Head of the Femur. These are either backward and upward, when they are described as *iliac* or *dorsal*, the bone resting upon the dorsum of the ilium (Fig. 316); or the dislocation may be backward, the head of the bone resting upon the ischiatic notch; these are known as *ischiatic* dislocations, or dislocations of the femur, *dorsal below the tendon* (of the obturator internus), according to Bigelow (Fig. 317).

The *reduction* of the posterior dislocations of the femur can generally be effected by manipulation. The patient

Fig. 316.

Backward and upward dislocation of femur. (Cooper.)

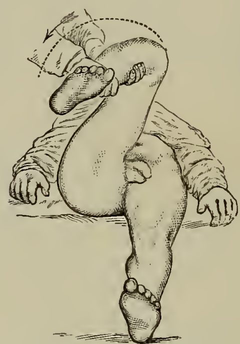
Fig. 317.

Backward dislocation of femur. (Cooper.)

being anæsthetized and placed upon his back, the surgeon grasps the leg at the ankle and knee, flexes the leg upon the thigh, and the thigh upon the pelvis in the position of adduction; he then abducts the limb and rotates it outward, bringing it in a broad sweep across the abdomen, and by bringing it down to its natural position the head of the bone will slip into the acetabulum (Fig. 318).

Allis, in the reduction of dorsal dislocations, recommends that, while the patient is supine, the surgeon kneel beside him, and in the case of the right arm grasp the ankle with the right hand and place the bent elbow of the

Fig. 318.



Reduction of backward dislocation of the femur. (Bigelow.)

left arm beneath the knee. He then turns the bent leg outward by means of the ankle and lifts upward, and next turns the leg inward and brings the femur down in extension.

Downward and Forward Dislocation of the Head of the Femur. In this variety of dislocation the head of the bone rests upon the thyroid foramen; this form of displacement is sometimes spoken of as a *thyroid* dislocation (Fig. 319).

The *reduction* of downward and forward dislocations of the head of the femur is effected by flexing the leg and thigh and bringing the limb into a position of abduction; it is then adducted and rotated inward in a broad sweep across the abdomen and brought down to its natural position, and the head of the bone slips into the acetabulum (Fig. 320).

In making these manipulations the head of the bone sometimes slips back upon the dorsum of the ilium, converting the downward dislocation into a posterior one; if

FIG. 319.

Downward and forward dislocation of femur. (COOPER.)

FIG. 320.

Reduction of downward and forward dislocation of femur. (BIGELOW.)

this accident occurs the displacement should be remedied by making the manipulations appropriate for the reduction of the latter dislocation.

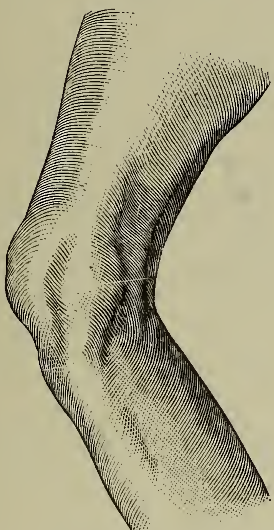
Upward and Forward Dislocation of the Head of the Femur. In this variety of dislocation the head of the bone rests upon the pubis; this form of displacement is also spoken of as a *pubic* dislocation (Fig. 321).

FIG. 321.

Forward and upward dislocation of the femur. (COOPER.)

The *reduction* of forward and upward dislocations of the head of the femur is effected by much the same manipulation as is employed in the reduction of downward and forward dislocations, except that in the pubic dislocation the flexed limb should be carried across the sound thigh at a higher point. The thigh being flexed the head of the bone is drawn down from the pubis; it is then semi-abducted and rotated inward to disengage the bone completely. While rotating inward and drawing on the thigh

FIG. 322.



Outward dislocation of the patella. (DUPLAY.)

the knee should be carried inward and downward to its place by the side of its fellow, and the head of the bone will usually slip into the acetabulum.

As before stated, various *anomalous displacements of the head of the femur* occasionally occur; the head of the bone may pass directly upward or downward between the sciatic notch and thyroid foramen, or downward and backward on the body of the ischium, or downward and backward into the lesser sciatic notch, or downward, inward, and forward into the perineum. These anomalous displacements usually occur where there has been extensive laceration of the capsular and Y-ligaments.

The dressing of cases after reduction of dislocations of the head of the femur consists in keeping the patient at rest in bed upon his back, and the limb should be kept at rest by sand-bags applied to either side of the limb, or the knees should be tied together.

The patient should be kept at rest for two or three weeks, and at the end of this time may be allowed to get out of bed and go about on crutches.

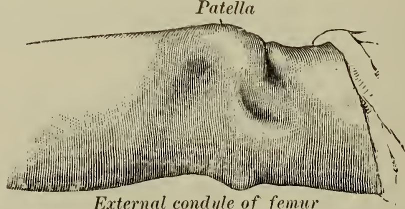
Dislocations of the Patella. The patella may be dislocated *outward*, *inward*, or *upward*, or it may be rotated upon its own axis. The *outward* dislocation is the displacement most usually seen (Fig. 322).

Upward dislocation of the patella can only result from laceration of the ligamentum patellæ, and the treatment in such cases is similar to that for fracture of the patella.

The *reduction* of dislocations of the patella is effected by extending the leg upon the thigh and flexing the thigh upon the pelvis, to relax the quadriceps femoris muscle, when the patella can usually be forced back into place; in some cases alternate flexion and extension of the leg will accomplish the same result.

The dressing after reduction of the displacement consists in the application of a posterior straight splint or a moulded binder's board or felt splint to keep the joint at rest; the splint should be worn for a week or ten days.

FIG. 323.



Forward dislocation of the knee. (BRYANT.)

Dislocations of the Knee. The head of the tibia may be dislocated *forward*, *backward*, or *laterally*; the latter dislocations are always incomplete, forward dislocation being the variety of displacement most commonly met with (Fig. 323).

The *reduction* of dislocations of the knee is effected by extension and counter-extension with forced flexion of the knee with pressure, aided by rocking movements. The treatment of cases of dislocation of the knee after reduction consists in fixing the knee-joint by the application of a straight posterior splint or a moulded splint of binder's board. As there is usually marked swelling following these injuries from violence to the joint structures, the application of evaporating lotions for a few days will be found useful. As soon as the swelling has subsided the joint should be put up in a plaster-of-Paris dressing, and this should be retained for four weeks.

Dislocation of the Semilunar Cartilages. The displacement here consists in the slipping forward or backward and wedging of the semilunar cartilages between the femoral condyles and the tibia.

Reduction of the displaced cartilages can usually be effected by hyperflexion of the knee, followed by sudden full extension, or by alternately flexing and extending the joint. Excision of the displaced cartilages is sometimes required in cases in which they cannot be reduced by manipulation.

The dressing of these cases after reduction of the displaced cartilages consists in the application of a posterior straight splint or a plaster-of-Paris dressing to fix the knee-joint; the splint should be worn for three or four weeks, and if there is a tendency to redisplacement the patient should wear a knee-cap of leather or muslin, to partially fix the joint, with compresses so arranged as to make pressure upon the edge of the joint.

Dislocations of the Fibula. Dislocations of the fibula may occur at either of its extremities, and the direction of the displacement may be *forward*, *backward*, or *upward*; dislocation of the head or upper extremity of the fibula being the most common, although all are rare forms of displacement.

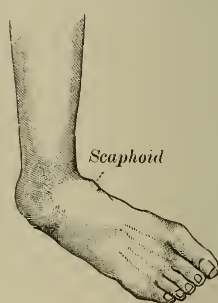
The *reduction* of dislocations of the head of the fibula is effected by flexing the leg upon the thigh and making direct pressure and extension. Dislocations of the lower extremity of the fibula are reduced by manipulation and pressure. The dressing of cases after reduction of dislocations of the fibula consists in the application of a compress and moulded binder's board splint, and the dressing should be retained for three or four weeks.

Dislocations of the Ankle. Dislocations of the foot upon the bones of the leg results from the separation of the articular surface of the astragalus from that of the tibia and fibula, and the displacement may be *forward*, *backward* (Fig. 324), or *lateral* (Fig. 325), the latter variety being often associated with fractures of the malleoli.

FIG. 324.

Dislocation of foot backward. (BRYANT.)

FIG. 325.



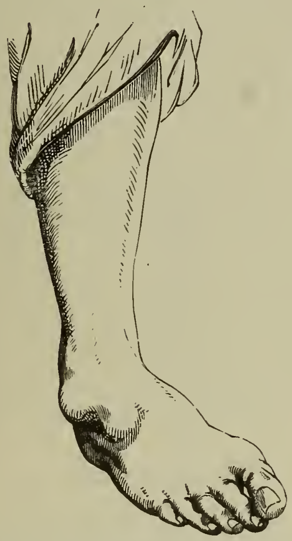
Dislocation of foot inward. (BRYANT.)

The *reduction* of dislocations of the ankle is effected by traction, combined with flexion and rotation of the ankle-joint, the leg being first flexed upon the thigh to relax the tendo-Achillis, and in some cases the subcutaneous division of this tendon is required before the reduction can be satisfactorily accomplished.

The dressing of dislocations of the ankle after reduction consists in the application of a fracture-box or of paste-board splints, to fix the ankle, care being taken to see that the foot is fixed at a right angle to the leg, and in the application of evaporating lotions for a few days; after the swelling has subsided a plaster-of-Paris dressing should be applied and retained for three or four weeks.

Dislocations of the Tarsal Bones. The *astragalus* may be dislocated from the bones of the leg and from the other tarsal bones, being thrust *forward*, *backward*, *outward* (Fig. 326), or *inward*. The *reduction* of dislocations of the *as-*

FIG. 326.



Dislocation of astragalus outward. (HAMILTON.)

tragalus outward is effected by first flexing the leg upon the thigh and making extension from the foot and rotating it at the same time, direct pressure being made upon the displaced bone; in some cases subcutaneous section of the tendo-Achillis has assisted materially in the reduction of the displaced bone. *Backward dislocation of the astragalus* is usually irreducible; the patient, however, in many cases recovers with a useful foot. In cases of irreducible dislocations of the astragalus, excision of the atragalus may ultimately be required.

After the reduction of dislocations of the atragalus, the foot and leg should be put at rest in a fracture-box, or by means of moulded splints of pasteboard or felt; evaporating lotions should also be employed over the region of the injury for a few days, and when the swelling has subsided a plaster-of-Paris dressing should be applied and retained for three or four weeks.

Dislocations of the calcaneum and scaphoid upon the astragalus, or of the *calcaneum* upon the *astragalus* and *cuboid*, or upon the *astragalus* alone; of the *scaphoid* and *cuboid* upon the *calcis* and *astragalus;* or of the *cuboid, scaphoid*, or *cuneiform* bones, are occasionally met with.

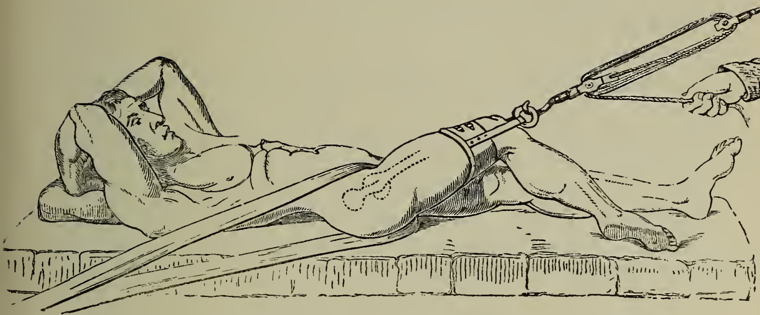
Their *reduction* is effected by traction and direct pressure, and after this has been accomplished the parts should be put at rest by the application of a splint and compresses.

Dislocations of the Metatarsal Bones and Phalanges of the Toes. These dislocations usually result from crushing forces which destroy the vitality of the soft parts so completely that amputation is required. Their *reduction* in cases of simple or uncomplicated dislocations is effected by traction, manipulation, and pressure. After reduction of the displacement the parts should be kept in position by the application of splints, compresses, and bandages.

Old Dislocations.

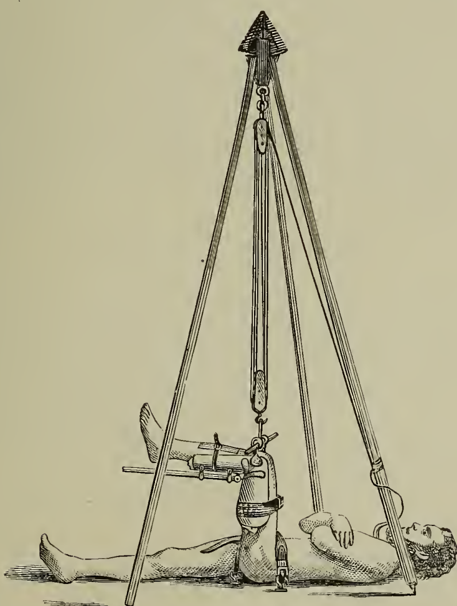
The reduction of old dislocations is attended with more difficulty and danger than that of recent dislocations, due to the permanent contraction and structural changes which occur in the muscles and to the adhesions which form between the displaced bone and the parts with which it is in contact. The *reduction* of old dislocations can usually be accomplished by the manipulations appropriate for recent dislocations of the same variety; but occasionally the use of more forcible extension is required, which is made by bands and pulleys (Fig. 327) or by vertical extension (Fig. 328). The first step in the reduction of old dislo-

FIG. 327.



Reduction of old dislocation of the femur by pulleys. (COOPER.)

FIG. 328.



Reduction of old dislocation of hip by vertical extension. (BIGELOW.)

cations consists in thoroughly breaking up the adhesions which have been formed between the displaced bone and the surrounding tissues; this has, in some cases, resulted in the laceration of muscles, nerves, and bloodvessels, and in the fracture of the displaced bones or neighboring bones, so that the manipulations should be made with the least force that will accomplish the object desired. After the reduction of old dislocations, difficulty is sometimes experienced in maintaining the bone in its proper place, due to the changes which have occurred in the articular surfaces.

Compound Dislocations.

These are always grave injuries, and amputation or excision may be required. At the present time, under the modern methods of wound treatment, operative measures are not often required. The reduction is effected in the same manner as in simple dislocations of corresponding parts, the greatest care being taken to render the wound aseptic, and to keep it in this condition by the application of a full antiseptic dressing. After reducing the dislocation and dressing the wound some form of fixation splint should be applied, to fix the joint for a short time.

Complicated Dislocations.

In dislocations complicated by fracture near the seat of displacement, the displaced bone should, if possible, be first reduced, and this in many cases is a matter of much difficulty, as the fracture prevents the surgeon from using leverage otherwise present, in the reduction, and he has often to depend entirely upon pressure and manipulation to overcome the displacement.

After reduction of the dislocation the fracture should be reduced and dressed.

Dislocation complicated by rupture of the main artery of the limb may require, after reduction of the displacement, exposure and ligation of the vessel or amputation of the limb. Rupture of an important nerve trunk complicating a dislocation may call for subsequent exposure and suturing of the divided nerve.

Spontaneous, Pathological, and Congenital Dislocations.

In the treatment of these varieties of dislocations after the reduction of the displacement by manipulation and pressure, much difficulty is often experienced in maintaining the reduction. To effect the latter object the use of splints and bandages is employed, and also the use of many ingenious forms of apparatus adapted to particular dislocations.

Tenotomy or *myotomy* is often required to prevent recurrence of the deformity, and continuous extension is also of much value in the treatment of these displacements.

PART V.

OPERATIONS.

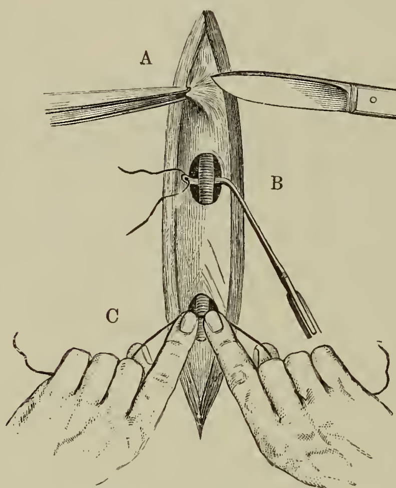
In view of the fact that at the present time in our medical schools much more attention is paid to practical surgery—that is, operative procedures upon the cadaver—it has been thought advisable to introduce a very brief description of a number of operations which can with advantage be performed upon the cadaver. Too much value cannot be attached to the importance of the student rendering himself familiar with the use of instruments and their manipulation in the various operative procedures, and also familiarizing himself with the appearance of the anatomical parts exposed in operations. The introduction of sutures, the application of ligatures, the closing of wounds, the cutting and fitting of flaps in plastic operations, are procedures the practical value of which to the student cannot be overestimated.

LIGATION OF ARTERIES

In the application of a ligature to an artery in its continuity the surgeon should make his incision in the line which corresponds to the general course of the vessel, and he should be thoroughly familiar with the anatomy and with the surgical landmarks of the part. A portion of the artery, when possible, should be selected for the application of the ligature half an inch or an inch from any large collateral branch. The position of the incision being selected, the surgeon steadies the skin with two fingers and makes an incision of the required length through it with a scalpel; the superficial fascia is next picked up on a director, any large superficial veins which come into view being displaced, and divided to an equal length with the incision in the skin; the deep fascia being exposed, it should be nicked and divided upon a director; the intermuscular space, or the edge of the muscle or muscles which are the guide to the vessel, should next be sought for, and small arteries coming from the main vessel through these spaces will often serve as valuable guides to the position of the artery. The surgeon next separates the tissues with the director, handle of the knife, or the finger until the sheath of the vessel is exposed; this is recognized by its communicated pulsation and by the absence of the smooth, shining surface and pinkish-white color which the surface of the artery presents. The sheath of the artery should be picked up with forceps and nicked with the point of the knife applied flatwise (Fig. 329 A); the incision into the sheath should be very limited, only large enough to allow the aneurism needle to pass through it around the vessel; extensive dissections or separations of the sheath from the artery should be avoided, as the nutrition of the artery at the point of ligature may thus be impaired, and sloughing and secondary hemorrhage may result. A distinct sheath is found only about the main arterial trunks, which is replaced in the smaller arteries by a layer of loose cellular tissue. The wall of the artery being exposed, an aneurism needle (Fig. 330) is passed around the vessel, threaded with a catgut ligature, and withdrawn (Fig. 329 B); the needle may be threaded before being passed, in which case the ligature is grasped with forceps and drawn through while the needle is withdrawn. The best material for ligatures is silk or carefully prepared chromicized catgut. The needle should be passed away from important structures, such as accompanying veins and nerves.

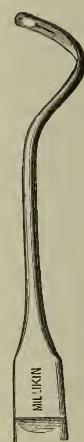
Before the ligature is tied the surgeon should satisfy himself that the ligature when tied will control the circulation in the artery below its point of application, by placing the tip of his finger upon the vessel and drawing upon the ends of the ligature, so as to occlude the vessel at the point of application. Being satisfied as to this point, the ligature is tied with a reef-knot, or a surgeon's knot and reef-knot combined, and the ends of the ligature are cut short in the wound (Fig. 329 C).

Fig. 329.



A. Opening sheath; B. Passing ligature around the vessel; C. Tying the artery. (Bryant.)

Fig. 330.



Aneurism needle.

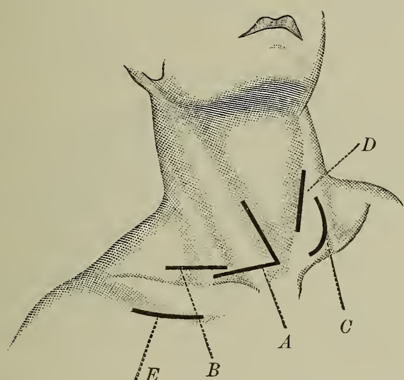
Some authorities recommend the application of two ligatures a short distance apart in the ligation of vessels in their continuity, and a division of the vessel between them, so that both ends can retract into the cellular sheath.

Ligation of Special Arteries.

Ligation of the Innominate Artery. The innominate artery lies immediately behind the sterno-clavicular articulation, and is in relation in front with the innominate veins and pneumogastric nerve, on the inner side with the trachea, on the outer side and behind with the pleura.

The *incision* is a V-shaped incision, each branch of which is two and a half or three inches in length, one of which lies over the anterior edge of the sterno-cleido-mastoid muscle and the other parallel to and a little above the clavicle (Fig. 331, *A*). The incisions are carried down to the superficial fascia and a flap is dissected up. If the anterior jugular vein is met with it should be displaced.

FIG. 331.



Line of incision for—*A*, innominate artery; *B*, right subclavian artery; *C*, left subclavian artery; *D*, vertebral or inferior thyroid artery; *E*, axillary artery below clavicle. (STIMSON.)

The sternal and clavicular attachments of the sterno-cleido-mastoid are next divided upon a director half an inch above the bone. The sterno-thyroid and sterno-hyoid muscles and the middle cervical fascia are then exposed, covered by the thyroid veins. The outer fibres of the sterno-hyoid and sterno-thyroid muscles are next divided, the thyroid vein being held aside, when upon tearing through the fascia with a director the common carotid artery is exposed and traced down to the innominate artery; the innominate veins are pressed against the sternum with the finger, and the artery is separated from its sheath about half an inch below its bifurcation, and the aneurism needle is passed around the vessel from the outer side, so as to avoid the vein, pneumogastric nerve, and pleura.

Ligation of the Subclavian Artery. This artery may be tied at three points; in its *first* portion, between the trachea and scaleni muscles; in its *second* portion, behind the scaleni muscles; and in its *third* portion, external to the scaleni muscles.

The left subclavian artery in its first portion is larger and more vertical in its direction than the right subclavian, and is situated more posteriorly. From the difficulty in exposing this portion, and from the possibility of injuring the thoracic duct, the ligation of this artery in its first portion has been seldom attempted.

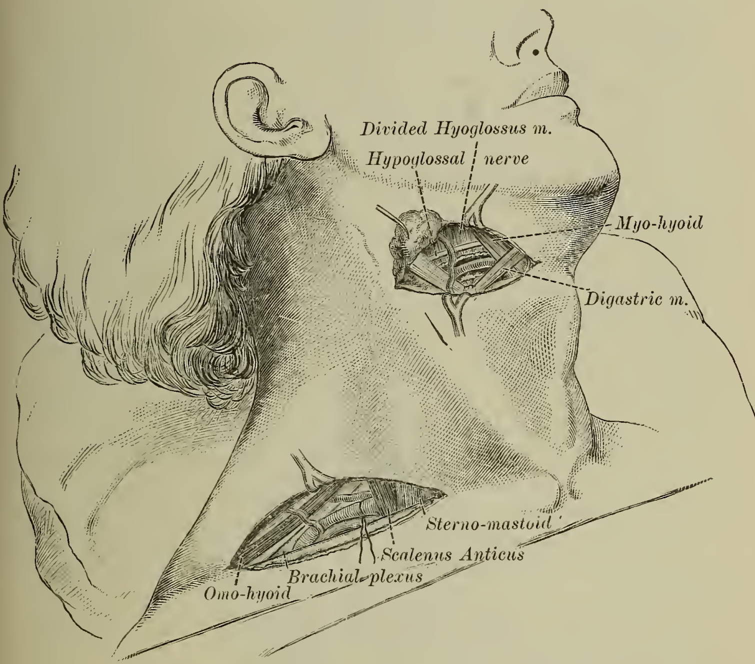
The *incision* for the *first portion* of the subclavian artery is the same as that for the innominate (Fig. 331, *A*), and the ligature is passed from the outer side, the pneumogastric and phrenic nerves being pressed inward toward the carotid artery.

The right and left subclavian arteries are also seldom tied in their second portions—that is, behind the scaleni muscles—but are frequently tied in their third portions—that is, external to the scaleni muscles.

The *incision* for the *second portion* of the subclavian artery begins an inch external to the sterno-clavicular articulation, half an inch above and parallel to the clavicle, and is three or four inches in length (Fig. 331, *B* or *C*). The steps of the operation are the same as for ligation of the third portion, and when the scalenus anticus muscle has been exposed it is divided upon a director; the phrenic nerve which lies upon its anterior aspect is to be avoided.

The *incision* for the *third portion* of the subclavian artery is the same as for the second portion (Fig. 331, *B* or *C*). The skin and platysma being divided, the external jugular vein is exposed and drawn to one side or divided between two ligatures; the superficial fascia is next divided upon a director; the posterior belly of the omo-hyoid muscle is next found and drawn upward and outward; the outer border of the scalenus anticus is next felt for and followed down to the tubercle of the first rib—the artery lies against this, between it and the lowest bundle of the brachial plexus. The artery is next denuded with the director, and the needle is passed from below, care being taken not to include the lowest bundle of the brachial plexus in the ligature (Fig. 332).

FIG. 332.



Ligation of subclavian and lingual arteries. (BRYANT.)

Ligation of the Vertebral Artery. The *incision* for the ligation of the vertebral artery is three or three and a half inches in length, parallel with the anterior edge of the sterno-cleido-mastoid muscle, ending an inch above the clavicle (Fig. 331, *D*). The anterior edge of the sterno-cleido-mastoid being exposed, the middle cervical fascia is divided and the carotid artery and jugular vein are exposed and drawn inward. The gap between the longus colli muscle and the scalenus anticus muscle is next felt for about an inch below the carotid tubercle; the fascia covering it is next torn through and the muscles are separated and the vertebral vein comes into view. When this vein is held aside the vertebral artery is exposed, and the ligature is then passed around it.

Ligation of the Inferior Thyroid Artery. The *incision* for the inferior thyroid artery is the same as that for the vertebral artery (Fig. 331, *D*.) The anterior edge of the sterno-cleido-mastoid muscle being exposed, it is drawn outward, the middle cervical fascia is next divided, and the carotid artery and internal jugular vein are drawn outward with a retractor. The head being flexed slightly, the surgeon feels for the carotid tubercle, and then separates the cellular tissue with a director, and the artery should be found below the carotid tubercle. The needle should be passed between the artery and vein.

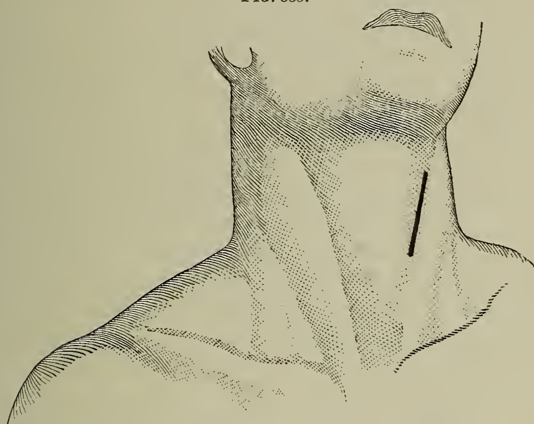
Ligation of the Internal Mammary Artery. The *incision*, a vertical one, two and a half inches in length, commences at the lower border of the clavicle, parallel with and three lines external to the margin of the sternum. Divide the skin and superficial fascia and expose the fibres of the great pectoral muscle, the external intercostal aponeurosis, and the muscular fibres of the internal intercostal muscle. Raise the fasciculi of the latter muscle upon a director and divide them, and the vessel will be exposed.

The internal mammary artery is not often tied below the fourth intercostal space.

Ligation of the Common Carotid Artery. The point of election for the ligation of the common carotid artery is just above the omo-hyoid muscle, about three-quarters of an inch below the bifurcation of the vessel, which takes place at a point on a line with the upper border of the thyroid cartilage.

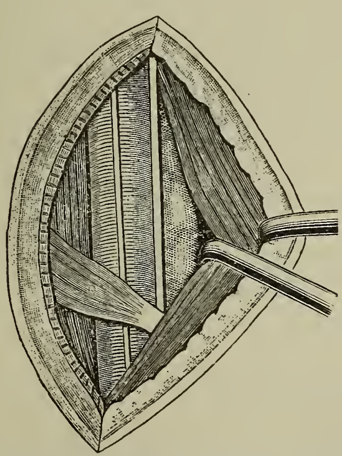
The *incision* for the common carotid artery is three inches in length along the anterior border of the sterno-

FIG. 333.



Line of incision for common carotid artery at point of election. (STIMSON.)

FIG. 334.

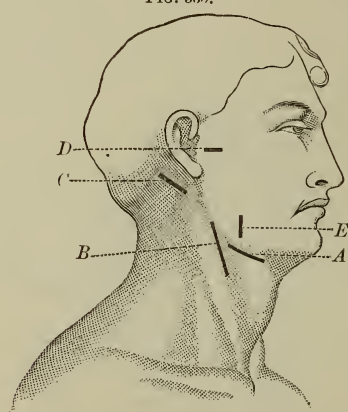


Relations of the left common carotid artery above the omo-hyoid muscle. (ESMARCH.)

cleido-mastoid muscle, the centre of which corresponds with the crico-thyroid space (Fig. 333).

Divide the skin, platysma, cellular tissue, and aponeurosis, avoiding the superficial veins, and expose the anterior edge of the sterno-cleido-mastoid; seek for the interspace between this muscle and the sterno-hyoid and sterno-thyroid muscles, draw the latter muscles inward, and the artery will be exposed with the jugular vein external to it; the descendens noni nerve lying upon its sheath should be displaced outward. The sheath is next picked up and opened and the artery is separated from it with a director; the artery lies internally, the internal jugular vein externally and somewhat more superficial, and the pneumogastric nerve lies between the two, and is more deeply placed. The sympathetic nerve is posterior to the vessel external to the sheath. The needle is passed from without inward, care being taken to avoid injury of the vein and nerve (Fig. 334).

FIG. 335.



Line of incision for—*A*, lingual artery; *B*, external and internal carotid arteries; *C*, occipital artery; *D*, temporal artery; *E*, facial artery. (STIMSON.)

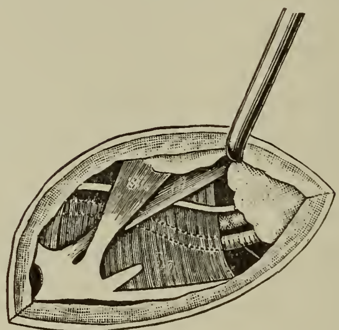
Ligation of the External Carotid Artery. The *incision* for the ligation of the external carotid artery is over the inner edge of the sterno-cleido-mastoid muscle from the angle of the jaw to a point corresponding to the middle of the thyroid cartilage (Fig. 335, *B*). The skin, platysma, and cellular tissue being divided, the external jugular vein is drawn aside when encountered; the deep fascia being opened, the facial and lingual veins will be exposed, which should be drawn to one side; the artery is next exposed, covered by the hypoglossal nerve and the stylo-hyoid and digastric muscles. The vessel should next be isolated from the internal carotid artery and internal jugular vein, both of which lie along its outer side. The needle should be passed from without inward.

Ligation of the Internal Carotid Artery. The *incision* is the same as for the external carotid artery (Fig. 335, *B*); the vessel is external to the external carotid artery, and in passing the needle the point should be directed away from the internal jugular vein—that is, from without inward.

Ligation of the Superior Thyroid Artery. The *incision* is about three inches in length along the anterior border of the sterno-cleido-mastoid muscle, starting a little lower down than that for the external carotid artery. The skin, superficial fascia, platysma, and deep fascia being divided, the cellular tissue in the sulcus between the upper portion of the larynx and the great vessels of the neck should be broken up with the director and the vessel exposed. The needle should be passed around the vessel from above downward.

Ligation of the Lingual Artery. The *incision* is a curved one two inches long, its concavity directed upward from the anterior edge of the sterno-cleido-mastoid muscle, half an inch above the great horn of the hyoid bone, to a point one inch within the median line of the neck (Fig. 335, *A*). Divide the skin and platysma, displacing the superficial veins, and open the deep fascia, when the submaxillary gland will be exposed; this is displaced upward with the handle of the knife and the tendon of the digastric muscle attached to the hyoid bone, and the hypoglossal nerve will be exposed; next divide the fibres of the hyoglossus muscle midway between the hypoglossal nerve and the hyoid bone, and the lingual artery will be exposed (Fig. 336).

FIG. 336.



Relations of the lingual artery. (ESMARCH.)

The needle should be passed around the vessel from above downward, in order to avoid the nerve.

Ligation of the Facial Artery. The facial artery passes over the inferior maxilla just in front of the anterior edge of the masseter muscle, and is accompanied by the facial vein, which lies nearer to the muscle.

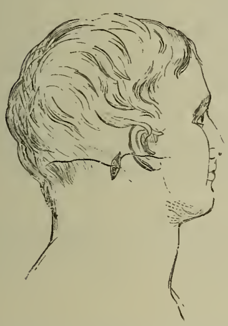
The *incision* is either a horizontal one along the lower border of the maxilla or a vertical one an inch in length (Fig. 335, *E*). The skin, subcutaneous tissue, and fascia being divided, the artery is exposed and the needle should be passed around the vessel away from the vein.

Ligation of the Occipital Artery. The *incision* is two inches in length, starting from a point half an inch below and in front of the apex of the mastoid process, and carried obliquely backward, parallel to the border of this process (Fig. 335, *C*). Divide the skin and fascia and expose the insertion of the sterno-cleido-mastoid muscle, which is also divided, and the aponeurosis of the splenius is exposed; this is also opened and the digastric groove is felt for, and when the belly of the digastric muscle is exposed the artery is brought into view by separating the cellular tissue in the anterior angle of the wound with a director (Fig. 337).

Ligation of the Temporal Artery. The *incision* is a transverse one, one inch in length, starting from the tragus of the ear forward over the zygomatic arch (Fig. 335, *D*), or a vertical one of the same length a little in front of the tragus of the ear.

Divide the skin and expose the subcutaneous cellular tissue, whch in this region is very dense and fibrous. This tissue should be broken up with a director, and the artery should be found in it about a quarter of an inch in front of the ear (Fig. 338). The temporal vein accom-

Fig. 337.



Ligation of the occipital artery. (Skey.)

Fig. 338.

Ligation of the temporal artery. (Skey.)

panies the artery and lies nearer to the ear, and in some cases the auriculo-temporal nerve is in close relation to the artery. The needle should be passed from behind forward.

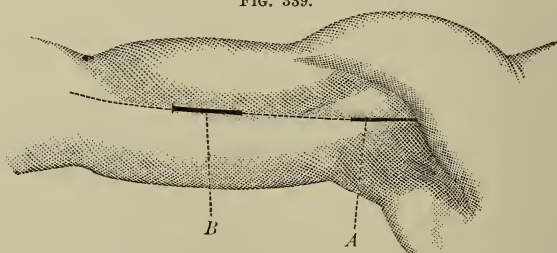
Ligation of the Axillary Artery. The axillary artery extends from the middle of the clavicle to the insertion of the teres major into the humerus; the axillary vein lies upon the inner side and in front of the artery. The axillary artery is tied either in its *upper* portion, just below the clavicle, or at its *lower* portion in the axilla.

Axillary Artery Below the Clavicle. The *incision* is four inches in length from the summit of the coracoid process inward a short distance below the clavicle (Fig. 331, *E*), or an incision three inches in length, commencing at a point one-half an inch from the sterno-clavicular articulation, and carried obliquely downward toward the axilla.

The skin and subcutaneous tissue having been divided the deep fascia is exposed and opened, and the axillary artery may be reached by following the intermuscular space between the sternal and clavicular fibres of the pectoralis major which leads upward toward the clavicle and to the pectoralis minor; or the fibres of the pectoralis major being exposed are cut through and the costo-coracoid membrane is next torn through with a director, care being taken to avoid injury of the cephalic vein at the outer portion of the wound; the pectoralis minor is now seen, and after separating the cellular tissue with a director the axillary vein is seen crossing from the upper edge of the muscle to the clavicle; the vein almost completely covers the artery, which is exposed by drawing the vein inward. The needle is passed around the artery from within outward.

Axillary Artery in the Axilla. The *incision* is two and a half inches long, started at the upper part of the axilla

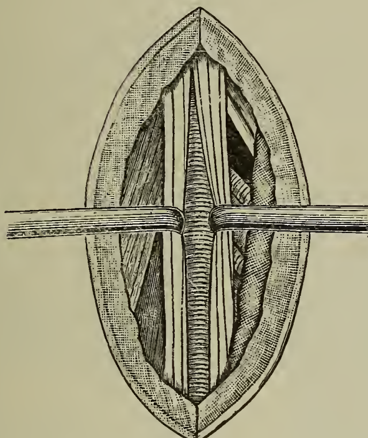
FIG. 339.



A. Incision for axillary artery in axilla. *B*. Incision for brachial artery. (STIMSON.)

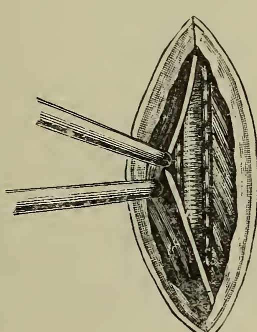
and carried down the arm at the edge of the coracobrachialis muscle (Fig. 339, *A*). The skin only is divided in the first incision. The deep fascia is then picked up and divided upon a director. As soon as the fibres of the

Fig. 340.



Relations of right axillary artery in axilla. (Esmarch.)

Fig. 341.



Relations of right brachial artery at middle of arm. (Esmarch.)

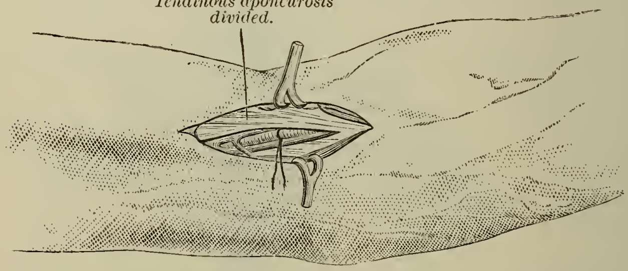
inner border of the coraco-brachialis muscle are exposed and held aside by a retractor, the operator will see the median nerve, the musculo-cutaneous nerve, and the axillary artery. To the inner side of the artery are the axillary vein, ulnar and internal cutaneous nerves (Fig. 340). The needle should be passed around the artery from the vein toward the coraco-brachialis muscle.

Ligation of the Brachial Artery. The *incision* is three inches long at the middle of the arm, on a line corresponding to the inner edge of the biceps muscle (Fig. 351, *B*). The skin and cellular tissue having been divided, care being taken not to injure the basilic vein, which should be drawn posteriorly, the deep fascia is next cut through and the fibres of the biceps muscle are exposed (Fig. 341); this muscle should be drawn forward and the sheath of the vessels enclosing the artery, veins, and median nerve exposed; the sheath having been opened, the median nerve is pressed aside and the artery is separated from its veins, and the needle is passed from the side of the nerve around the vessel.

In ligating the brachial artery the occasional high division of the vessel must be borne in mind.

Brachial Artery at Bend of the Elbow. The *incision* is two inches in length, along the inner border of the tendon

FIG. 342.



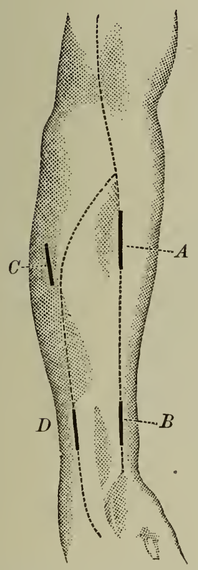
Ligation of the brachial artery at the bend of the elbow. (BRYANT.)

of the biceps muscle. Divide the skin, superficial fascia, and the bicipital aponeurosis, under which the artery will be exposed, resting upon the brachialis anticus muscle

(Fig. 342). The median nerve is to the inner side and some distance from the artery. The needle should be passed around the vessel, after isolating the veins, from within outward.

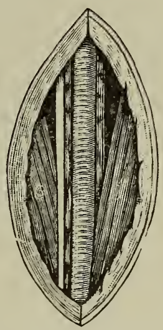
Ligation of the Radial Artery. The radial artery extends in a straight line from a point half an inch below the centre of the fold of the elbow to the inner side of the styloid process of the radius.

Fig. 343.



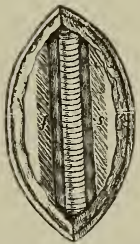
Line of incision for—*A*. Radial artery in upper third. *B*. Radial artery in lower third. *C*. Ulnar artery in upper third. *D*. Ulnar artery in lower third. (Stimson.)

Fig. 344.



Relations of right radial artery in the upper third of the forearm. (Esmarch.)

Fig. 345.



Relations of right radial artery above the wrist. (Esmarch.)

The radial artery may be tied at its upper, middle, or lower third, or at the root of the thumb.

Radial Artery in the Upper Third of the Forearm. The *incision* for the radial artery at its upper third is two and a half inches in length on a line drawn from the middle of the bend of the elbow to the ulnar side of the styloid process of the radius; the incision should begin one and a half inches below the bend of the elbow (Fig. 343, *A*). Divide the skin and superficial fascia, avoiding the superficial veins. When the deep fascia is exposed, find the edge of the supinator longus muscle and divide the aponeurosis along its ulnar side, and expose the fibres of the pronator radii teres muscle. The vessel lies in the interspace between these muscles surrounded by adipose tissue, and upon being exposed the veins should be isolated and the needle passed from without inward. The radial nerve lies so far external to the artery that it is not often exposed in the operation (Fig. 344).

Radial Artery in the Middle Third of the Forearm. The *incision* is two inches in length, following the same line as that for the upper third of the artery. After dividing the skin, superficial and deep fascia, the artery is found in the interspace between the flexor carpi radialis on the inner side and the supinator longus on the outer side; the radial nerve at this part of the arm is in close relation with the vessel to the radial side, and the needle should be passed around the artery from without inward.

Radial Artery in the Lower Third of the Forearm. The *incision* is two inches in length, following the same line (Fig. 343, *B*), ending one inch above the wrist. The skin, superficial and deep fascia being divided, the artery will be found between the tendon of the flexor carpi radialis on the inner side and the tendon of the supinator longus on the outer side (Fig. 345). The veins being separated the needle may be passed in either direction.

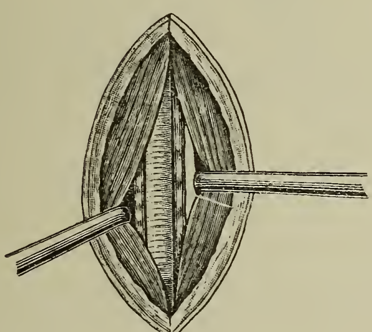
Radial Artery at the Root of the Thumb. The radial artery may also be tied at the root of the thumb.

The *incision* is one inch in length between the tendons of the extensor ossis metacarpi pollicis and extensor primi internodii pollicis on the outer side, and the tendon of the extensor secundi internodii pollicis on the inner side. The skin and superficial fascia being divided and the radial vein being displaced, the deep fascia is opened and the artery is exposed at the bottom of the wound; the needle may be passed in either direction.

Ligation of the Ulnar Artery. The ulnar artery is tied at the junction of the upper and middle third of the forearm and at the lower third.

Ulnar Artery at the Junction of the Upper and Middle Thirds of the Forearm. The *incision* is three inches in length, starting four inches below the internal condyle of the humerus, on a line passing from the internal condyle of the humerus to the outer border of the pisiform bone (Fig. 343, *C*). Divide the skin and superficial fascia, and when the deep fascia has been exposed and the interspace between the flexor carpi ulnaris and the flexor sublimis digitorum appears, enter this interspace and raise

FIG. 346.

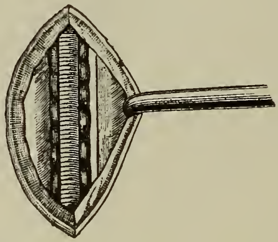


Relations of the right ulnar artery at upper third of the forearm. (ESMARCH.)

the flexor sublimis digitorum and work transversely across the arm. The artery will be found resting upon the deep flexor, with the ulnar nerve to the ulnar side. The needle should be passed from the nerve around the artery (Fig. 346).

Ulnar Artery in the Lower Third of the Forearm. The *incision* is two inches in length, a little to the radial side of the tendon of the flexor carpi ulnaris, which is attached to the pisiform bone, ending an inch above the wrist (Fig. 343, *D*). Divide the skin and superficial fascia and open the deep fascia, and the artery will be exposed, with its accompanying veins, between the tendons of the flexor carpi ulnaris and flexor sublimis digitorum, the ulnar nerve being to the ulnar side of the vessel. The needle should be passed from within outward to avoid the nerve (Fig. 347).

FIG. 347.



Relations of right ulnar artery above the wrist. (ESMARCH.)

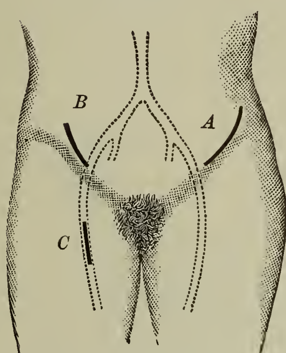
Ligation of the Interosseous Artery. The *incision* is similar to that employed in the ligation of the ulnar artery in its upper third.

Ligation of the Abdominal Aorta. The *incision* is in the linea alba from a point three inches above the umbilicus to a point three inches below it. The superficial structures being divided, the peritoneum is opened upon a director, and the intestines are pressed aside and the aorta is exposed, covered by peritoneum, with the filaments of the sympathetic nerve resting upon it and the vena cava to the right side. Tear through the peritoneum and pass the needle from right to left around the vessel. After tying the ligature the ends should be cut short and the external wound should be closed as in the ordinary cœliotomy wound.

The vessel may also be exposed by an incision along the anterior border of the quadratus lumborum muscle, from the last rib to the crest of the ilium. The skin, lumbar muscles, and fascia transversalis being divided, the wound is held open with blunt hooks, so that the retro-peritoneal space is exposed and the aorta brought into view. The vessel being separated from the vena cava and nerves, the needle is passed around it and the ligature applied.

Ligation of the Common Iliac Artery. The aorta divides into the two common iliac arteries on the left side of the fourth lumbar vertebra, and these arteries are usually about two inches in length, and bifurcate opposite the sacro-iliac synchondrosis to form the internal and external iliac arteries; the length of the common iliac artery, however, may vary considerably, being three or four inches in length in some cases.

Fig. 348.

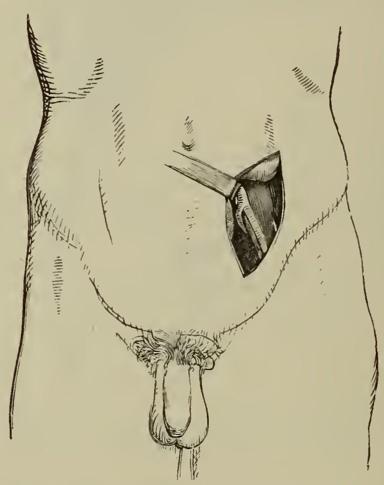


Line of incision for—*A*. Common iliac artery. *B*. External iliac artery. *C*. Femoral artery in Scarpa's triangle. (Stimson.)

The *incision* for ligation of the common iliac artery is four to six inches in length, beginning one-half inch above the middle of Poupart's ligament, and is carried outward, curving upward after passing the anterior superior spine of the ilium (Fig. 348, *A*).

Divide the skin, superficial fascia, and aponeurosis of the external oblique muscle, and then divide the fibres of the internal oblique and transversalis muscles upon a director and expose the transversalis fascia. This is opened at the lower part of the wound, and the finger is introduced and the peritoneum is pressed back; the opening in the transversalis fascia is next enlarged, and the peritoneum is carefully drawn inward and upward with the fingers toward the inner edge of the wound. The operator next feels for the external iliac artery, and passes the finger along this until the common iliac artery is reached. The loose cellular tissue in which it is embedded is next separated, and the needle is passed from within outward, to avoid the common iliac vein (Fig. 349), which on the left side lies on the inner side of the

Fig. 349.



Ligation of the common iliac artery. (Liston.)

artery, and on the right side lies behind the artery. The ureter generally remains attached to the peritoneum; if not, it is seen crossing the bifurcation of the common iliac with the genito-crural nerve, and care should be taken to avoid injury of these structures if present.

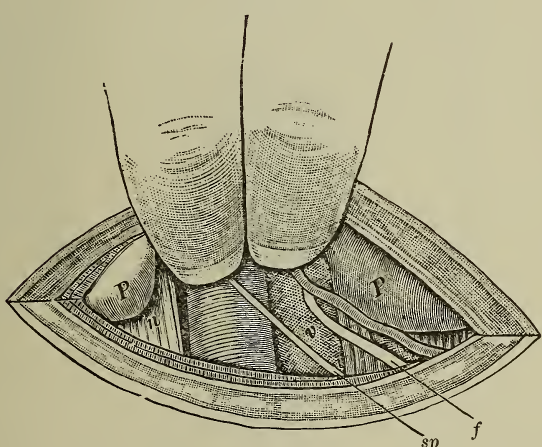
Transperitoneal Method. The common iliac artery may also be exposed and tied by an incision made over the artery through the abdominal wall opening the peritoneal cavity; the vessel being tied, the ends of the ligature are cut short, and the external wound is closed in the same manner as that resulting from the exposure of the abdominal aorta by incision through the peritoneum.

Ligation of the Internal Iliac Artery. The *incision* is in the same line as for the common iliac artery, but it need not be quite so long (Fig. 348, *A*). The peritoneum being exposed, it is pushed upward and inward, and the internal iliac artery is exposed. The vessel is carefully isolated from the vein, which lies behind and on the inner side, and the needle is passed from within outward.

The *transperitoneal* method may also be employed in exposing and ligating this vessel.

Ligation of the External Iliac Artery. The *incision* is three or four inches in length, half an inch above the

FIG. 350.



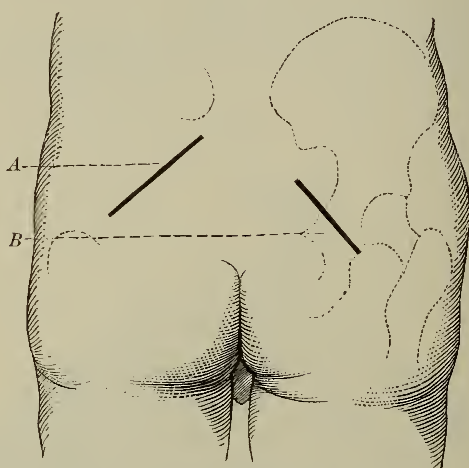
Relations of the right external iliac artery. (ESMARCH.)

middle of Poupart's ligament, made at first parallel to it and then curved upward (Fig. 348, *B*). The tissues of the abdominal wall being divided and the peritoneum exposed, it is pushed upward and inward in the same manner as for exposure of the common iliac artery. The artery lies at the inner border of the psoas muscle, the vein on its inner side and the anterior crural nerve covered by the iliac fascia on the outer side; the genito-crural nerve passes obliquely across the artery (Fig. 350). The needle should be passed from within outward.

The *transperitoneal* method may also be employed in ligating this vessel.

Ligation of the Gluteal Artery. The *incision* is three or four inches in length, from the posterior superior spinous

FIG. 351.



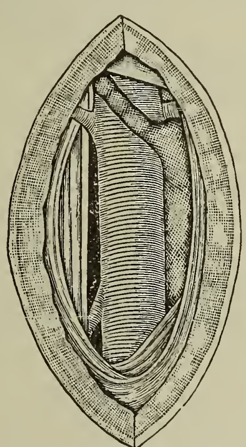
Line for—*A*. Gluteal artery. *B*. Sciatic and internal pudic artery. (STIMSON.)

process of the ilium to a point midway between the tuber ischii and the great trochanter (Fig. 351, *A*). After division of the skin and fascia, the fibres of the gluteus maximus muscle are separated and held apart and the deep fascia is divided, and the artery should then be sought for above the pyriformis muscle at the upper border of the great sacro-sciatic notch. It is accompanied by large veins, injury to which should be avoided in exposing the artery and passing the needle.

Ligation of the Sciatic and Internal Pudic Arteries. The *incision* is three or four inches in length, a little lower than that employed for exposure of the gluteal artery (Fig. 351, *B*). Divide the skin, superficial fascia, and fibres of the gluteus maximus muscle and deep fascia, and search for the vessels as they leave the great sciatic notch at the lower edge of the pyriformis muscle. The internal pudic artery enters the pelvis through the lesser sciatic notch, lying on the inner side of the sciatic artery during its passage over the spine of the ischium. The vessels are isolated and the needle is passed so as to avoid injury of the veins.

Ligation of the Femoral Artery. The femoral artery may be ligated just below Poupart's ligament, at the apex of Scarpa's triangle, at the middle of the thigh, or in Hunter's canal.

Fig. 352.

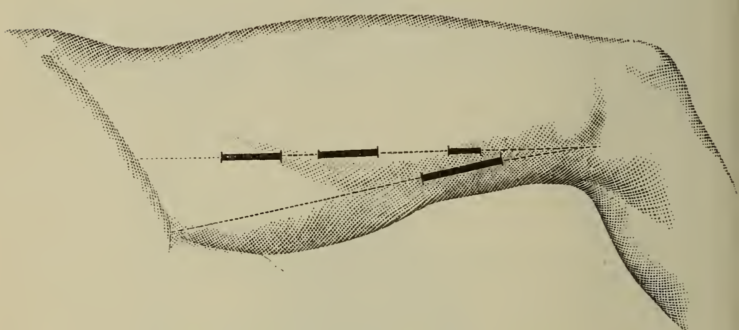


Relations of the right femoral artery below Poupart's ligament. (Esmarch.)

Femoral Artery below Poupart's Ligament. The *incision* begins midway between the anterior superior spinous process of the ilium and the symphysis pubis, one-fourth of an inch above Poupart's ligament, and extends two inches downward. Divide the skin and superficial fascia and the deep fascia so as to expose the sheath of the vessels; open this one-half an inch below Poupart's ligament and isolate the femoral artery from the femoral vein which lies to the inner side; the anterior crural nerve lies to the outer side. Pass the needle from within outward (Fig. 352).

Femoral Artery at the Apex of Scarpa's Triangle. The *incision* is three inches long, the centre of which should be a little above the point where the sartorius muscle crosses

FIG. 353.

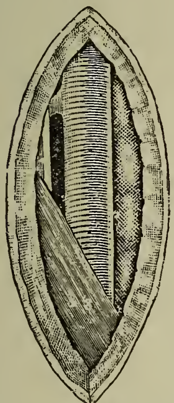


Lines of incision for the femoral artery. (STIMSON.)

a line drawn from the middle of Poupart's ligament to the inner condyle of the femur (Fig. 353). Divide the skin, superficial and deep fascia, avoiding the internal saphenous vein, and expose the edge of the sartorius muscle, which may be recognized by the direction of its fibres. This muscle is drawn outward and the sheath of the vessels is exposed and opened; the vein lies on the inner side and somewhat behind the artery, and the long saphenous nerve is on the outer side (Fig. 354). Pass the needle from within outward.

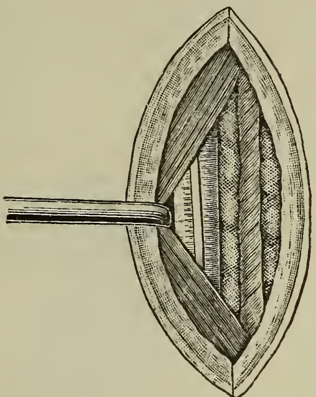
Femoral Artery in the Middle of the Thigh. The *incision* is in the line above mentioned, its centre being a little above the middle of the thigh. Divide the skin, superficial and deep fascia, and expose the sartorius muscle, which is drawn outward after the leg has been flexed; the sheath of the vessels is exposed and opened; the long saphenous nerve lies upon the artery and the femoral vein

Fig. 354.



Relations of right femoral artery at the apex of Scarpa's triangle. (Esmarch.)

Fig. 355.



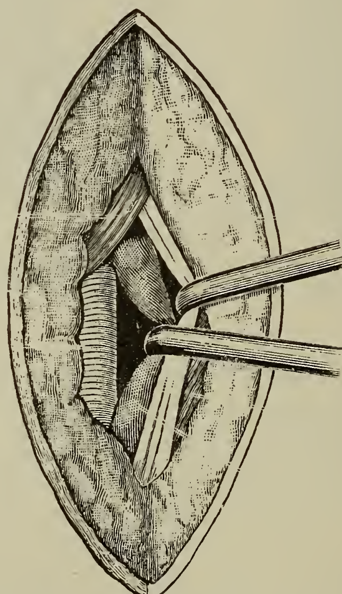
Relations of the right femoral artery in the middle of the thigh. (Esmarch.)

lies behind the artery; the saphenous vein lies more superficially and internal to the vessel. Pass the needle from within outward (Fig. 355).

Femoral Artery in Hunter's Canal. The *incision* is three inches in length along the tendon of the adductor magnus, the centre of which is at the junction of the lower and middle thirds of the thigh (Fig. 353). Divide the skin, superficial and deep fascia, care being taken not to injure the internal saphenous vein, which should be displaced, and expose the sartorius muscle, which should be displaced downward, and expose the aponeurosis which forms the anterior wall of the vascular canal; this should be opened upon a director, and the artery is uncovered and should be separated from the vein which lies upon the outer side. The needle is passed from without inward.

Ligation of the Popliteal Artery. The *incision* is three or four inches in length, along the external border of the semi-membranosus muscle. Divide the skin and superficial fascia, taking care not to injure the sapheneous vein, and open the deep fascia. The edges of the wound being held apart the adipose tissue is broken up with a director, and the internal popliteal nerve will be first exposed, and next the vein—both external to the artery (Fig. 356). The artery is isolated and the needle passed from without inward.

FIG. 356.

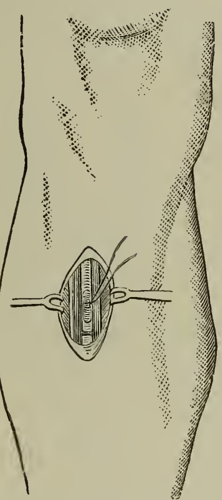


Relations of the right popliteal artery. (ESMARCH.)

Ligation of the Anterior Tibial Artery. The anterior tibial artery may be tied in the upper, middle, and lower thirds of the leg; the general direction of the artery corresponds with a line drawn from the middle of the space between the head of the fibula and the tubercle of the tibia to the middle of the anterior intermalleolar space.

Anterior Tibial Artery in the Upper Third of the Leg. The *incision* is two and a half to three inches in length, one and one-fourth inches external to the spine of the tibia. Divide the skin and superficial fascia, and when the deep fascia is exposed open it on a line corresponding to the intermuscular space between the tibialis anticus and the

FIG. 357.



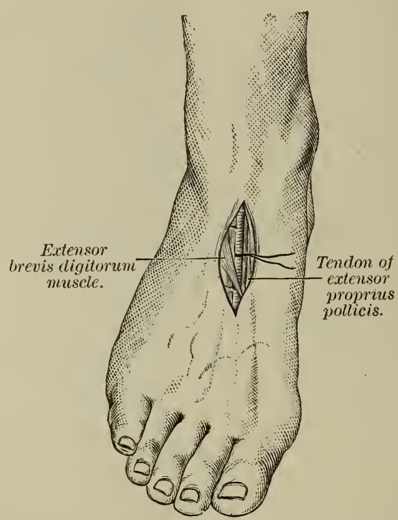
Ligation of the anterior tibial artery at its upper third. (STIMSON.)

extensor longus digitorum muscles. Separate the muscles and work down in this interspace until the artery is found with a vein on either side of it, and the anterior tibial nerve externally (Fig. 357). The needle should be passed from without inward after isolating the veins.

Anterior Tibial Artery at its Middle Third. The *incision* is three inches in length in the same line as that for the upper portion of the vessel. After dividing the skin, superficial and deep fascia, the interspace between the tibialis anticus and the extensor longus digitorum muscles is opened and a third muscle comes into view, the extensor proprius pollicis. The artery lies between the extensor proprius pollicis and the tibialis anticus muscles; and the anterior tibial nerve is to the outer side. The veins should be isolated and the needle should be passed from without inward.

Anterior Tibial Artery in its Lower Third. The *incision* is two inches in length, beginning three inches above the ankle-joint on the line of the artery. Divide the skin, superficial and deep fascia, and seek for the tendon of

Fig. 358.



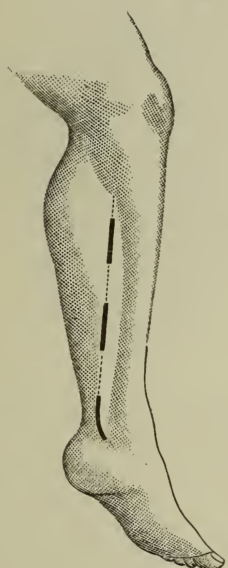
Ligation of the dorsalis pedis artery. (Bryant.)

the extensor proprius pollicis muscle, the second tendon from the tibia. The artery is found in the interspace between this tendon and the tendon of the extensor longus digitorum muscle, the nerve being to the outer side. The veins are isolated from the artery, and the needle is passed from without inward.

Ligation of the Dorsalis Pedis Artery. The *incision* is one inch in length on a line drawn from the middle of the anterior intermalleolar space to a point midway between the extremities of the first two metatarsal bones or along the outer border of the tendon of the extensor proprius pollicis. Divide the skin, superficial and deep fascia, and the artery will be found lying next to the inner tendon of the short extensor muscle of the toes (Fig. 358). The nerve is to the outer side. After separating the veins the needle is passed from without inward.

Ligation of the Posterior Tibial Artery. The course of the posterior tibial artery is indicated by a line drawn

FIG. 359.



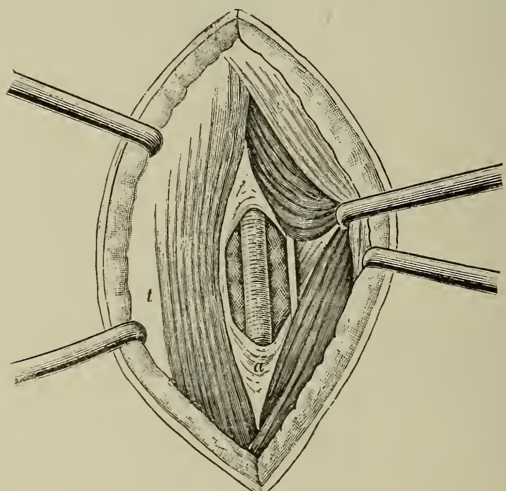
Lines of incision for the posterior tibial artery. (STIMSON.)

from the middle of the popliteal space to a point midway between the tendo-Achillis and the internal malleolus of the tibia.

The posterior tibial artery may be ligated in its upper, middle, and lower thirds.

Posterior Tibial Artery at its Upper Third. The *incision* is three inches and a half in length, one-half inch from the inner edge of the tibia, beginning two inches from the upper edge of the bone (Fig. 359). Divide the skin and superficial fascia, avoiding large superficial veins; next open the deep fascia and detach the origin of the soleus muscle from the tibia, and on raising it the under surface

Fig. 360.



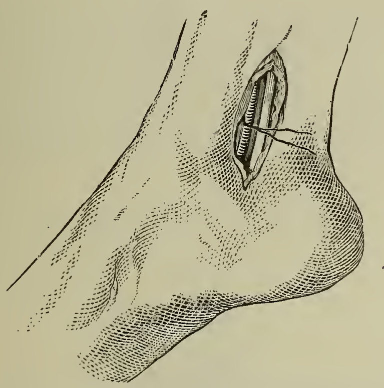
Relations of the right posterior tibial artery in its upper third. (Esmarch.)

will present a white, shining sheath of tendinous material, beneath which will be seen a layer of fascia covering the tibialis posticus muscle. If search is made toward the middle of the leg the artery will be found covered by the intermuscular fascia, the nerve being to the outer side. The needle is passed from without inward after the veins have been separated from the artery (Fig. 360).

Posterior Tibial Artery at its Middle Third. The *incision* is two and a half inches in length, parallel with the inner edge of the tibia and half an inch from its border. Divide the skin, superficial and deep fascia, and the inner edge of the soleus will be exposed; press this outward and the artery with its veins will be exposed, also the posterior tibial nerve to the outer side. Pass the needle from without inward after separating the veins.

Posterior Tibial Artery Behind the Inner Malleolus. The *incision* is a curved one two inches in length, midway between the tendo-Achillis and the internal malleolus (Fig. 359). Divide the skin and superficial fascia, then lift

FIG. 361.



Ligation of the posterior tibial artery behind the inner malleolus. (BRYANT.)

the deep fascia upon a director and open it freely, when the artery will be exposed, with the tendons of the tibialis posticus and flexor longus digitorum muscles on the inner side and the posterior tibial nerve and the tendon of the flexor longus pollicis muscle on the outer side (Fig. 361). After separating the veins from the artery the needle should be passed from without inward.

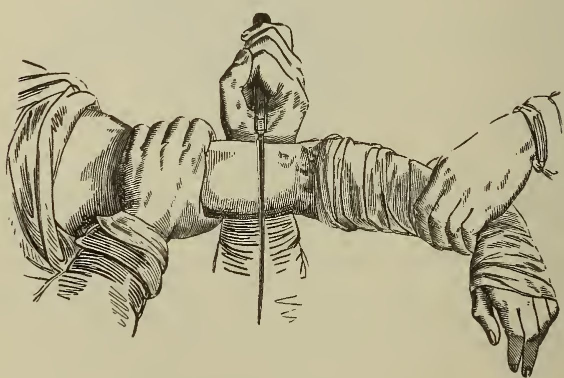
PART VI.

AMPUTATIONS.

THE term amputation is now generally applied to the removal of a limb, and this may be removed through the bones, when the operation is spoken of as an amputation in the *continuity* of the limb; or it may be removed through its joints, and it is then known as an amputation in the *contiguity* or a disarticulation.

Methods of Amputating.

FIG. 362.



Amputation by circular method. (DRUITT.)

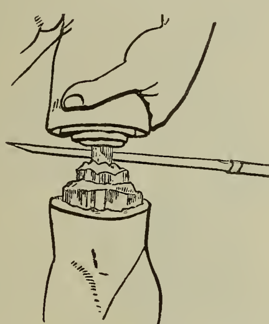
Amputations may be performed by the *circular*, *flap*, *oval*, and *elliptical* methods; and the *modified circular* operation and *Teale's method* by rectangular flaps are also employed.

Circular Method. In performing an amputation by this method the incision of the skin is made at a distance below the point where the bone is to be divided. An assistant grasps the limb and draws the skin evenly and firmly toward the root of the part and the surgeon passes the heel of the knife well into the tissues and makes a circular sweep around the limb and completes the division of the skin and cellular tissue with one motion of the knife (Fig. 362).

In some cases a cutaneous sleeve, consisting of the skin and cellular tissue, is dissected up and turned back, and sometimes it may be necessary to make a slit on one side of the flap, to allow it to be turned up.

The second incision in an amputation by the circular method consists, after retraction of the skin, in making a circular cut through all of the tissues down to the bone (Fig. 363).

FIG. 363.

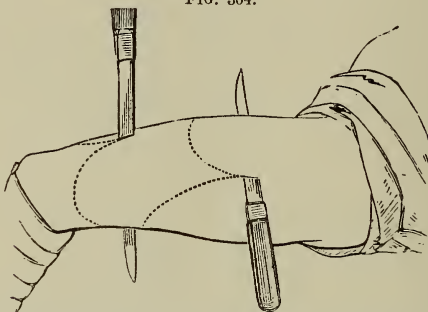


Division of muscles in circular amputation. (SMITH.)

The third step in an amputation by the circular method consists, after retracting the skin and muscles and holding them back by a retractor, in the division of the bone with a saw.

Flap Method. This method of amputating is susceptible of many variations. There may be one or two flaps of equal or unequal length ; the flaps may be cut antero-posteriorly, laterally, or obliquely (Fig. 364). They may be made by transfixing the limb and cutting outward, or

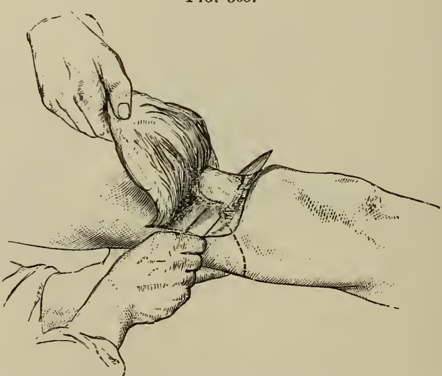
Fig. 364.



Double-flap amputation ; antero-posterior and lateral flaps. (Smith.)

they may be cut from without inward; they may be made to include the whole thickness of the tissues down to the bone, or merely the skin and superficial fascia, the deeper

Fig. 365.



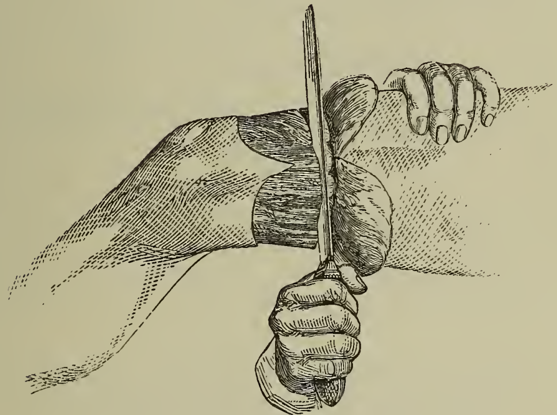
Amputation by antero-posterior flaps. (Bryant.)

structures being divided by a circular incision. The flaps may have a curved outline or may be rectangular in shape.

In amputating by the antero-posterior flap operation the surgeon grasps the limb and enters the point of a long knife into the tissues at the side nearest himself, and pushing it across and round the bone or bones brings its point out through the skin at a point diametrically opposite its point of entrance. He then shapes the flap by cutting downward with a rapid sawing motion and then cuts obliquely forward until all the tissues are divided. The flap being turned up, he re-enters his knife at the same point and passes it on the other side of the bone or bones and cuts the second flap in the same manner (Fig. 365). A retractor is next applied and the bone is divided with a saw.

The Oval Method. The oval amputation is really a circular one, in which the cuff of skin has been slit at one

FIG. 366.



Modified circular amputation. (SKEY.)

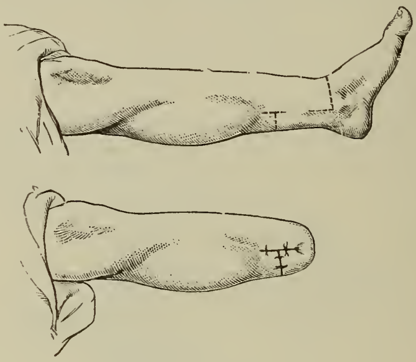
side and the angles rounded off. This is the form of amputation frequently performed at the metacarpo-phalangeal and metatarso-phalangeal joints, and is one of the methods of amputation at the shoulder-joint.

Elliptical Method. This is a form of the oval method of amputation which is employed in amputations at the knee-joint and elbow-joint, the incision forming an ellipse, coming below the joint on the front or outside of the limb, the resulting flap being folded upon itself.

Modified Circular Method. In this method of amputation two oval skin flaps, antero-posterior or lateral, are turned up, and the muscles are next divided by a circular sweep of the knife down to the bone (Fig. 366).

Teale's Method by Rectangular Flaps. In this method of amputation two flaps are made of unequal length; the incisions are so planned that the shorter flap contains the main vessel or vessels. The flaps are cut of equal width and the length of the long flap should be one-half of the

FIG. 367.



Teale's method of amputation. (BRYANT.)

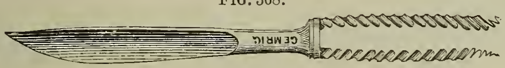
circumference of the limb at the point where the bone is to be divided; the length of the short flap should be one-eighth of the circumference of the limb. The flaps are cut from without inward, and embrace all of the tissues of the limb down to the bone. After the flaps have been dissected up the bone is divided with a saw, and the long flap is folded over and sutured to the short flap (Fig. 367). The disadvantage of this method of amputation is that in muscular limbs it requires the bone to be divided at a higher point than would otherwise be necessary.

Periosteal Flaps. In any of the methods of amputation previously described the periosteum may be dissected up in two flaps attached to the muscles, or pushed up as a sleeve by means of a director or periosteotome before the bone is sawed. This procedure is most easily accomplished in young subjects. When these flaps are made and are brought together, the periosteum covers the cut surface of the bone, to which it soon forms adhesions.

Instruments Required for Amputations. The instruments required for amputations are knives of various shapes and sizes, saws, dissecting forceps, bone forceps, artery forceps, tenacula, hæmostatic forceps, scissors, periosteotomes, tourniquets, Esmarch's bandage and strap, retractors, ligatures, sutures, and needles.

Amputating Knives. The knives required for amputations vary according to the method of amputation and the part to be amputated. In certain amputations a scalpel

Fig. 368.



Scalpel.

(Fig. 368) or straight bistoury (Fig. 369) may be used, while in other cases the employment of amputating knives of various sizes will be found more satisfactory. For amputations of the thigh a knife with a blade of eight or

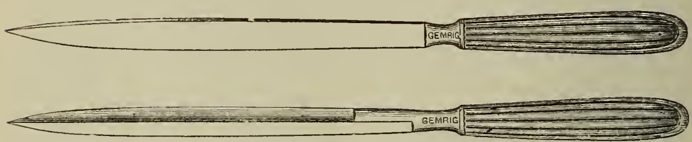
Fig. 369.

Straight bistoury.

nine inches is generally employed, and for smaller limbs a knife with a blade of six or seven inches in length; double-edged catlins are employed in amputations of the leg and forearm, to divide the interosseous tissues before applying the saw. The amputating knives now employed are constructed with solid metal handles, so that they can be rendered thoroughly aseptic by immersion in boiling water before being used (Fig. 370).

Amputating Saws. Several kinds of amputating saws are in general use; one with a blade ten inches long by two and a half inches wide, with a heavy back to give it

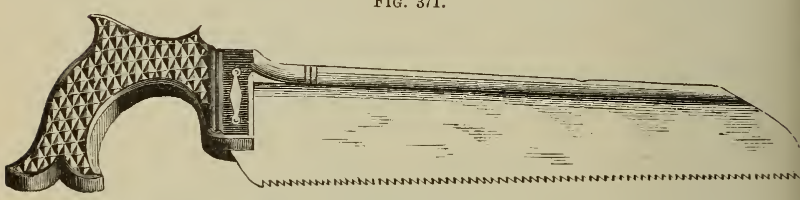
FIG. 370.



Amputating knife and catlin.

additional firmness, is a very good variety of saw (Fig. 371). For amputations about the foot or hand a narrow

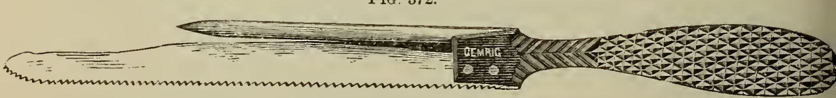
FIG. 371.



Amputating saw.

saw with a movable back will be found very convenient (Fig. 372). A bow saw with a metallic handle and a

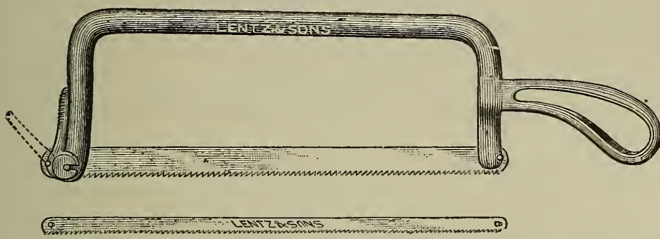
FIG. 372.



Small amputating saw.

reversible blade is a very useful variety of saw, as it can be used either in amputations or in excisions, and, being constructed entirely of metal, it can be easily rendered aseptic (Fig. 373).

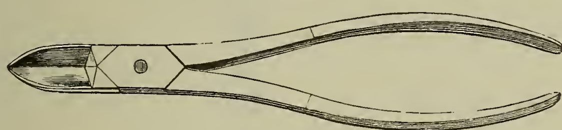
FIG. 373.



Amputating saw with reversible blade.

Bone-forceps, or Cutting Pliers. These instruments are used in smoothing off any rough edges of bone left after the use of the saw, or for the division of the small bones

FIG. 374.

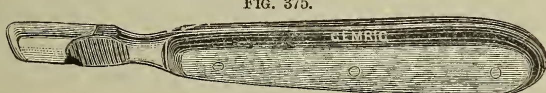


Bone-forceps, or cutting pliers.

in amputations of the fingers and toes. The forceps should be from ten to twelve inches in length, with blades from one to one and a half inches in length (Fig. 374).

Periosteotome. The periosteotome, or raspatory, is employed for dissecting up a flap of periosteum, which, after

FIG. 375.



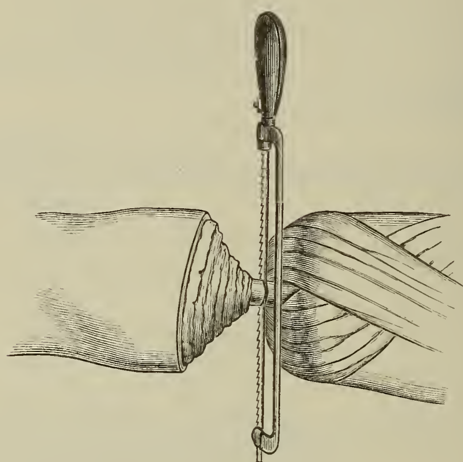
Periosteotome.

sawing the bone, is drawn down over the sawed end of the bone (Fig. 375).

Artery Forceps and Tenacula. These instruments are used for taking up the vessels, and one of the best forms of artery forceps is that known as the double-spring artery forceps (Fig. 226). Tenacula are also employed for the same purpose (Fig. 227). *Hæmostatic forceps* will also be found most useful in cases of amputation, for the rapid control of hemorrhage from small vessels after the tourniquet has been removed, the vessels being secured by torsion or by ligatures before the hæmostatic forceps are removed.

Retractors. These consist of pieces of muslin six or eight inches in width, one end of which is split into two or three tails; the former variety of retractor is employed where one bone is divided, as in amputations of the arm and thigh, and the latter in cases where two bones are divided, as in amputations of the forearm and leg (Fig. 376).

Fig. 376.



Retractor applied. (Esmarch.)

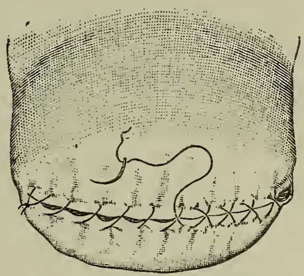
Ligatures. The best material to employ for the ligature of vessels is plain or chromicized catgut or sterilized silk, the preparation of which has been described (p. 134).

Sutures. The materials employed for sutures in cases of amputation may be silkworm-gut, catgut, silk, or silver wire; deep or buried sutures of catgut, in bringing together the edges of the periosteal flaps, muscles, and fascia, are often employed with advantage in amputations (Fig. 377), the skin flaps being brought together with interrupted or continuous sutures of silk, catgut, silkworm-gut, or silver wire (Fig. 378).

FIG. 377.

Deep or buried sutures of muscles.
(ESMARCH.)

Fig. 378.



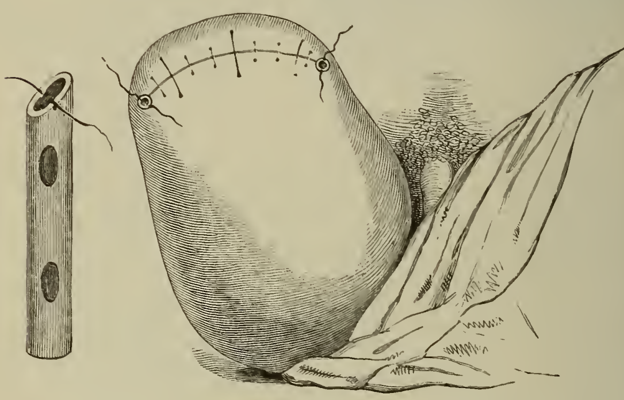
Sutures of the skin.
(ESMARCH.)

Tourniquets. For the control of hemorrhage during the amputation the Esmarch apparatus (Fig. 225) or Petit's tourniquet (Fig. 219) is employed; or the employment of both at the same time will often be found most satisfactory. The Esmarch bandage and tube being applied, after removal of the bandage, the tourniquet of Petit is loosely applied at a higher point, and after the main vessels have been secured the elastic strap is removed, and the tourniquet is screwed down and controls the bleeding until the smaller vessels have been secured by ligatures. Wyeth's pins may be used in conjunction with the elastic strap in amputations at the hip-joint and shoulder-joint.

Details of an Amputation. The following are the steps of an amputation of the lower part of the thigh :

The skin is first thoroughly cleansed by rubbing it with turpentine, soap and water, and alcohol. It is then washed with a solution of bichloride of mercury, 1 : 2000. Provision is next made to prevent the loss of blood during the operation by the application of Esmarch's bandage and tube; the bandage being removed a tourniquet is placed over the femoral artery in Scarpa's triangle and loosely secured. The limb is again washed with bichloride solution. The instruments having been previously thoroughly sterilized, a rubber cloth covered with towels wrung out in a bichloride solution is placed under the limb. The variety of amputation having been decided upon, the flaps are cut and the muscles are divided down to the bone; the periosteum being dissected up, a two-tailed retractor is applied, and the tissues are held back by an assistant while the surgeon divides the bone with the saw. When the bone has been divided the retractor is removed, and the

FIG. 379.



Stump showing application of sutures and drainage-tubes. (SMITH.)

surface of the wound is irrigated with a 1 : 2000 bichloride solution. The femoral artery and vein are next found and secured with ligatures, and any branches which can be found are also secured. The elastic strap is removed after screwing down the tourniquet, and by gradually letting up the pressure on the smaller vessels which bleed, are picked up with artery forceps or hæmostatic forceps and secured. After all bleeding has been controlled the tourniquet is removed, and the wound is again thoroughly irrigated with a 1 : 2000 bichloride solution. If there is much oozing from the smaller vessels, this solution should be as hot as the hands of the operator can comfortably stand, which will act promptly in controlling this variety of bleeding. The periosteal flaps, if they have been made, are brought together by two or three catgut sutures, and a drainage-tube is next introduced, or two short tubes are introduced at either extremity of the wound and secured by sutures or safety-pins; the muscles should next be brought together by a few deep or buried sutures of catgut, and the skin flaps should then be brought into apposition by a number of interrupted sutures (Fig. 379). The inner surface of the stump is next irrigated by a stream of bichloride solution introduced through the drainage-tube, and the surface of the stump is washed with the same solution; a piece of protective or silver foil is next placed over the line of the wound, and over this is placed a moist bichloride gauze dressing, and over this a number of layers of dry gauze; this is next covered by rubber-tissue and a number of layers of bichloride cotton, or, if the dry method of dressing is preferred, the rubber-tissue is omitted and a number of layers of bichloride cotton are laid over the gauze dressing, and the whole dressing is held in place by a recurrent bandage of the stump.

If the *aseptic* method is employed, no antiseptic solutions are brought in contact with the wound, sterilized water only being used if it is necessary to flush the wound, and after bringing the flaps together a sterilized gauze dressing is applied.

Re-dressing of Amputations. The first dressing of an amputation, if strict antiseptic precautions have been observed at the time of operation, need not, as a rule, be made for a week or ten days, except in cases where the oozing is so profuse as to soak the dressings, or where consecutive hemorrhage has occurred, or the patient's condition shows that the wound is not running an aseptic course. The re-dressing of a stump can be accomplished without pain to the patient if the surgeon and his assistants are careful in their manipulations.

The dressings to be applied, the solutions for irrigation, and the instruments required should be prepared and at hand before the stump is exposed. The surgeon and his assistants should wash their hands carefully, and then soak them in a 1 : 2000 bichloride solution. The bandage retaining the dressings to the stump should be divided with bandage scissors without lifting the stump from the pillow upon which it rests. After the bandage has been divided and turned aside, the gauze dressing is next unfolded and turned down; an assistant now slips his hands under the stump and gently raises it from the dressings, and at the same time a rubber cloth covered with towels which have been wrung out in a 1 : 2000 bichloride solution is slipped under the stump and the soiled dressings are removed. The protective covering the incision is next removed and the surface of the stump is irrigated with a 1 : 2000 bichloride solution; the drainage-tubes are next examined and the cavity of the stump irrigated with the bichloride solution through the tubes by means of a syringe or an irrigating apparatus, or the irrigation may be omitted.

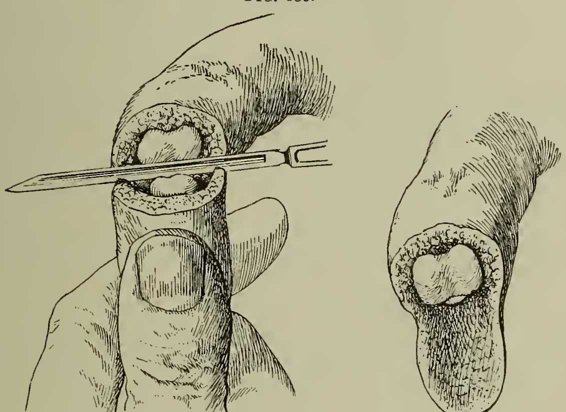
If the wound is aseptic and there seems to be no further indication for the use of the drainage-tubes, they may be removed. The sutures are next examined, and if the wound is firmly healed alternate sutures may be removed; if catgut or silkworm-gut sutures have been used, they need not be disturbed at this dressing, and their removal may be postponed until a subsequent dressing.

The wound should next be covered with a gauze dressing consisting of a number of layers, and over this several layers of bichloride cotton, and the dressings should be held in place by a recurrent bandage of the stump. In holding the stump the assistant should hold it firmly to prevent muscular spasm, and after the dressings have been secured it should be placed upon a clean pillow prepared for its reception. The same procedures are adopted at subsequent dressings, and if the wound has run an aseptic course, two or three dressings, at most, will be required.

Amputations of the Hand.

Amputations of the Fingers. The fingers may be amputated in the continuity of the phalanges or in their contiguity, and, as a rule, as it is important to save as much as possible of the finger, the former method is generally to be employed instead of disarticulation at a higher point. The incision should be so planned that the cicatrix does not occupy the palmar surface; the larger flap should, therefore, be taken from the palmar aspect of the finger. In amputating the phalanges of the fingers in their *continuity*, the circular method (Fig. 384, *B*) or a short dorsal flap and a long palmar flap may be employed. In *disarticulating* a phalanx it is best to enter the joint with a narrow knife from the dorsal side, and after having carried it through the joint, to cut a long palmar flap, keeping close to the bone (Fig. 380). In

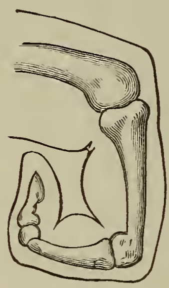
FIG. 380.



Amputation of a finger by the long palmar flap. (After ESMARCH.)

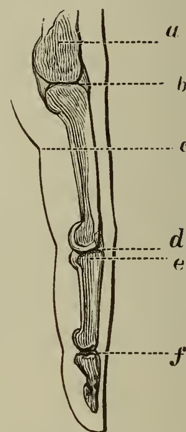
locating the position of the phalangeal joints, it is well to remember that the prominence of the knuckle when the finger is flexed is formed entirely of the head of the proximal and not of the base of the distal phalanx (Fig. 381), and also that the folds on the palmar surface of the finger do not correspond exactly to the joints (Fig. 382).

Fig. 381.



Phalanges flexed.

Fig. 382.

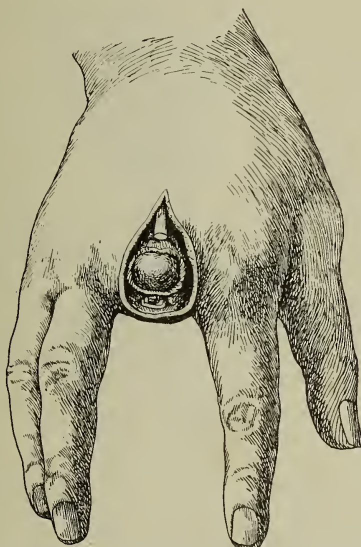


Guides to articulations of the fingers. (Smith.)

Amputation of the Finger through the Metacarpo-phalangeal Articulation. In this variety of amputation an incision is made from a point on the dorsal surface of the metacarpal bone a quarter of an inch above the articulation, which is carried through the interdigital web and back upon the palmar surface to a point a quarter of an inch above the flexor fold (Fig. 384, *C*). A similar incision beginning and ending at the same points is made upon the opposite side of the finger. The flaps are dissected back, and the lateral ligaments, tendons, and remainder of the capsule are divided (Fig. 383). The finger may also be amputated at the metacarpo-phalangeal joint by making an incision on one side and dissecting the flap back to the joint, then dividing the lateral ligament, opening the joint and carrying the knife across this, dividing the tendons and lateral ligament on the other side and cutting a flap from within outward.

Removal of the head of the metacarpal bone if desired may be accomplished by the use of cutting pliers (Fig. 385); but, as a rule, this procedure is not to be recommended, for, although the deformity is lessened, the strength of the hand is diminished.

FIG. 383.



Racket-shaped incision for amputation of the finger at metacarpo-phalangeal joint. (After ROTTER.)

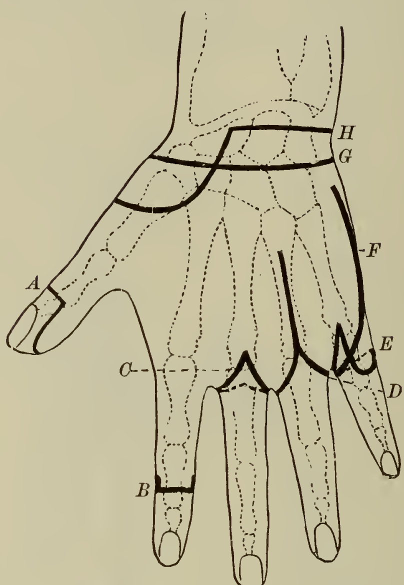
In amputating the *little* and *index* fingers a full lateral flap may be cut on the free side and an incision is next carried across the palmar surface to the angle of the web and thence back to the joint, which is opened and the disarticulation effected (Fig. 384, *E*).

Amputations of the Metacarpal Bones. In amputating the metacarpal bones it is advisable to leave the carpal ends of the bones to avoid opening the wrist-joint, except in the case of the first and fifth metacarpal bones,

30

which do not communicate with the others and with the synovial sacs.

FIG. 384.

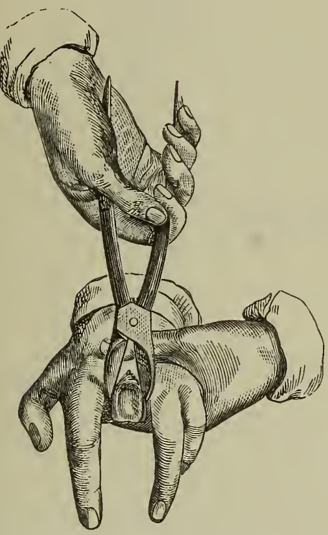


A. Disarticulation of phalanx; palmar flap. *B*. Amputation in continuity by a circular flap. *C*. Metacarpo-phalangeal disarticulation. *D*. Amputation of metacarpal bone in continuity. *E*. Disarticulation of little finger. *F*. Disarticulation of fifth metacarpal bone. *G*. Amputation at the wrist, circular. *H*. Amputation at the wrist, lateral. (STIMSON.)

The incisions for the removal of the metacarpal bones are the same as for the removal of a finger at the metacarpo-phalangeal joint, the incision being prolonged backward as far as necessary over the dorsal surface of the bone (Fig. 384, *D*). After the metacarpal bone has been bared for a sufficient distance, it is cut through with bone-pliers or disarticulated, and the distal end is raised from its bed and carefully separated from the soft parts, care being taken to avoid injury of the structures of the palm of the hand.

In amputating the *fifth* metacarpal bone the incision should be made along the inner border of the hand and carried down to the bone between the skin and the ab-

FIG. 385.

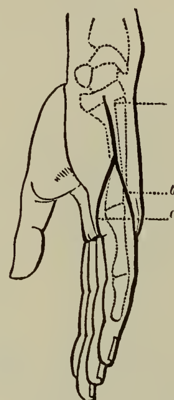


Removal of the head of a metacarpal bone. (SKEY.)

ductor minimi digiti muscle (Fig. 386). The lower end of the incision passes over the knuckle to the web of the finger, and backward under the palmar surface to join the first incision.

Amputation of the entire *thumb* with its metacarpal bone is effected by making an oval flap from the palmar surface; in the case of the left thumb the joint may be opened by an oblique incision on the dorsal surface of the hand, beginning a little in front of the joint and being carried down to the web between the thumb and forefinger; the palmar flap is then made by thrusting the knife upward to its point of entrance and cutting downward and outward. In amputating the right thumb with its metacarpal bone it is better to make the palmar flap first by transfixion, the dorsal flap being made subsequently.

FIG. 386.



Incision for removal of the fifth metacarpal bone. (SMITH.)

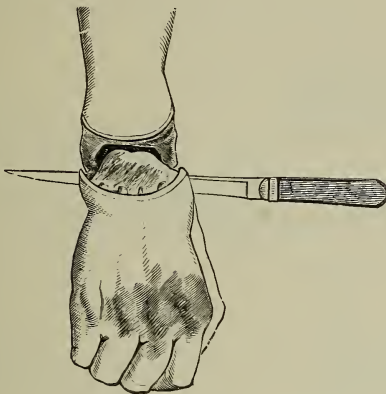
Amputation of the hand at the carpo-metacarpal joint is occasionally performed, or between the rows of carpal bones; but is not, as a rule, to be recommended, as the carpal bones are apt subsequently to become diseased and require removal; it is, therefore, better to amputate at the radio-carpal joint.

Amputations at the Wrist.

Circular Method. The skin of the forearm near the wrist being retracted by an assistant, a circular incision of the skin and cellular tissue is made half an inch below the point of the styloid process of the radius (Fig. 384, *G*). The skin and cellular tissue are next dissected back as far as the joint, which is opened and the disarticulation is completed.

Antero-posterior Flap Method. This method is also employed in amputations at the wrist-joint; an incision curved downward is made on the back of the hand from one styloid process to the other; the hand being flexed the tendons are divided and the joint opened, and the palmar flap, which should extend as far as the base of the metacarpal bones, is cut from within outward (Fig. 387).

FIG. 387.



Amputation at the wrist. (ERICHSEN.)

Amputation at the wrist is sometimes performed by cutting a single flap from the palm, the joint being opened by a transverse incision on the back of the hand from one styloid process to the other.

Lateral Flap Method. This method (Fig. 384, *H*) is also sometimes employed in amputation at the wrist, and may be employed with advantage in cases of laceration of the hand, in which the injury to the tissues prevents the formation of the flaps used in the other methods of amputation.

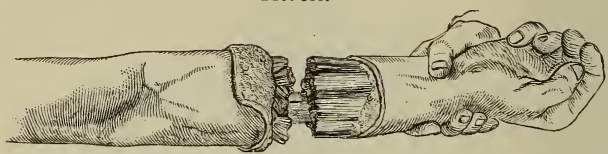
Amputations of the Forearm.

The forearm may be amputated by the circular or flap methods, or by making rectangular flaps (Teale's method).

Circular Method. At the lower portion of the forearm the circular method of amputation is to be preferred. A circular incision of the skin and cellular tissue is made and a cuff is dissected up, the muscles and interosseous membrane being cut through; a three-tailed retractor is next applied and the bones are divided with a saw.

Oval Method. Amputation of the forearm by the oval or mixed method, which consists in first dissecting up two antero-posterior oval flaps of skin and cellular tissue and then dividing the muscles by a circular incision, is also a satisfactory operation (Fig. 388).

FIG. 388.



Amputation of the forearm by the modified circular method. (BRYANT.)

In amputation at the upper portion of the forearm, *antero-posterior* or *lateral* flaps, cut from without inward or by transfixion, or *rectangular* flaps may be made with advantage.

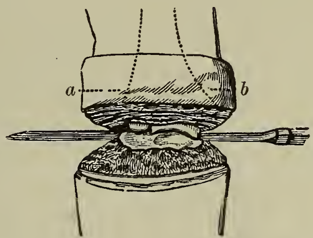
Amputations at the Elbow.

The methods of amputation employed at the elbow are the anterior flap, lateral flap, circular, and elliptical.

Anterior Flap Method. A flap of three inches in length, with its base parallel to and half an inch below the condyles of the humerus, is cut either by transfixion or from without inward. The joint is next opened and the lateral ligaments divided. The olecranon is then exposed and the attachment of the triceps muscle separated and a posterior flap is cut from without inward, or from within outward, a little below the line of the condyles (Fig 389, *A*).

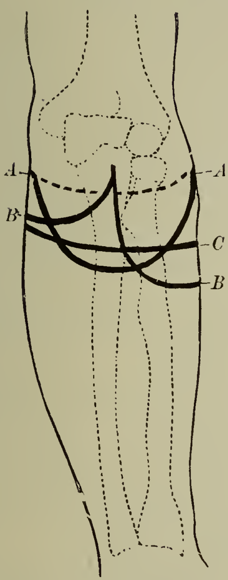
Lateral Flap Method. In amputation at the elbow-joint lateral flaps may be employed, cut either from without inward or by transfixion (Fig. 389, *B*). An external flap three inches in length is made on the outer side of the forearm, starting from a point a finger's breadth below the bend of the elbow, by transfixion or by cutting from without inward; a shorter internal flap is next cut in the same manner, and the joint is opened and the disarticulation is effected.

Fig. 390.



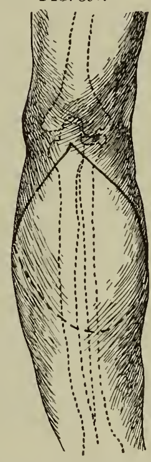
Circular amputation at the elbow. (Smith.)

Fig. 389.



Amputation at the elbow-joint. *A.* Anterior flap method. *B.* External flap method. *C.* Circular method. (Stimson.)

Fig. 391.



Incision for elliptical amputation at the elbow. (After Treves.)

Circular Method. An incision dividing the skin and cellular tissue is made around the limb three inches below the line of the condyles of the humerus (Fig. 389, *C*), the skin is dissected up and a circular incision made through the muscles, the joint is opened and the disarticulation is effected (Fig. 390).

Elliptical Method. In this method of amputating at the elbow an incision is carried from the olecranon process downward and forward to a point a little above the middle of the forearm. The incision is then continued across the anterior aspect of the limb, and is carried back to the olecranon process (Fig. 391). The incision involves only the skin and the cellular tissue. The flap having been dissected up for a short distance, the soft parts close to the joint are transfixed; the muscles are cut obliquely, so that an anterior flap is formed. This flap is held up, the bones are disarticulated, the attachment of the triceps tendon to the olecranon is divided, and any tissues which have escaped division along the posterior aspect of the limb are severed. After the vessels have been secured the flap is turned over and sutured, and a curved cicatrix on the posterior aspect of the limb results.

Amputations of the Arm.

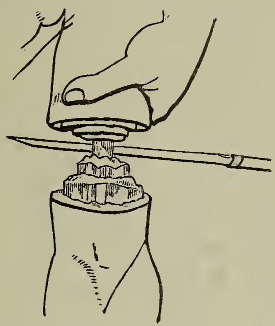
The arm may be removed at any point below the attachment of the muscles at the axilla, by either the circular, flap, oval, or modified circular methods.

Circular Method. This operation is usually employed in removing the arm in its lower third: a circular incision of the skin and subcutaneous tissue is first made, and when the cuff has been dissected up a circular division of the muscles is made, and after applying the retractor the bone is sawed through (Fig. 392).

Flap Method. From the central position of the bone in the arm the flap method in amputating the arm is preferred by many operators. The arm being grasped by the hand the point of a medium-sized amputating knife is thrust through the arm so as to pass over the humerus and make its exit at a corresponding point in the skin on the opposite side; a flap of sufficient length is cut from within outward. The knife is next passed behind the bone and a posterior flap is cut in the same manner (Fig.

393); the bone is next cleared of muscular tissue, the flaps are retracted, and it is divided with a saw.

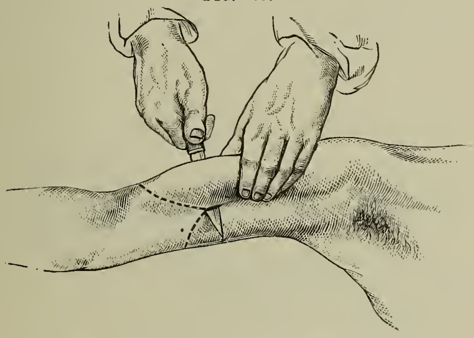
FIG. 392.



Circular amputation of the arm. (SMITH.)

Lateral flaps may be made in this amputation in the place of the antero-posterior flaps, and they may be cut from within outward in the same manner.

FIG. 393.

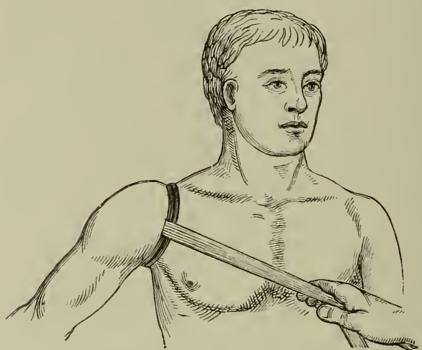


Amputation of the arm by flap operation. (BRYANT.)

Modified Oval Method. This method of amputating the arm is also employed with advantage. Two oval flaps of skin and cellular tissue are cut and dissected up, and the muscles are next divided by a circular sweep of the knife.

In high amputations of the arm there is sometimes not room enough to apply Esmarch's strap or a tourniquet to the arm itself to control the hemorrhage during the opera-

Fig. 394.



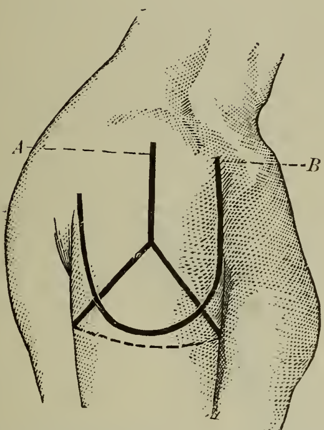
Esmarch's strap applied in high amputation of the arm. (Smith.)

tion, and in such cases the strap may be passed from the axilla around the outer end of the clavicle, as is done to control the bleeding during amputation at the shoulder-joint (Fig. 394), or Wyeth's pins may be employed.

Amputations at the Shoulder-joint.

Several methods of operation are employed in amputating at the shoulder-joint, such as the oval or Larrey's method, flap method, as Lisfranc's and Dupuytren's methods, and Spence's method (Fig. 395). The control of the bleeding from the axillary artery during the operation is a matter of the first importance, and it may be arrested by pressure made upon the subclavian artery, as it crosses the first rib, with the thumb, or the padded handle of a large key, or by the fingers of an assistant grasping the axillary flap and compressing the vessel after the head of the bone has been disarticulated, or by the use of an elastic strap applied around the axilla and shoulder (Fig. 394).

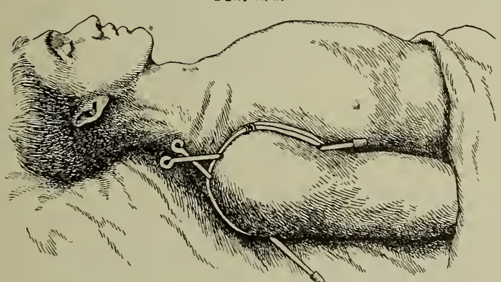
FIG. 395.



Amputation at the shoulder-joint. *A.* Oval, or Larrey's method. *B.* Double-flap, or Dupuytren's method. (STIMSON.)

Wyeth's pins may also be employed with an elastic tube or strap to control bleeding during amputation at the

FIG. 396.

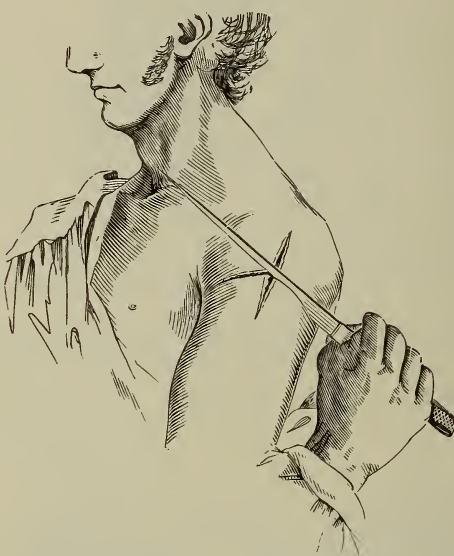


Method of applying Wyeth's pins.

shoulder-joint. The anterior pin is passed through the anterior fold of the axilla, and is brought out in front of the acromion, the posterior pin is passed through the posterior fold of the axilla and is brought out behind the acromion, the rubber strap or tube is then wrapped around the shoulder behind the pins and controls the hemorrhage during the operation (Fig. 396).

Oval, or Larrey's Method. In this method of amputation the point of the knife is entered just below the acromion process and a deep incision three inches in length is

Fig. 397.

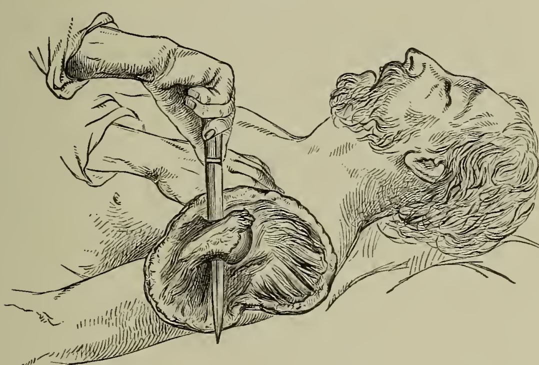


Amputation at the shoulder-joint by Larrey's method.

made down to the head of the bone along the axis of the arm; from the middle of this incision two others are made obliquely downward to the points where the anterior and posterior folds of the axilla end in the tissues of the arm; the latter incisions should be only deep enough to divide the skin and superficial fascia (Fig 395, *A*). The flaps are then dissected up until the head of the bone is well exposed, and, after opening the capsule and dividing the muscles inserted into the neck and tuberosities of the humerus, which division may be facilitated by rotating the head of the bone outward and inward, the disarticulation is effected by adducting the elbow; the knife is next passed downward behind the bone and made to cut outward in the line of the cutaneous incisions—an assistant controlling the artery before it is divided by grasping the axillary tissues behind the knife with his fingers.

Flap, or Dupuytren's Method. In this method of amputation at the shoulder-joint the flaps may be cut either by transfixion or from without inward; the large flap embraces the greater part of the deltoid muscle (Fig. 395, *B*), and the smaller or short flap is cut from the inside

Fig. 398.

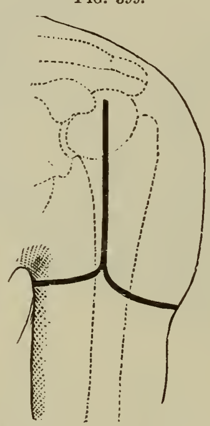


Amputation at the shoulder-joint. Dupuytren's method. (Bryant.)

of the arm after the head of the bone has been disarticulated. When cut by transfixion, the point of the knife should be entered an inch in front of the acromion process and pushed across the outer aspect of the head of the humerus, and should be brought out at the posterior fold of the axilla; the knife is made to cut downward until a large deltoid flap is formed. This flap is turned up, and the head of the bone is disarticulated; the knife being placed behind it, a short flap is formed, keeping close to the bone, so that the vessels are divided with the last cut of the knife (Fig. 398). An assistant should control the vessel by grasping the axillary tissues with his fingers behind the knife.

Double Flap, or Lisfranc's Method. In this method of amputation at the shoulder-joint the point of the knife is entered at the outer side of the coracoid process, and is carried across the outer aspect of the head of the humerus and brought out a little below the posterior border of the acromion process, and a long flap is cut downward. This flap is turned up and the attachments of the head of the bone are divided and it is disarticulated. The knife is again entered behind the bone, and a long posterior flap is cut from within outward.

FIG. 399.



Amputation at the shoulder-joint. Spence's method. (STIMSON.)

Spence's Method. In this method of amputation at the shoulder-joint an incision is made down to the head of the humerus immediately in front of the coracoid process, and is continued downward through the clavicular fibres of the deltoid and the pectoralis major muscles until the attachment of the latter to the humerus is reached (Fig.

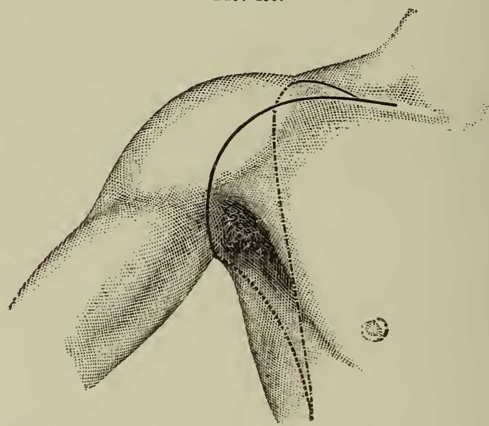
399). The incision is now carried backward to the posterior fold of the axilla. A second incision, including only the skin and cellular tissue, is next made from the anterior portion of the first incision across the inside of the arm to meet the incision on the outer part. The outer flap thus formed is turned up and the head of the bone is disarticulated. The operation is completed by dividing the remaining tissues on the axillary aspect.

Many other methods of removing the arm at the shoulder-joint have been devised and employed, including the circular method.

Amputations Above the Shoulder-joint. This form of amputation consists in the removal of the arm with a part or the whole of the scapula and sometimes a portion of the clavicle.

As this form of amputation is required in cases in which the laceration of the parts has passed beyond the shoulder-joint, or in cases of growths involving the tissues beyond the joint, no definite rule can be laid down for the incisions; the only rule being as far as possible to make them in such a manner that the least possible amount of skin is sacrificed, so that a sufficient covering for the wound can be obtained. Treves recommends the following method: The patient should be placed on his back close to the edge of the operating-table. An incision should be made over the clavicle, extending from the inner extremity outward to a point a little beyond the acromio-clavicular articulation, which should be carried down to the bone; the clavicle being exposed, it should be divided in its middle third or disarticulated from the sternum, and, its outer portion being lifted up, it is disarticulated at its acromial extremity. The subclavian vessels are thus exposed, and should be tied by two ligatures, about an inch apart, and the vessels should finally be divided beween the ligatures. The axillary plexus of nerves should next be divided. The second incision is made at the centre of the first incision, and the knife is carried directly across the anterior part of the axilla and inner border of the arm to the inferior angle of the scapula; from the outer extremity of the first incision over the clavicle a third incision should be made posteriorly, across the dorsum of the scapula to its inferior angle, joining the termination of the second incision (Fig. 400). Upon turning back the posterior flap thus formed

FIG. 400.



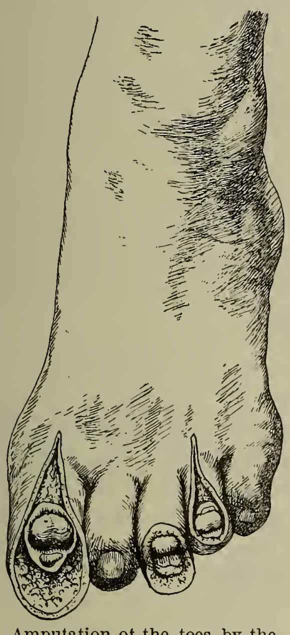
Amputation of arm, scapula, and clavicle, the dotted line representing posterior incision. (TREVES.)

and severing the connections of the scapula with the trunk and the muscular attachments which remain anteriorly, the upper extremity will be entirely freed from the trunk. The wound, when closed, forms an oblique line running from above downward, outward, and backward.

Amputations of the Foot.

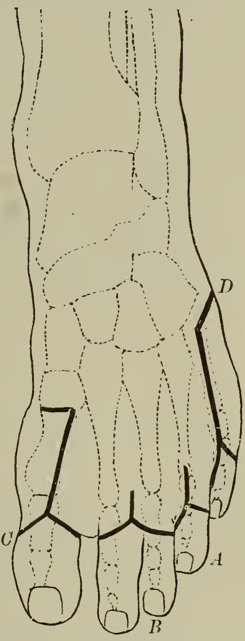
Amputations of the Toes. The phalanges of the toes may be removed in the same manner as those of the fingers. It is better to amputate at the metatarso-phalangeal articulations than to attempt to remove them at the joints in front of this articulation, except in the case of the great toe, as the preservation of a portion of a toe is rather a discomfort than an advantage, except in the instance mentioned. All incisions should be made so that the resulting cicatrix does not occupy the plantar surface, and it is well to remember that the web of the toes is considerably below the position of the metatarso-phalangeal joint.

FIG. 401.



Amputation of the toes by the racket-shaped incision and flap method. (After ROTTER.)

FIG. 402.



Incisions for amputation of toes and metatarsal bones. (STIMSON.)

The toes are usually removed by an incision on the dorsal surface a little above the joint, which is carried down the bone for about an inch and then diverges into the web, and is carried under the toe and back on the other side to the point of divergence (Figs. 401, 402).

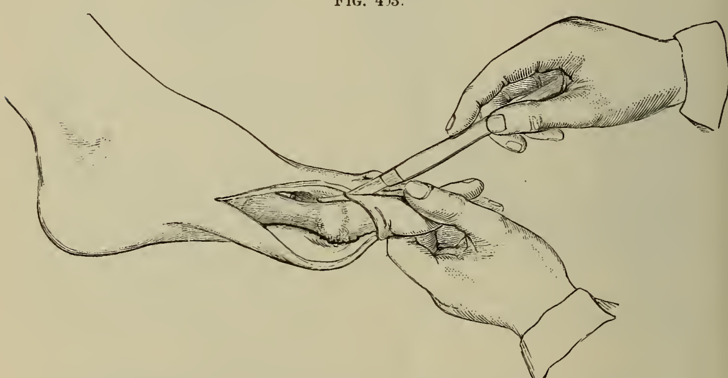
Amputation of Two Adjoining Toes. The dorsal incision should be made in the inter-metatarsal space just above the level of the joint (Fig. 402, *B*) and carried down to the beginning of the web; then over the toes to the beginning of the adjoining web, then under the plantar surface of both toes in the line of the digito-plantar fold, through the web and back to the point of divergence.

Amputation of the Great Toe. This may be accomplished by means of the racket-shaped incision employed in amputation of the other toes (Fig. 401) or by means of a lateral flap. In the latter case the knife is made to enter the joint by cutting through the commissure, and the operation is completed by carrying the knife through the joint and along the outer side of the bone, forming a flap of the required size.

In this amputation a short dorsal flap and long plantar flap may be employed, or a large internal flap may be used.

Amputation of the Great Toe with its Metatarsal Bone. The incision begins upon the dorsal surface of the meta-

FIG. 403.

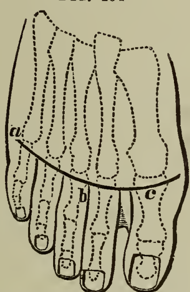


Amputation of the great toe and first metatarsal bone. (SMITH.)

tarsal bone, a little below the point at which the bone is to be divided, and is carried down below the metatarso-phalangeal joint, then diverges and passes under the toe and comes back again to the point of divergence (Fig. 402, *C*). The bone is exposed and cut through with cutting forceps, and is then lifted up and dissected loose from the tissues (Fig. 403).

Amputation of All the Toes. To amputate all the toes, make a dorsal incision from the head of the fifth to the head of the first metatarsal bone; the incision should be a curved one passing just in front of the joints (Fig. 404). Dissect up the flap and open the joints, dividing the lateral

FIG. 404



Incision for amputation of all the toes. (SMITH.)

ligaments, and pass the knife behind the phalanges and cut a flap from the plantar surface.

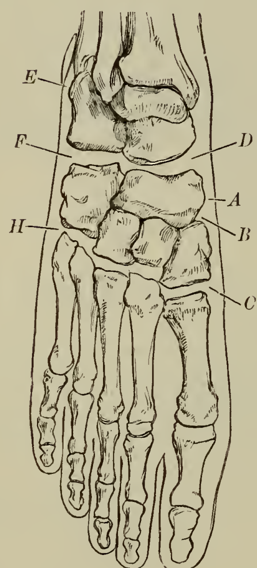
Amputations of the Metatarsal Bones. It is better in these amputations to leave the tarsal head of the metatarsal bone in place and divide the bone, or, in other words, to do an amputation in continuity to prevent opening up the tarsal articulations.

Amputation of the Little Toe and the Fifth Metatarsal Bone. The incision for the removal of the little toe and the fifth metatarsal bone is made over the bone a little below the metatarso-tarsal articulation, and is carried down and curved around the toe (Fig. 402, *D*), and after the bone is exposed by dissecting back the flaps, it is divided, or the joint is opened and it is dissected out.

Amputation Through all the Metatarsal Bones. In performing this amputation an incision is made across the dorsum of the foot, and a short dorsal flap is dissected up; the metatarsal bones are next divided with a saw and a long plantar flap is cut from within outward by entering the knife behind the ends of the bones.

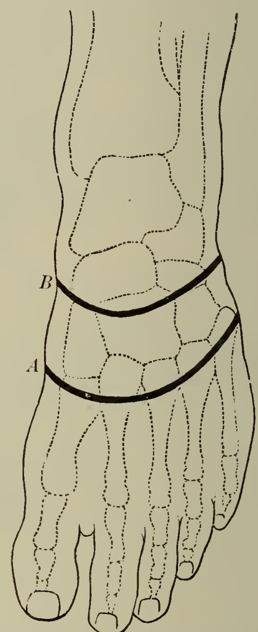
Tarso-metatarsal Amputations. In all amputations of the foot involving the tarsus the surgeon should be thoroughly familiar with the anatomy of the foot and the surgical landmarks of the different articulations. I shall refer to those laid down by Mr. Bryant, which are as follows:

FIG. 405.



Surgical guides to the foot as expressed by anatomy. (BRYANT.)

FIG. 406.



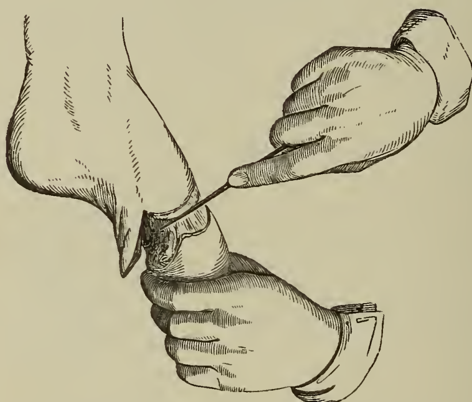
Incision for—*A*. Lisfranc's amputation. *B*. Chopart's amputation. (STIMSON.)

"On the *inner* side of the foot, not far from the inner malleolus, the tubercle of the scaphoid (Fig. 405, *A*), is to be felt as a marked prominence; about one-half an inch in front of this will be found the articulation with the cuneiform bone (*B*), and one inch in front of this the joint which the surgeon will have to open in Lisfranc's or Hey's operation (*C*); just above the tubercle of the scaphoid will be found the articulation with the astragalus, the line of Chopart's amputation (*D*). On the *outer* side of the foot, one inch below the external malleolus, a sharply defined projection will always be felt, which is the peroneal tubercle (*E*); one-half an inch in front of this will be found the joint which separates the os calcis from the cuboid (*F*), this joint forming the outer circle to Chopart's amputation. Half an inch in front again, or one inch from the tubercle, the prominence of the fifth metatarsal bone is always to be felt (*H*), the line above this prominence indicating the articulation with the cuboid bone, which forms the outer boundary of the incision for Hey's or Lisfranc's amputations."

Tarso-metatarsal Amputation (Lisfranc's). The incision for this amputation is a curved one carried across the dorsum of the foot from the base of the fifth to the base of the first metatarsal bone (Fig. 406, *A*). The incision should involve the skin only, its centre lying half an inch or more below the centre of the line of the articulations, and it should begin and end at the sides of the foot at their junction with the sole. A plantar flap should be marked out by a curved incision crossing the sole of the foot near the origin of the toes, starting and ending at the same points as the dorsal incision.

The dorsal flap is next dissected back to the line of the articulations; the tendons, muscular fibres, and fascia being divided, the joints between the tarsal and metatarsal bones are opened with a stout, narrow-bladed knife (Fig. 407). Difficulty is sometimes experienced in opening the joint between the head of the second metatarsal bone and the second cuneiform bone, which occupies a position higher on the foot than the other articulations. The disarticulation may also be facilitated by forcibly depressing the anterior portion of the foot. After all the joints have been opened, the knife is passed behind the ends of the metatarsal bones, and a plantar flap is cut from within outward, following the line of the incision previously marked out. The plantar flap may be cut from without inward if preferred.

FIG. 407.



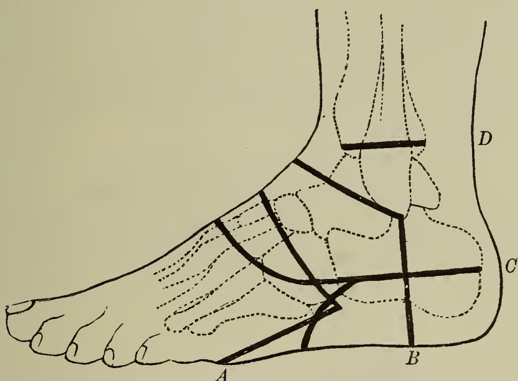
Amputation at the tarso-metatarsal joint. (LISFRANC'S.)

Tarso-metatarsal Amputation (Hey's). The line of incision and the steps of this operation are similar to those in Lisfranc's amputation, with the exception that Hey sawed off the projecting portion of the internal cuneiform bone after disarticulating the metatarsal bones. This modification, although it improves the appearance of the stump, possesses no advantages over the previous procedure.

Medio-tarsal Amputation (Chopart's). In this amputation the disarticulation is through the joints formed by the astragalus and calcaneum behind and the scaphoid and cuboid in front. An incision is made from the tubercle of the scaphoid across the dorsum of the foot an inch in front of the head of the astragalus to the lower and outer border of the cuboid (Fig. 406, *B*). The plantar flap is next marked out by an incision beginning and ending at the same points as the first incision and crossing the sole of the foot four or five finger-breadths nearer the toes

(Fig. 408, *A*). The dorsal flap is next dissected up, and after the tendons and fascia have been divided the joint

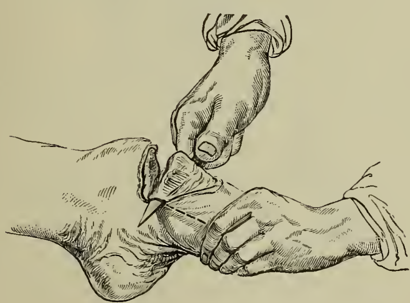
FIG. 408.



Lines of incision for—*A*. Chopart's amputation. *B*. Syme's amputation. *D*. Section of bone in Syme's amputation. *C*. Subastragaloid amputation. (STIMSON.)

is opened and a plantar flap is cut from within outward, following the line of the previously marked-out plantar incision (Fig. 409).

FIG. 409



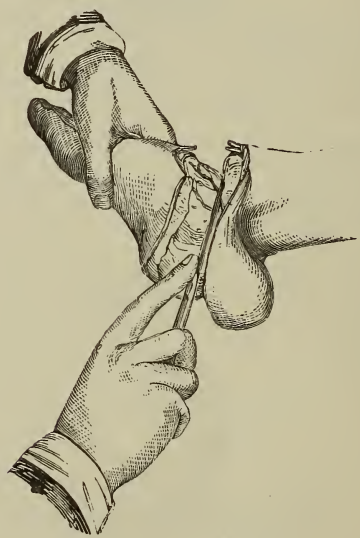
Chopart's amputation. (BRYANT.)

Subastragaloid Amputation. In this amputation all the bones of the foot are removed except the astragalus, An incision is made, beginning an inch below the tip of the external malleolus, which is carried forward to the base of the fifth metatarsal bone; it is then carried over the dorsum of the foot to the calcaneo-cuboid articulation (Fig. 408, *C*). The joints between the scaphoid and astragalus and between the astragalus and os calcis are opened, and the latter bone is carefully dissected out; the ligaments are divided and the astragalus only is allowed to remain in place.

Amputations at the Ankle-joint.

Syme's Amputation at the Ankle-joint. In this amputation, the foot being at a right angle to the leg, an

FIG. 410.



Syme's amputation at the ankle-joint. (SKEY.)

incision is made from the centre of one malleolus directly across the sole of the foot to the centre of the opposite malleolus (Fig. 408, *B*). The tissues of the heel are next carefully dissected from the bone by keeping the knife close to the osseous surface until the tuberosity of the os calcis is fairly turned (Fig. 410). The two extremities of the first incision are then joined by a transverse one across the instep, and, the joint being opened, the lateral ligaments are divided to complete the disarticulation. The knife is next used to clear the malleoli, and they are next removed by the saw in the line indicated (Fig. 408, *D*).

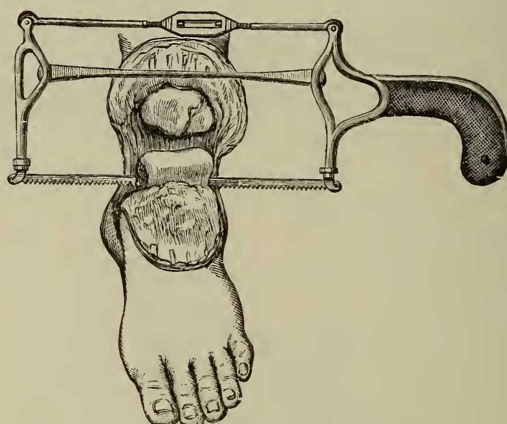
Pirogoff's Amputation at the Ankle-joint. In this amputation the posterior portion of the os calcis is retained. The incision is carried from the tip of the inner

FIG. 411.

Pirogoff's amputation. *A*. Cutaneous incision. *B*. Line of section of bones. (STIMSON.)

malleolus, over the instep, half an inch in front of the anterior edge of the tibia, to a point half an inch in front of the tip of the outer malleolus; a second incision, crossing the sole of the foot and carried down to the bone, is next made (Fig. 411, *A*). The plantar flap is dissected back for a quarter of an inch, the joint is opened by dividing the lateral ligaments, and the astragalus is disarticulated, and the malleoli are exposed. A narrow saw is next applied to the upper and posterior part of the calcaneum behind the astragalus, and it is divided obliquely downward in the line of the plantar incision (Fig. 412). The malleoli and a thin slice of the tibia are next removed with the saw, as in Syme's amputation (Fig. 411, *B*). Some surgeons do not remove the malleoli but press the sawed surface of the os calcis between them when it is

FIG. 412.



Application of saw to os calcis in Pirogoff's amputation. (ERICHSEN.)

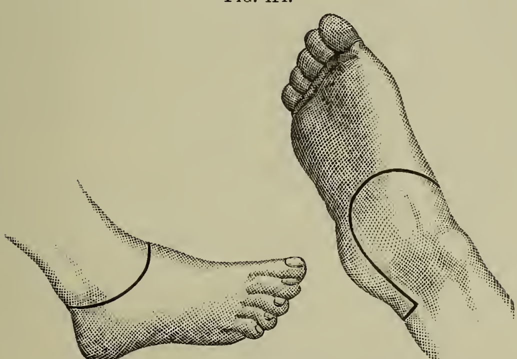
possible to do so. The position of the os calcis in relation to the tibia after union has occurred is shown in Fig. 413.

Roux's Amputation at the Ankle-joint. In this method of amputation an incision is made at the outer edge of the tendo-Achillis, a little above its insertion, which is carried forward under the outer malleolus, and across the instep half an inch in front of the anterior edge of the tibia, and back to a point just in front of the inner malleolus; the incision is carried from this point downward and partly across the sole of the foot, and then back to the point of origin of the orginal incision (Fig. 414). The flaps are dissected up for a short distance, the ankle-joint is then opened, the disarticulation is effected, and the internal flap is carefully dissected from the bones.

FIG. 413.

Union between calcaneum and tibia in Pirogoff's amputation. (HEWSON.)

FIG. 414.



Incision in Roux's amputation.

Other methods of amputation of the foot are sometimes employed, such, for instance, as that advocated by *Hancock,* who has combined Pirogoff's amputation with the subastragaloid method, bringing the sawed surface of the os calcis in contact with a transverse section of the astragalus.

Hancock has advocated the propriety of amputating in the foot without regard to the position of the tarsal joints, cutting the flaps of sufficient length and dividing the bones with a saw.

Tripier has also modified the subastragaloid amputation by leaving the upper part of the calcaneum, which he saws through on a level with the sustentaculum tali, and at right angles to the axis of the leg; the external incisions are made as in Chopart's amputation.

In the method advocated by *Mikulicz* the astragalus and calcaneum are removed, the ends of the tibia and fibula are sawed off, and the sawed surfaces of the scaphoid and cuboid are approximated to these, the stump resulting resembling the foot of *pes equinus.*

Amputations of the Leg.

The leg may be amputated at its lower, middle, or upper third, the rule being to save as much of the limb as possible; but as regards the application of prosthetic apparatus, I think the stumps resulting from amputations in the middle and upper thirds will be found more satisfactory. It is well also in sawing the bones to divide the fibula at a slightly higher point than the tibia.

The leg may be amputated by the circular, modified circular, oval, elliptical, long anterior flap, rectangular flap, antero-posterior flap, lateral flap, or external flap methods.

Circular Method. A circular incision is made through the skin and connective tissue just above the malleoli, and the cuff is dissected up for a sufficient distance, and a circular incision of the tendons and muscles is next made, and the tissues being retracted, the bones are divided with a saw.

Modified Circular Method. In this method of amputation of the leg a circular incision of the skin and connective tissue and two short lateral incisions are made.

The flaps are then dissected up to the ends of the incisions, and a circular division of the muscles is next made (Fig. 415, *A*).

Fig. 415.

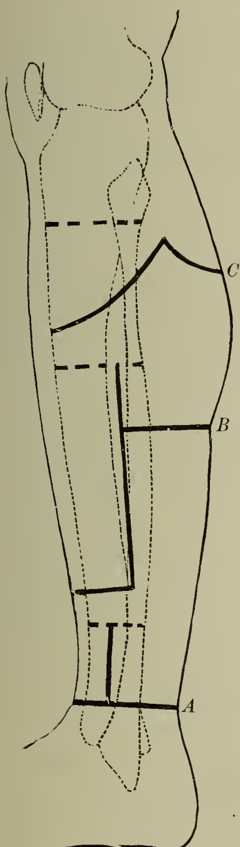


Fig. 416.

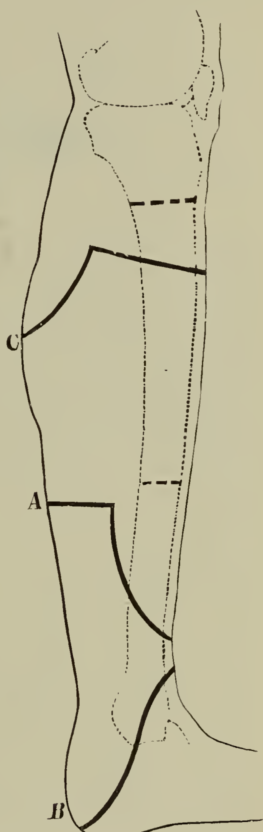
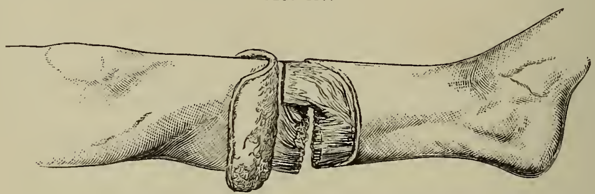


Fig. 415.—Amputation of the leg. *A*. Modified circular method. *B*. Rectangular flap. *C*. Antero-posterior flap. The dotted lines indicate the levels at which the bones are to be sawn through. (Stimson.)

Fig. 416.—Amputation of the leg. *A*. Long anterior flap. *B*. Elliptical flap. *C*. At upper third. (Stimson.)

Oval Method. Oval skin flaps are made and dissected up and the tissues are next divided down to the bone by a circular incision and the bones are divided with a saw (Fig. 417).

FIG. 417.



Oval skin flaps with circular division of the muscles. (BRYANT.)

Elliptical Method. In this method of amputation the incision is in the form of an ellipse; its lower end crosses the heel below the insertion of the tendo-Achillis, and the upper end of the incision is about an inch above the anterior articular edge of the tibia (Fig. 416, *B*).

Long Anterior Flap Method. An anterior flap equal in length to the diameter of the leg at its base is marked out by a curved incision through the skin beginning at the posterior edge of the tibia on the inner side, a little below the point at which the bones are to be divided, and is carried over the leg to a point directly opposite over the fibula (Fig. 416, *A*). The anterior muscles are divided transversely half an inch above the lower end of the flap and are dissected from the bone to the base of the flap.

The posterior flap is then made by entering the knife behind the bones at the point of the original incision and cutting directly outward.

Long Anterior Rectangular Flap Method (Teale). In this method of amputation of the leg an incision equal in length to half of the circumference of the leg is made from the point at which the bones are to be divided on one side of the leg, and is carried across the limb and back upon the opposite side to a point opposite the point of starting. The flap thus marked out is dissected up to its base, and a posterior flap of one-fourth the length is next cut by a transverse incision down to the bones, and is dissected back to the line of the origin of the first incision (Fig. 415, *B*). The long flap is next doubled back and its edges secured to the posterior flap, or the long flap may be cut from the posterior surface of the leg and the short flap from the anterior surface.

Antero-posterior Flap Method. A long anterior flap, including half of the circumference of the limb, may be cut from without inward, composed of skin, connective tissue, and muscles, and a short posterior flap, cut from within outward, may also be employed. This method is often employed in amputations in the upper portion of the leg (Fig. 415, *C*).

Lateral Flap Method. In the lower and middle thirds of the leg the method of amputation by means of lateral skin flaps may be employed with advantage. In this method an incision is made over the spine of the tibia, and an oval flap, embracing one-half of the circumference of the leg, composed of the skin and connective tissue, is dissected up; starting from the same point a similar flap is formed on the opposite side of the leg and dissected up; the muscles at the upper extremity of the flaps are next divided by a circular incision and the bones are divided with a saw.

External Flap Method (Sedillot). In this method of amputation of the leg the point of the knife is entered a finger's breadth external to the spine of the tibia and carried outward, grazing the fibula, and is brought out as far as possible to the inner side; a flap three or four inches in length is then cut from within outward; the extremities of the incision are next united by an incision across the inner side of the limb involving the skin only; any remaining muscular tissue is next divided and the bones are sawed. The long external flap is then brought over the ends of the bones and fastened to the edges of the incision on the inner side of the limb. Prof. Ashhurst modifies this operation by cutting the long external flap from without inward, and makes also a short internal flap in the same manner. By either method the resulting stump is a good one, with the ends of the bones covered by the tissues of the external flap.

Amputations at the Knee-joint.

Amputations at the knee-joint may be done either by the circular or elliptical incision, or by means of flaps, and may consist in simple disarticulations or sections through the condyles of the femur.

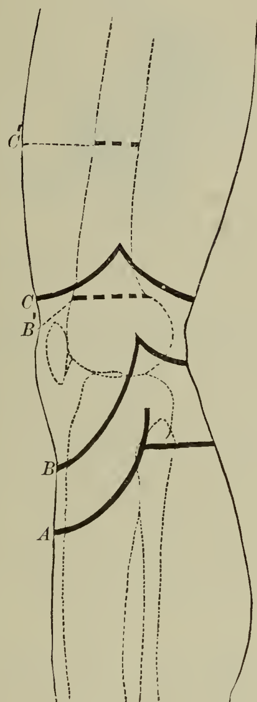
Elliptical or Oval Method. In this operation an incision crossing the spine of the tibia, five finger-breadths below the lower extremity of the patella, is carried around the back of the leg three finger-breadths higher than in front; the tissues on the front of the leg are dissected up until the tendon of the patella is exposed; the leg is then flexed and the ligament of the patella is divided; the capsular ligament and the lateral and crucial ligaments are next severed, care being taken not to injure the popliteal vessels with the point of the knife. The tibia is next drawn forward and the knife is passed behind its posterior border, and the remaining soft parts are divided from within outward.

Anterior Flap Method In this method of amputation a long cutaneous flap is formed; the incision beginning half an inch below the articulation is carried five inches below the patella; crossing the anterior surface of the leg it is carried back to the condyle of the femur on the opposite side. This flap is dissected up and the ligament of the patella is divided, and the disarticulation is effected. A short posterior flap, uniting the anterior incision one inch below its extremities, is next cut by transfixion or from without inward (Fig. 418, *A*). The patella is not removed.

Amputation Through the Condyles of the Femur. In this amputation, which is known as *Carden's* amputation, an anterior flap, whose lower extremity is three finger-breadths below the patella, is cut and the disarticulation is effected, and the posterior soft parts are divided. The patella is removed, and the condyles next sawed through just above the edge of the articular cartilage (Fig. 418, *B*).

Lateral Flap Method. In this operation an incision is made just below the patella, which is carried down the

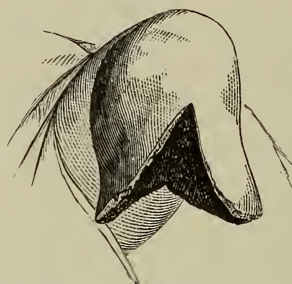
FIG. 418.



Amputations at the knee-joint and lower third of the thigh. *A*. Long anterior flap. *B*. Amputation through condyles. *B'*. Line of section of the condyles of the femur. *C*. Modified flap at lower third of thigh. (STIMSON.)

spine of the tibia for three inches, and is then carried backward to the middle of the leg at a point opposite the beginning of the incision; a similar flap is cut on the opposite side of the leg, and the flaps are dissected up to the line of the articulation. When this point is reached the joint is opened and the disarticulation is effected. The patella is not removed (Fig. 419).

Fig. 419.



Amputation at the knee-joint by lateral flaps. (Smith.)

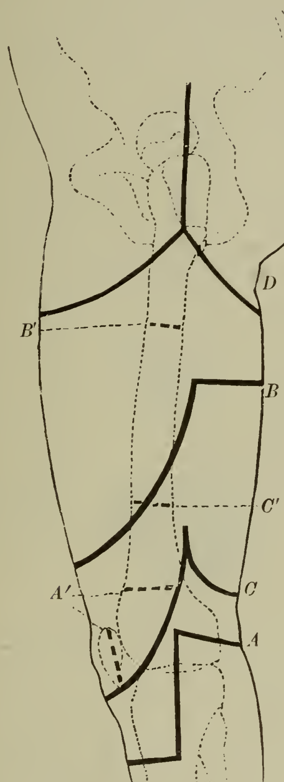
Gritti's Amputation of the Knee-joint. In this operation a long rectangular anterior flap is first cut and dissected up, and after the disarticulation has been effected the skin covering the posterior surface of the knee is cut from within outward. The condyles of the femur are next removed by a saw above the edge of the articular cartilage, and the articular surface of the patella is removed by the saw or cutting forceps. The patella is next brought down, so that its sawed surface is in contact with the sawed surface of the condyles, and the flaps are brought together (Fig. 420, *A*).

Amputations of the Thigh.

Modified Flap Method. Two semilunar flaps of skin and connective tissue, the upper extremities of which are several inches above the condyles of the femur, are cut and dissected up, and the muscles are next divided by a circular incision, and the bone is cut through with the saw (Fig. 418, *C*).

Long Anterior Flap Method. In this operation an incision is made on the anterior aspect of the thigh, marking out a flap whose length is equal to one-third, and whose width at its base is equal to two-thirds, of the circumference of the limb. The anterior muscles are

FIG. 420.



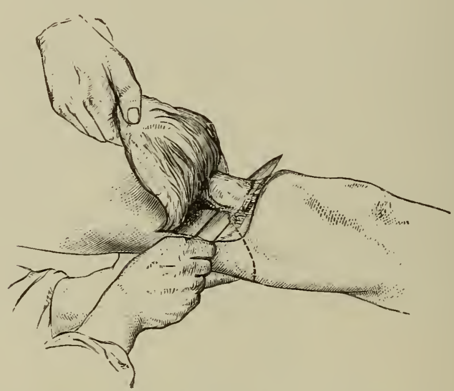
A. Gritti's amputation at the knee. *A′*. Lines of division of the bones. *B*. Amputation of the thigh, long anterior flap. *B′*. Division of the bone. *C*. Amputation at the lower third of the thigh. *C′*. Division of the bone. *D*. Disarticulation at the hip-joint. (STIMSON)

next divided obliquely upward and backward, so that the flap shall not be too thick, and the posterior muscles are cut transversely and the bone is divided with a saw (Fig. 420, *B*).

Amputation in the lower third of the thigh may also be effected by employing a *long anterior* and *short posterior* flap. The anterior flap is cut, its lower extremity extending down to the lower edge of the patella, and after dissecting up the skin and cellular tissue to the upper extremity of the patella, the muscles are cut obliquely up to the point at which the bone is to be divided. A short posterior flap is next cut, and the soft parts being retracted, the bone is sawed through (Fig. 420, *C*).

Amputation of the Thigh by Transfixion. In amputations of the thigh the flaps may also be cut by transfixion, either *lateral* or *antero-posterior* flaps being employed (Fig. 421).

FIG. 421.



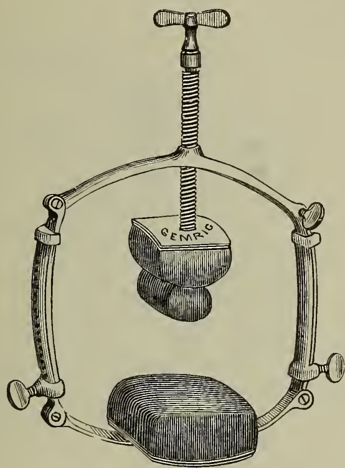
Amputation of thigh by flaps cut by transfixion.

Amputation of the Thigh through the Trochanters. When, for any reason, it is inadvisable to amputate at the hip-joint, an amputation may be made through the trochanters, a long anterior and short posterior flap being employed, with a circular division of the muscles.

Amputations at the Hip-joint.

In amputations at the hip-joint it is important that provision be made for the control of hemorrhage during the operation, and this is accomplished by the use of an abdominal tourniquet (Fig. 422), or by compression of

FIG. 422.

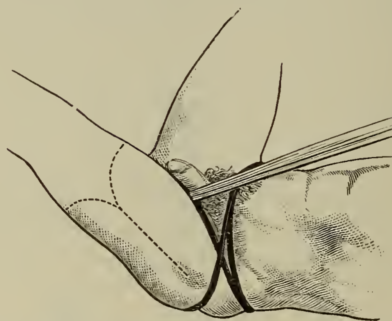


Abdominal tourniquet.

the femoral artery by the fingers of an assistant, or by the preliminary ligation of the femoral artery just below Poupart's ligament. Esmarch's elastic strap may also be employed for the control of bleeding during amputation at the hip-joint, the strap being applied in such a manner that it occupies the postion of the turns of a spica-bandage of the groin (Fig. 423).

Dieffenbach and Wyeth, to avoid hemorrhage, make first a circular amputation in the continuity of the thigh, and after controlling the hemorrhage disarticulate the head of the femur and remove it; Jordan and Senn disarticulate the head of the bone first through an external incision and control the bleeding before the amputation is completed by passing an elastic tourniquet around the soft parts above the point where they are to be divided.

FIG. 423.



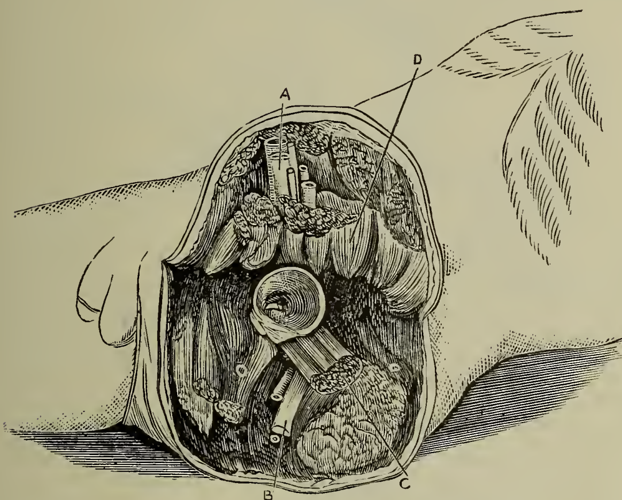
Esmarch's elastic strap applied to control hemorrhage during amputation at the hip-joint.

The methods of amputation at the hip-joint are the oval, antero-posterior flap and lateral flap, and modified circular methods.

Oval Method. This is performed by entering the point of a strong knife into the tissues below the anterior superior spinous process of the ilium and making two oblique incisions, one forward and downward and the other backward, both incisions meeting on a transverse line on the inner side of the thigh. The muscles are next divided on a little higher line, and when the joint is exposed disarticulation is effected from the outer side and any remaining tissue is divided.

Antero-posterior Flap Method. In this method the point of a long amputating knife is thrust into the tissues about two finger-breadths below the anterior superior spinous process of the ilium, and is pushed through the tissues grazing the hip-joint, and is brought out on the opposite side of the thigh close to the junction of the scrotum. The knife is next carried downward close to the bone, and an anterior flap of sufficient length is cut from within outward. This flap is held up by an assistant and the head of the bone is disarticulated, and the knife being passed behind the bone, a posterior flap of equal length is cut from within outward (Fig. 424).

FIG. 424.



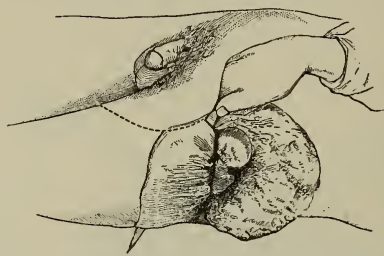
Amputation at the hip-joint by antero-posterior flaps. (HOLMES.)

Guthrie's method of amputation at the hip-joint consists in cutting the flaps from without inward, a smaller knife being used for this purpose and the posterior flap being cut first.

Modified Circular Method. In this operation short antero-posterior flaps of skin and connective tissue are cut and dissected up, and the muscles are divided by a circular incision on the level of the joint, and the disarticulation of the head of the femur is next effected.

Lateral Flap Method. In this operation two flaps are cut from the inner and outer side of the thigh by transfixing, or by cutting from without inward and exposing the joint, which is opened and the disarticulation of the head of the femur is effected as in the previous methods (Fig. 425).

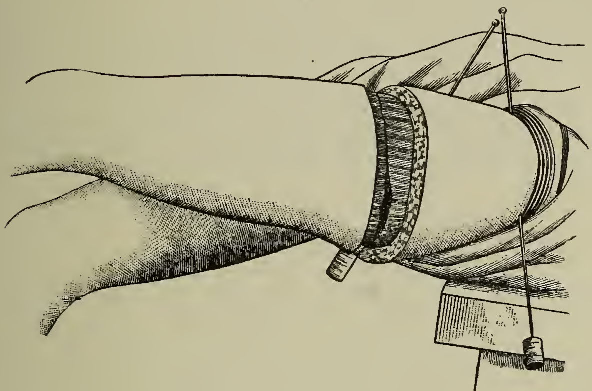
FIG. 425.



Amputation at the hip-joint by external and internal flaps. (BRYANT.)

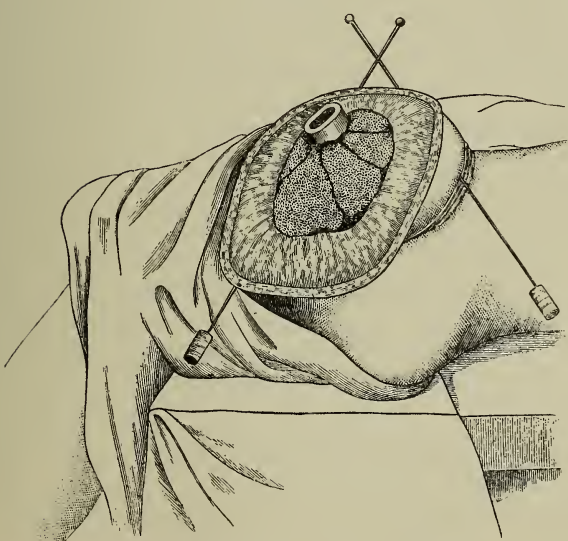
Wyeth's Method of Controlling Hemorrhage in Amputating at the Hip-joint. In amputating at the hip-joint by this method the hip to be operated upon is brought well over the edge of the table and an Esmarch bandage is applied to the limb, and two stout steel pins, twelve or fourteen inches in length, are required; the point of one of these pins is passed through the skin one and a half inches below and slightly to the inner side of the anterior superior spine of the ilium and carried through the tissues about half-way between the great trochanter and the spine of the ilium external to the neck of the femur, and its point is made to emerge just behind the trochanter; the second pin is made to enter the skin an inch below the crotch, internal to the saphenous opening, and its point is made to emerge about an inch and a half in front of the tuber ischii. The points of the pins are next protected with corks, and a long piece of rubber tubing or an Esmarch elastic strap is wound tightly five or six times about the limb above the fixation pins (Fig. 426). The Esmarch bandage should then be removed and a circular incision of the skin and cellular tissue should be made five inches below the constricting band; this cellulo-cutaneous cuff should next be reflected to the level of the trochanter minor; a circular division of all the muscles should next be made at this point and the bone divided with a saw. The large vessels should next be secured,

FIG. 426.



Pins inserted and tube applied.

FIG. 427.



Limb amputated and bone sawed. (WYETH.)

and after this has been done the rubber tube should be removed and any vessels which bleed should be tied. The exposed end of the femur is then grasped with bone forceps, and an incision is next made upon the outer side through the skin and muscles until the neck and head of the bone are exposed, and the disarticulation is accomplished. Wyeth now practises disarticulation of the head of the femur in this amputation without first sawing the bone; the circular method or antero-posterior flaps may be employed to expose the head of the bone.

PART VII.

EXCISIONS OR RESECTIONS.

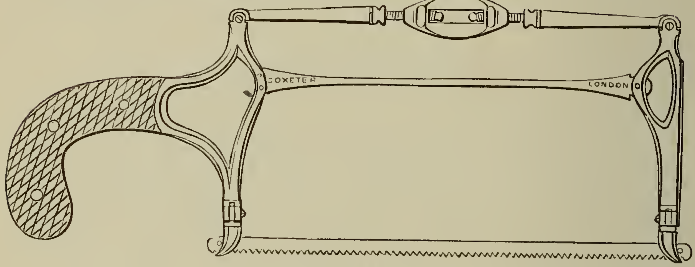
EXCISION OF THE JOINTS.

This implies the partial or complete removal of the articular surface of the bones making up the joint. The term resection is sometimes used as synonymous with excision, but is usually employed to indicate the removal of a portion or the whole of the shaft of one of the long bones. Excisions or resections of joints and bones may be required on account of injury, disease, or anchylosis of a joint in faulty position. In the operation of excision of the joint the incision should be free enough to permit of an inspection of the diseased portions of the joint, and it is preferable to remove the diseased articular surface of the bone with a saw; small areas of diseased bone may be removed with the curette or gouge forceps. In performing excisions of joints in young subjects care should be taken to see that the epiphyseal cartilage is not encroached upon, for if this is removed the subsequent growth of the limb is interfered with. The result desired in cases of excision of joints, in addition to the removal of the diseased tissue, varies somewhat with the joint involved; for instance, in a knee-joint anchylosis is desired; in the shoulder, hip, elbow, and wrist, we wish to obtain a movable false joint; when the latter condition is desired after excision, care should be exercised not to divide muscles or tendons, and as far as possible not to interfere with their attachments. When anchylosis is desired the division of muscles or tendons is not a serious consideration; any injury to the principal arteries, veins, and nerves should always be avoided.

FIG. 428.

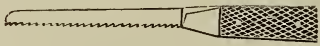
Heavy scalpel.

FIG. 429.



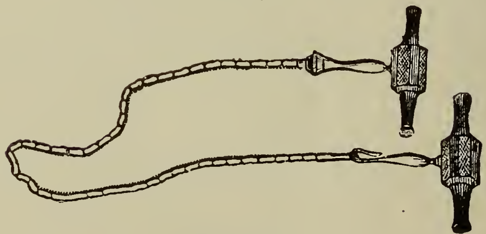
Butcher's saw.

FIG. 430.



Narrow-bladed saw.

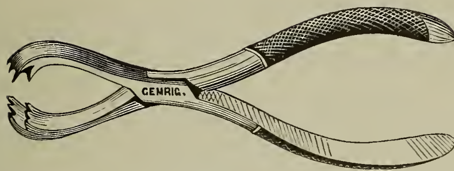
FIG. 431.



Chain saw.

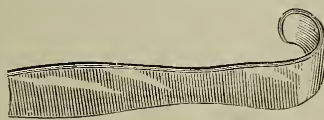
The instruments required for the excision of joints are a stout scalpel (Fig. 428), probe-pointed knife, and ex-

Fig. 432.



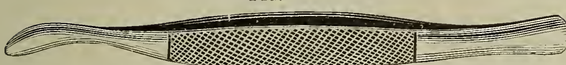
Lion-jawed forceps.

Fig. 433.



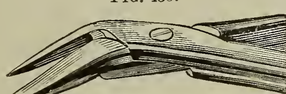
Retractor.

Fig. 434.



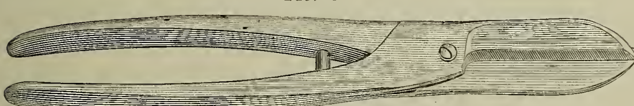
Elevator.

Fig. 435.



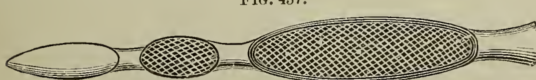
Bone-cutting pliers.

Fig. 436.



Knife-bladed forceps.

Fig. 437.

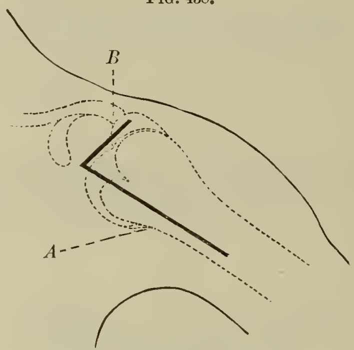


Periosteotome.

cision saw with reversible blade (Fig. 429), narrow-bladed saw (Fig. 430), or chain saw (Fig. 431), strong lion-jawed forceps (Fig. 432), retractors (Fig. 433), an elevator (Fig. 434), heavy bone-cutting pliers (Fig. 435), knife-bladed forceps (Fig. 436), and a periosteotome (Fig. 437).

Excision of the Shoulder-joint. In excising the shoulder-joint the arm is adducted and rotated inward, and a straight incision is made extending from the beak of the coracoid process down the arm in the line of the bicipital groove; this incision may be supplemented by a short,

Fig. 438.



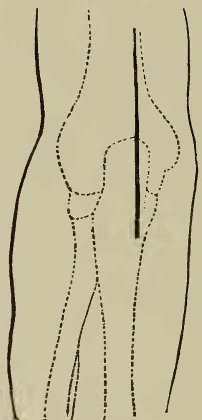
Excision of shoulder-joint: *A*. Regular incision. *B*. Supplementary. (Stimson.)

transverse incision from the upper edge of the first incision to the acromion process (Fig. 438). As the incision is deepened the fibres of the deltoid muscle are divided in this line, and the capsule of the joint is exposed and divided along the outer edge of the tendon of the long head of the biceps muscle; this tendon is held to one side and the capsule of the joint is freely opened, and the muscles inserted into the tuberosities of the humerus are divided with a probe-pointed knife and freed with an elevator; the head of the bone can then be removed by sawing across the surgical neck of the bone with a narrow metacarpal saw or chain-saw, and the sawed surface of the humerus should then be rounded off with bone pliers. If upon examination the glenoid cavity is found to be diseased, this with the neck of the scapula may be removed with gouge forceps or a small saw. The bone is then reduced and the wound is drained and closed.

Resection of the Humerus. The whole or a portion of the humerus may require resection for injury or disease. The incision should be made upon the outer side of the bone and carried down in the muscular interspaces on a line with the shaft, care being taken to avoid injury of the musculospiral nerve, which, as it passes around the posterior surface of the humerus, lies close to the bone between the humeral heads of the triceps muscle at a point corresponding to the deltoid insertion anteriorly—*i. e.*, about the centre of the shaft of the humerus. This nerve should be isolated and held aside and the bone should be exposed. After separating the periosteum as completely as possible, if the shaft of the bone is diseased, it should be removed by dividing it in the middle with a saw or forceps, and removing each fragment as far as the upper and lower epiphysis, or the upper or lower portion only may require removal In resecting the humerus for an ununited fracture the incision is made upon the outer surface of the arm over the seat of fracture, and when the latter has been exposed the fragments are separated, and the end of each fragment is removed with a saw, to obtain a fresh bone surface. The freshened ends of the bone are then drilled and united by heavy silver-wire sutures, silver plates, or screws.

Excision of the Elbow-joint. In excising the elbow-joint, the forearm is slightly flexed and a longitudinal incision is begun about two inches above the olecranon process and a little to its inner side, and carried about three or four inches down in the line of the ulna (Fig. 439); the tissues are then divided down to the bones and the ulnar nerve is dissected from its groove behind the inner condyle of the humerus and held aside by a retractor; the tendon of the triceps is divided and its attachment to the fascia and periosteum over the olecranon process is separated with an elevator or periosteotome and turned downward; the joint is next opened and the lateral ligaments are divided as the forearm is flexed upon the arm. The upper part of the ulna and the head of the radius are freed with a probe-pointed knife and are removed with a narrow-bladed saw, care being taken in making the section

FIG. 439.

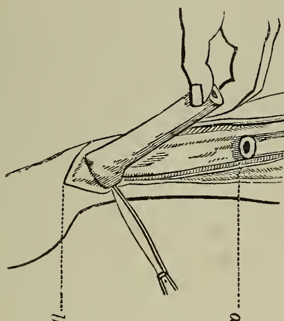


Incision for excision of the elbow-joint. (STIMSON.)

of the radius to divide its neck so that the attachment of the biceps muscle is not interfered with. The condyles of the humerus are next freed and removed with a saw. In freeing the bones at the anterior portion of the joint great care should be used to avoid injury of the brachial artery and vein and the median nerve.

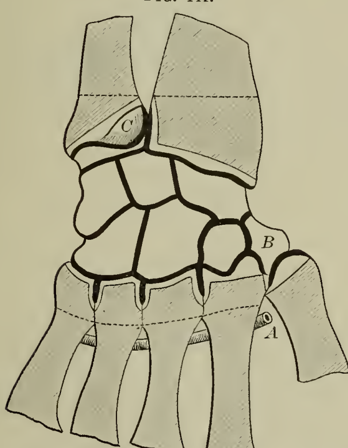
Resection of the Radius and Ulna. The radius or ulna may be resected either entirely or partially by making an incision over the bone to be removed upon the back of the forearm; the bone being exposed, the periosteum is separated with an elevator and the bone is divided with a saw, and each fragment is lifted and separated from its muscular attachments up to the point where it is desired to remove it (Fig. 440). If the articular surface of the bone is to be removed the disarticulation should be made carefully with a strong scalpel or a probe-pointed knife, care being taken to avoid injury of the vessels and nerves lying upon its palmar surface.

FIG. 440.



Resection of the lower end of the radius.

FIG. 441.



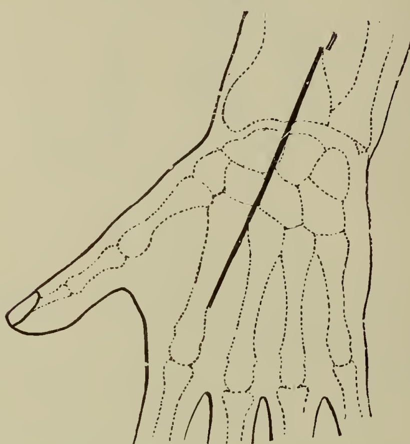
Articulations of the wrist-joint. (LISTER.)

Excision of the Wrist. The wrist is covered on its posterior and lateral aspects with skin, fascia, and tendons;

33

the relative position of the bones entering into the articulation can be seen in the accompanying figure (Fig. 441). The wrist-joint may be excised by making a dorsal incision, which begins at the middle of the ulnar border of the second metacarpal bone, and is carried upward about four inches, crossing the ulnar edge of the tendon of the extensor carpi-radialis-brevior, and splitting the dorsal ligaments of the wrist between the tendons of the extensor secondi-internodii and the extensor of the forefinger (Fig. 442). The incision should be carried down to the bone

Fig. 442.



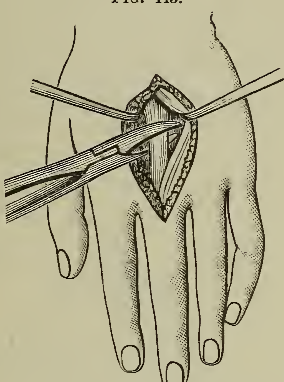
Incision for excision of wrist-joint. (Stimson.

and the soft parts and tendons should be dissected loose with an elevator. By flexing the hand the first row of the carpus is made to present in the wound, and the scaphoid is separated from the trapezium and removed; the semilunar and cuneiform should next be removed; the trapezium and pisiform should be left if possible. In removing the second row of carpal bones the knife should be passed between the trapezium and trapezoid and then into the carpo-metacarpal joint, and by cutting the ligaments on the dorsal side of the ends of the metacarpal bones the trapezoid, os magnum, and unciform can then be removed.

The lateral ligaments are next carefully divided and the articular ends of the radius and ulna removed with a saw; the ends of the metacarpal bones should next be removed with a saw or cutting pliers.

Resection of a Metacarpal Bone. A metacarpal bone may be resected by making a longitudinal incision on the back of the hand over the bone to be removed. The incision should extend from one articular end to the other, and the extensor tendon when exposed should be held to one side by retractors; the periosteum should next be separated as far as possible, and when the bone has been

FIG. 443.



Resection of metacarpal bone.

fully exposed it may be removed by dividing it in the middle with bone-cutting pliers and then disarticulating each fragment; or the articular ends may be freed and the bone removed in one piece (Fig. 443).

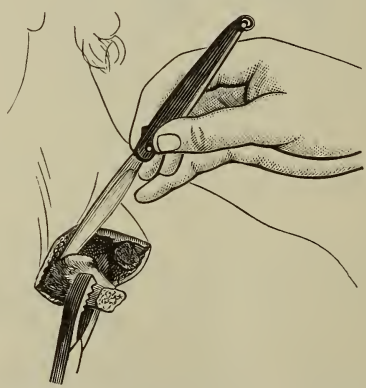
Excision of Metacarpo-phalangeal Joints or Interphalangeal Joints. In excising a metacarpo-phalangeal joint the joint is exposed by a longitudinal incision over the dorsal surface of the knuckle; the extensor tendon being exposed and held to one side, the lateral ligaments are divided. The articular ends of the bones are then exposed and removed with a metacarpal saw or with bone-cutting pliers (Fig. 444). In excising the interphalangeal

FIG. 444.

Excision of a metacarpo-phalangeal joint.

joints the incision is usually made upon the side of the joint, and when the articular surfaces of the bone have been exposed they are removed with a small saw or cutting pliers.

FIG. 445.



Resection of the sternal end of the clavicle.

Excision of the Clavicle. The clavicle is excised by making an incision over the bone from one articulation to the other, which is carried directly down to the bone; the periosteum is then separated and the shaft of the bone may be divided at the middle and each fragment raised and disarticulated; or the bone may be disarticulated at one extremity, then raised up and freed from its adherent tissues and disarticulated at the other extremity. In disarticulating the sternal articulation of the clavicle (Fig. 445) a probe-pointed knife should be used, and great care should be exercised to avoid injury of the important vessels and nerves which lie in close proximity to it.

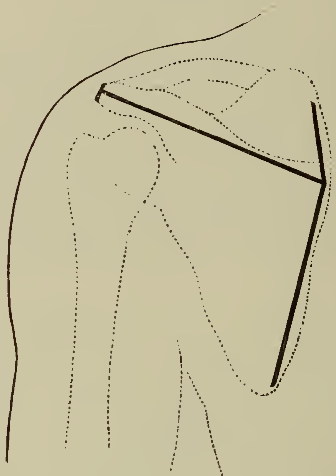
Resection of the Ribs. In resecting a rib the incision should correspond in length and direction with the portion of bone to be removed, and may be crossed at each end by a short transverse incision. The tissues overlying the rib are then dissected loose, the periosteum is separated as far as possible, and the rib is divided by cutting-pliers at two points, and the piece is grasped with forceps and the attachments to the under surface of the rib are separated with an elevator. Care should be taken to avoid opening the pleural cavity.

Estlander's Operation. This operation is employed in cases of empyema, and consists in resecting the portions of several adjoining ribs to allow the chest-wall to sink inward and unite with the pulmonary pleura. The incision is made along the intercostal space occupied by the fistula and the adjoining ribs as far as it may be necessary. To resect them a rectangular or oval flap, including all of the tissues external to the ribs, is made and dissected up, and portions of several ribs are divided with bone-cutting pliers and removed with forceps. If the costal pleura is very thick, to expose the cavity so as to permit of free drainage and allow the chest-wall to sink in it may be cut away over a part of the area from which the ribs have been resected; one to four inches of three to six adjoining ribs may be removed.

Resection of the Sternum. Resection of the sternum is performed by making a longitudinal incision over the portion of the bone to be removed; the periosteum is separated, and the diseased portion of the sternum is then carefully freed with an elevator and removed.

Excision of the Scapula. To excise this bone an incision should be made along the whole length of the spine of the scapula, and from its posterior extremity two other incisions should be made, one running about an inch or two above, and the other passing down the posterior border of the bone to its inferior angle (Fig. 446);

FIG. 446.



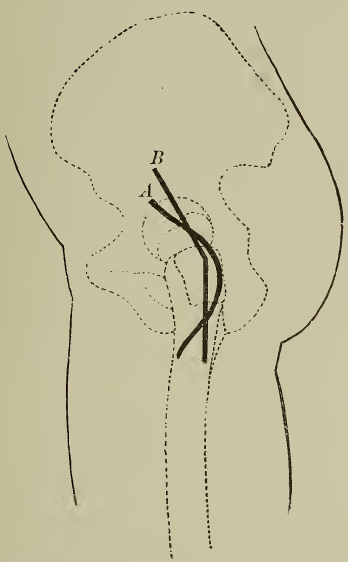
Incision for excision of scapula. (STIMSON.)

the flaps thus made are loosened by separating the muscles attached to the outer surface of the bone. The attachments of the deltoid and trapezius muscles to the acromion and spine of the scapula are separated, and the lower angle is freed by detaching the teres major and serratus magnus. The bone is then raised, and the subscapularis muscle is detached from below upward. The neck of the scapula should be divided with a chain-saw or cutting forceps; the acromion is next separated from the clavicle and the scapula turned upward, the joint being opened from below.

The coracoid process should be separated from its muscular and ligamentous attachments, or may be divided with a saw and left in place. In clearing the supraspinous fossa care should be taken not to injure the suprascapular nerve in the suprascapular notch; it should be raised with the periosteum and its fibrous sheath.

Excision of the Hip. In excising the hip-joint a curved or angular incision is made from a point about three inches below the crest of the ilium, and about the same distance

FIG. 447.



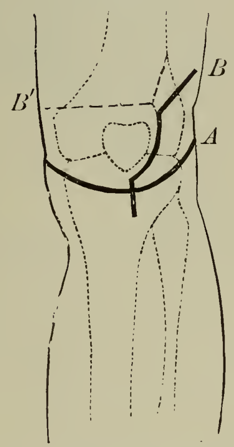
Incisions for excision of the hip-joint. (STIMSON.)

behind the anterior superior spine of the ilium, which should be carried downward over the great trochanter in the line of the femur for about five or six inches (Fig. 447); the soft parts are dissected from the great trochanter and upper part of the sheath of the femur, and the capsule of the joint is opened. An assistant should next rotate the thigh inward and outward, and with a blunt-pointed knife the muscles attached to the trochanters are shaved off close to the bone; the neck of the femur is next freed by the use of a knife and elevator; the thigh is adducted and pushed upward, and the head and neck of the bone are made to project from the wound. A transverse section of the bone is then made with a saw just below the great trochanter. In some cases it is difficult to remove the head of the bone, which may be anchylosed firmly to the acetabulum; here the bone may first be divided with a chain-saw passed around the femur just below the great trochanter, or may be divided with a chisel, the head and neck of the bone afterward being removed with gouge or bone-cutting pliers. After the head and neck of the bone have been removed the acetabulum is examined, and if it is found to be diseased the diseased tissues should be removed with a curette, gouge, and forceps.

Anterior Excision of the Hip. In this method of excising the hip-joint an incision is made upon the front of the thigh over the joint, beginning half an inch below the anterior superior spine of the ilium, and is carried three or four inches downward and a little inward; as the incision is deepened the tensor vagina femoris and the glutei muscles are exposed, and should be drawn to the outer side, and the sartorius and rectus muscles are held to the inner side and the neck of the femur is exposed; the neck of the bone is then divided with a metacarpal saw or Adams' saw, and the diseased portion of the bone is next grasped with strong sequestrum forceps, and by the use of these and an elevator the head of the bone is removed; the acetabulum is then examined, and, if diseased, the diseased tissue is removed with gouge or curette.

Excision of the Knee-joint. The knee-joint is excised by making an incision which begins at the inner side of the limb over the inner condyle of the femur, and is carried over the front of the knee just below the patella to a corresponding point upon the external condyle of the femur (Fig. 448, *A*), or by an angular incision (Fig. 448, *B*). The flap thus formed is dissected up to a point corresponding with the upper edge of the patella, the ligamentum patella is then cut through, the leg is slightly flexed, and the joint is opened; the lateral ligaments are then divided, and by flexing the leg upon the thigh the joint is freely exposed. The semilunar cartilages are next removed and the condyles of the femur are freed; a narrow-bladed saw is placed under the condyles and a transverse section of the condyles is removed; the head of the tibia is next

FIG. 448.



Incision for excision of the knee-joint. *A*. Curved incision. *B*. Angular incision. (STIMSON.)

cleared and a transverse section of this bone is also removed with a saw. The patella may be removed before excising the ends of the bone, or, if anchylosed to the condyles, may be removed with the section of bone which removes a portion of the condyles. After sufficient bone has been removed, if localized areas of carious bone present themselves upon the sawed surface of the bones, they may be removed with a gouge or gouge forceps. In excising the knee-joint in young persons care should be taken to remove only so much bone as may be done without encroaching upon the lines of epiphyseal cartilages, as removal of the epiphyseal cartilage would interfere with the subsequent growth of the bones.

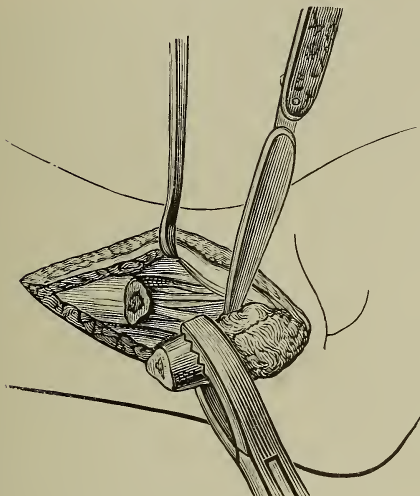
Arthrectomy of the Knee-joint. This operation is employed as a substitute for the operation of excision in disease of the knee-joint, and is performed by exposing the joint by an incision similar to that employed in excision; the ligamentum patella is divided and the patella is reflected with the skin flap. When the joint has been freely exposed the diseased articular cartilages, semilunar cartilages, crucial ligaments, and synovial pouches are removed by the use of the knife or scissors and the curette; if the surface of the bone is found to be carious, it is removed by the curette or gouge. After the joint has been thoroughly cleared of diseased tissue it is irrigated, and the divided ligamentum patella is sutured with several strands of chromicized catgut or silk, and the wound is drained and closed.

Excision of the Patella. The patella may be excised by making a longitudinal or crucial incision; the periosteum is carefully separated from the bone, and the latter is grasped with strong bone forceps and dissected free from its attachments upon the under surface. The knee-joint is generally opened in removing the patella, unless the removal of the bone be undertaken for necrosis or caries, when it is possible to accomplish its complete removal without opening the joint.

Resection of the Tibia or Fibula. In resecting the tibia or fibula the bones may be exposed by a longitudinal incision over the bone to be removed, and after the shaft of the bone has been exposed and the periosteum separated as completely as possible, the shaft of the bone may be divided at its middle and each fragment grasped with forceps and dissected up, and removed at its epiphyseal junction (Fig. 449).

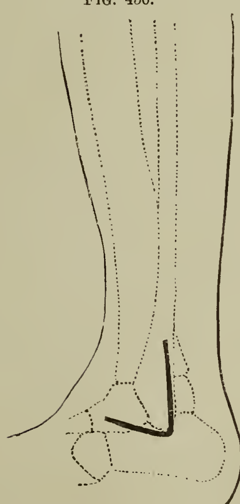
Excision of the Ankle-joint. In excising the ankle-joint an incision is made at a point two inches above the external malleolus, and carried downward over the fibula to the tip of the external malleolus; it is then curved

FIG. 449.



Resection of lower end of fibula.

FIG. 450.



Incision for excision of ankle-joint. (STIMSON.)

slightly upward toward the dorsum of the foot (Fig. 450), care being taken that the incision does not extend so far forward as to endanger the extensor tendons or the dorsal artery. The bone is exposed in this incision and the periosteum is separated and turned aside; the peroneal tendons are next exposed and held to one side by retractors; the external malleolus is next divided with bone-cutting pliers and removed, and the astragalus is exposed. The upper articulating surface of the astragalus is next removed with bone forceps or a saw, or the whole bone may be removed. The foot is next inverted and the end of the tibia is cleared with a probe-pointed knife, care being taken not to injure the posterior tibial artery, nerve, or vein, and when the articular surface has been freed it is removed with a saw or bone-cutting pliers. The articular end of the tibia may be exposed by making an additional incision upon the inner side of the ankle over the internal malleolus if desired.

Excision of the Astragalus. In excising the astragalus a semilunar incision is made upon the outside of the ankle-joint, very similar to that employed in excising the ankle; the external lateral ligaments are divided with a probe-pointed knife, and the astragalus is exposed by forcibly inverting the foot; the bone is then seized with strong forceps, and its ligamentous attachments are divided with a probe-pointed knife, and it is removed.

Excision of the Os Calcis. An incision is made on the level of the upper part of the bone, beginning at the inner border of the tendo-Achilles, dividing this tendon and passing around the back and outer surface of the foot to the base of the fifth metatarsal bone; a short incision is then made at the anterior end of the first incision and carried down to the sole of the foot; the bone is exposed and held by forceps; the flap thus formed, which includes the peronei tendons, is then separated from the bone, and the cuboid ligaments are cut and also the interosseous ligament between the os calcis and the astragalus, and the bone is removed with forceps.

Resection of the Metatarsal Bones. Any of the metatarsal bones may be resected by an incision on the dorsum of the foot over the bone to be removed; the bone is exposed, the extensor tendons being held aside by retractors; the bone is disarticulated at either end or is cut in its middle and each fragment dissected up and removed at its articulation. The metatarsal bone of the great toe is exposed by making a curved incision over that bone on the inner side of the foot (Fig. 451).

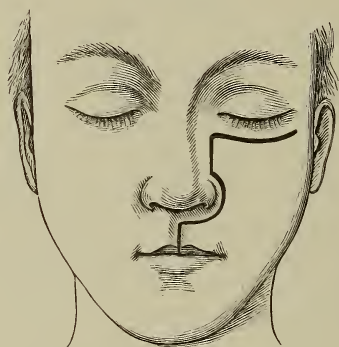
FIG. 451.

Incision for the resection of the metatarsal bone of the great toe. (SMITH.)

Excision of the Coccyx. In excising the coccyx the finger is passed into the rectum and the position of the bone is determined; a longitudinal incision through the skin and fibrous tissues covering the coccyx is made from a point about a quarter of an inch above its upper limit, and is carried down to a little below its lower extremity. This incision may be supplemented with a transverse incision. The sacro-coccygeal articulation is then opened; an elevator is next introduced into the articulation and the bone is raised up and grasped with forceps. It should then be freed from its lateral attachments, and those upon its anterior surface, with the knife and elevator.

Excision of the Upper Jaw. In excising one-half of the upper jaw the incision is begun half an inch below the inner canthus of the eye, and is carried downward along the line of junction of the nose and face, along the course which limits the alæ nasi, and longitudinally to the septum, and then down through the free border of the lip; it is also advisable to carry the incision along the lower edge of the orbit upward over the malar bone (Fig. 452); the flap being dissected away from the surface of the bone, a small, narrow metacarpal saw is then applied to the floor of the nostril until a deep groove is made; the soft palate and the tissue covering the hard palate are next divided from within the mouth with a strong knife; one or two incisor teeth should be removed, and one blade of a pair of strong bone-cutting pliers is introduced into the floor of the nose in the line of the saw incision, the other is introduced into the mouth in the line of the division of the structures of the

FIG. 452.



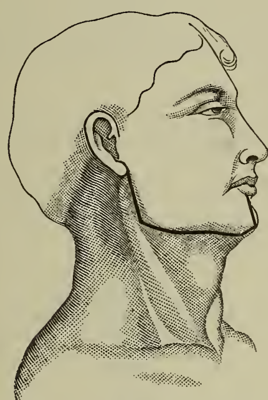
Incision for excision of the upper jaw.

palate, and the bone is divided. The malar bone is next divided with a saw or forceps, and, finally, the blades of a strong pair of bone-cutting forceps are introduced, one into the nostril and the other at the edge of the orbit, the important structures of the orbit being held upward with a retractor, and the inner angle of the orbit is cut across; the superior maxillary bone is then grasped with strong, lion-jawed forceps, and can be twisted out, any band of tissues which holds it being divided with the knife or scissors.

Excision of the Lower Jaw. Partial or complete excision of the lower jaw may be practised.

Excision of the Ramus and Half of the Body of the Lower Jaw. The incision should be made from a point just below the free border of the lip over the symphysis and carried down to the lower border of the jaw, and from this point it is carried along the ramus to the lobe of the ear (Fig. 453); the flap is then dissected up, separating the masseter muscle from the bone as far as possible without opening the cavity of the mouth; an incisor tooth is next drawn and the bone is sawed through near the symphysis; the jaw is then seized with forceps and drawn downward and forward and denuded upon its inner surface. The insertion of the tem-

Fig. 453.



Incision for excision of the lower jaw.

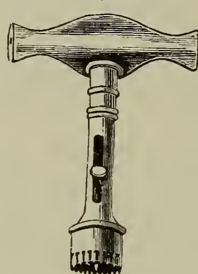
poral muscle into the coronoid process is divided, and the condyle of the jaw is disarticulated from the glenoid cavity, and the remaining soft parts are carefully detached with a knife or elevator. The facial artery and the inferior dental nerve and artery are necessarily divided in removing this portion of the jaw.

Partial Excision of the Lower Jaw or Alveolus. The removal of a portion of the alveolar process of the jaw may often be accomplished through the mouth without the aid of a cutaneous incision. The condyle of the jaw may be excised by making an incision close in front of the temporal artery and carrying it forward along the zygoma for an inch and a half; the tissues being divided and the bone exposed, a second incision involving only the skin is then carried from the centre of the first directly downward for about an inch; the soft parts are next carefully separated with a knife and elevator from the margin of the zygoma and outer surface of the joint and drawn downward with a retractor, to prevent injury of the parotid gland, nerves, and vessels. The neck of the condyle is then cleared by working around it in front and behind with a director, keeping close to the bone to avoid injury of the internal maxillary artery. A chain-saw is then passed around the neck of the bone, which is divided, and the condyle is seized with forceps and removed with an elevator or gouge.

TREPHINING THE SKULL.

This is an operation in which a circular disk of bone of the skull is removed by a circular saw or trephine to ex-

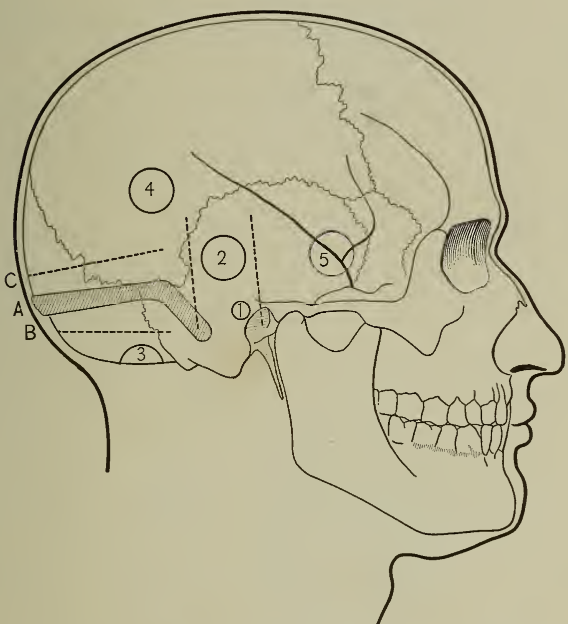
FIG. 454



Trephine.

pose the membranes and the brain. If a wound is already present in the scalp, exposing the skull, as in the case of compound fracture of the skull, it is exposed and bared, so that the crown of the trephine can be placed fairly on the bone; if no wound exists a U-shaped flap is made, including all the structures down to the bone. The base of the flap should be so situated as to contain a sufficient blood-supply, and the flap should be so planned as to favor drainage from the wound. When the bone has been exposed the trephine is placed with the centre pin projecting about one-sixteenth of an inch, and the instrument is turned from right to left until a groove is made in the bone; the trephine is then removed, and the centre pin is raised so that as the teeth of the trephine approach the inner table of the skull the point of the centre pin will not injure the membranes or brain. The instrument is then reapplied and worked cautiously as the groove in the bone is deep-

Fig. 455.



1. Trephine opening for mastoid antrum. 2. For abscess from otitis media. 3. To expose cerebellum. 4–5. For middle meningeal hemorrhage. *A.* Lateral sinus. *B.* and *C.* Limit of up and down variation. (Stimson.)

ened. When the diploë is reached there is usually some bleeding from the wound, and as the trephine approaches the inner table of the skull it should be manipulated with great care, and when the resistance is felt to diminish at any one part of the bone the trephine is made to cut at other points of the bone where the resistance is still apparent. When the disk is completely cut through it can be lifted out in the crown of the trephine or can be removed with forceps or an elevator. If the opening in the skull has to be enlarged to obtain greater exposure of the membranes or brain it can be done very satisfactorily with a form of rongeur forceps.

A portion of the skull may also be removed by the use of the gouge and mallet; the gouge is generally preferred to the trephine in opening the mastoid cells.

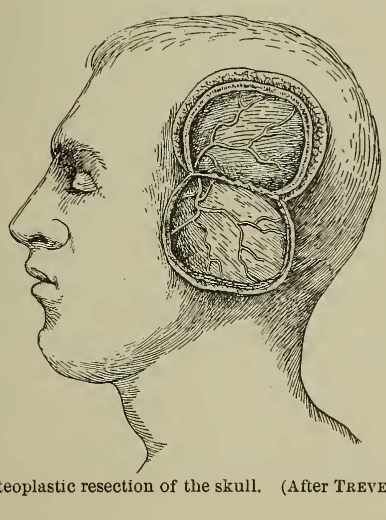
When the trephine is applied to expose hemorrhage from the middle meningeal artery, or hemorrhage from the lateral sinus, or an abscess from middle-ear disease, or to open the mastoid antrum, the positions for the application of the trephine are indicated in Fig. 455.

Osteoplastic Resection of the Skull. In this operation for exposing the membranes of the brain, a portion of the skull having the soft parts attached is turned aside, so that it can subsequently be replaced and sutured in its original position. A horseshoe-shaped incision is made, and the edges are allowed to retract (Fig. 456). A groove is next cut through the bone, following the line to which the skin flap has retracted, with a chisel or with a circular saw run by a dental engine or electro-motor. The line of division of the bone should be oblique, so that the outer table of the flap shall rest upon the inner table of the skull when the bone flap is turned back into place. The base of the bone flap is then partly divided with the chisel, with as little disturbance of the soft parts as possible, and the remaining bone in the base of the flap is broken and the flap turned back, the scalp acting as a hinge (Fig. 457).

Gigli's wire saw may be used in operating upon the skull. Two small trephine openings are made and a flat director passed into one of the openings, to separate the dura on a line between them, and the wire saw drawn through this space by a thread attached to a flexible silver

FIG. 456.

FIG. 457.



Osteoplastic resection of the skull. (After TREVES.)

probe. The bridge of bone is then divided by the saw. Any desired amount of bone can be removed by making three or four trephine openings and sawing between them.

If the osteoplastic flap method is employed the skin is left undivided on one side and adherent to the bone flap, and the saw is made to cut the bridge of bone between the trephine openings obliquely, so as to bevel the edges of the flap.

Trephining the Antrum of Highmore. The antrum may be opened by extracting the first or second molar tooth and deepening its socket with a small gouge or bone drill.

The antrum may also be opened through the mouth, to avoid a scar upon the face, by the use of a small trephine or bone gouge; the gingivo-labial fold is divided up to a point just below the infra-orbital foramen, the trephine is placed here and a disk of bone removed, opening the antrum.

Trephining the Frontal Sinus. This sinus may be opened by a trephine or bone gouge. An incision is made from the centre of the supra-orbital ridge to the median line above the root of the nose. The tissues are divided down to the periosteum; this is incised and turned aside, and the trephine or gouge is placed at the centre of the incision near the inner edge of the supra-orbital ridge and a disk of bone is removed, exposing the frontal sinus.

LAMINECTOMY.

This operation, which consists in exposing and cutting away the arches of the vertebræ, to secure a free exposure of the spinal canal and cord, is resorted to in cases of fracture of the vertebræ, tumors of the spinal cord, and in cases of tuberculosis of the spine in which there is marked deformity with paralysis, the object being, as a rule, to relieve the spinal cord from pressure. A straight incision, four or five inches in length, is made over the point at which the arches of the vertebræ are to be removed, and the skin, muscles, and fascia are divided, and the spinous processes and arches of the vertebræ are laid bare. Then with strong bone-cutting forceps the arches of the vertebræ on each side are divided, care being taken to avoid injuring the dura. A better method is the formation of a lateral flap by an incision over the arches upon one side, the periosteum and muscles being reflected to the base of the spinous processes, the latter then being divided with bone forceps or chisel and lifted up in the flap, the dissection of which is continued toward the other side until the arches are exposed from end to end. The latter are then cut away. It is often necessary to remove several laminæ if any considerable amount of the spinal cord or canal is to be exposed.

OPERATIONS UPON NERVES.

Neurotomy. Neurotomy is an operation in which the nerve-trunk is exposed and a section made through the nerve. As in the case of ligation of vessels, it is most important that the operator should have an accurate knowledge of the anatomical relations of the nerves and the surrounding structures. The nerve is exposed by an incision similar to that for the exposure of an artery for the application of a ligature.

Nerve-stretching, Neurectasy, or Neurotony. In the operation of neurectasy, or stretching of nerves, the nerve is exposed and isolated and is lifted upon a blunt hook or retractor; or, in the case of the larger nerves, is hooked out of the wound by the finger, and is thoroughly stretched and replaced in the wound and the latter is closed with sutures.

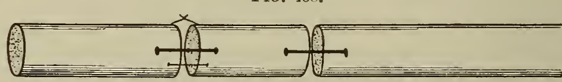
Neurectomy. In this operation the nerve is exposed and a portion of the nerve is excised.

Suture of Nerves or Neurorrhaphy. In bringing into apposition the ends of divided nerves primary or secondary sutures may be employed. The material employed for sutures should be fine silk or fine chromicized catgut.

In using primary sutures the suture in the case of the smaller nerves should be passed through the sheath and substance of the nerve, and in the larger nerves two sets of sutures can be used, one passing through the substance of the nerve the other being passed through the sheath.

Nerve-grafting. In employing secondary sutures to unite the divided ends of nerves when there has been a loss of substance in the nerve, or there has been so much retraction of the nerve that it is impossible to bring the ends together, *nerve-grafting* may be made use of; the ends of the nerve being freshened, a section of a fresh nerve from an amputated limb or animal is sutured to

FIG. 458.

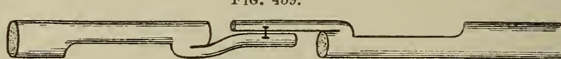


Nerve-grafting. (WILLARD.)

the ends of the divided nerve to fill up the gap, as seen in Fig. 458.

Neuroplasty. Another method of lengthening the ends of the divided nerve, known as neuroplasty, may be employed where the ends cannot be brought into apposition by the ordinary method; in this method flaps are made for the nerve in the same way as in the lengthening of

FIG. 459.



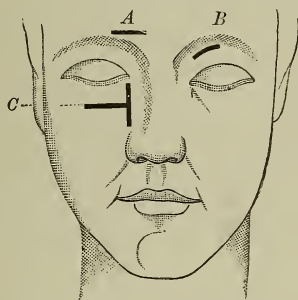
Neuroplasty. (WILLARD.)

shortened tendons, and the ends of the flaps are sutured together, as seen in Fig. 459. *Sutures a distancé* may also be employed, as in the case of the separated ends of tendons (p. 544).

The following incisions are given to expose the nerves for some of these various operations :

The Supra-orbital Nerve. This nerve is exposed at the supra-orbital notch at the junction of the middle and inner thirds of the supra-orbital arch. An incision is made one and a half inches in length, parallel to the eyebrow (Fig. 460, *A* and *B*), and is carried down to the bone; the nerve is exposed and grasped with forceps, and resected or stretched as may be desired.

FIG. 460.



A and *B*. Incisions for resection of supra-orbital nerve. *C*. Incision for resection of the superior maxillary nerve.

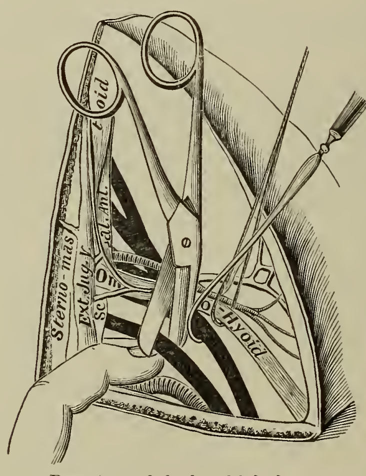
The Superior Maxillary Nerve. A vertical incision is made along the inner side of the nose from the bony ridge of the nasal process of the superior maxillary bone to the ala of the nose; a second incision is begun at the upper part of this incision and carried outward along the lower margin of the orbit beyond its centre (Fig. 460, *C*); the lower flap is dissected up and the nerve is exposed. The upper flap is next lifted up with the lower eyelid and eyeball, exposing the floor of the orbit, and the infra-orbital canal can be recognized running backward and inward; the canal is opened with a knife or chisel, and the nerve is separated from the artery and cut off as far back as may be necessary. The nerve may also be reached by exposing the anterior wall of the antrum, and trephining this and the posterior wall, and, when found, may be cut off close to the exit of the main trunk from the round foramen in the sphenoid bone.

The Inferior Dental Nerve. To expose this nerve, an incision is made along the lower jaw, from a point just behind the angle, and carried forward to a point just in front of the edge of the masseter muscle; the periosteum and masseter muscle are then separated from the bone with an elevator, and the inferior dental canal may be opened with a small trephine or chisel; the exposed nerve is then raised upon a hook and resected.

The Lingual Nerve. The lingual nerve can be felt just behind the attachment of the pterygo-maxillary ligament, on the inner side of the lower jaw, close to the bone, below the last molar tooth; the tongue should be drawn to one side and the mucous membrane divided for an inch, parallel to the alveolar process, beginning at the last molar tooth; the nerve is then found in the submucous tissue.

The Facial Nerve. This nerve may be exposed at the posterior border of the ramus of the jaw by an incision

FIG. 461.



Resection of the brachial plexus.

extending from just in front of the tragus of the ear to the angle of the jaw. The parotid fascia is divided and the cervico-facial branch may be exposed first, and can be followed back to its junction with the temporo-facial branch.

The Brachial Plexus. The brachial plexus consists of the four lower cervical nerves and the greater part of the first dorsal; it lies between the anterior and middle scaleni muscles and crosses the floor of the subclavian triangle at the base of the neck. To expose the brachial plexus the neck and head are extended and the face is turned toward the opposite side; an incision is made half an inch above the clavicle, between the sterno-cleido-mastoid and trapezius muscles, and is carried forward for about three inches parallel to the anterior border of the trapezius. The skin and platysma are divided, and the external jugular vein is either cut and ligatured or held to one side; the deep cervical fascia is next opened in the line of the external incision, and the outer border of the anterior scalene muscle is felt for; the brachial plexus is found just outside the latter, and is exposed by careful dissection (Fig. 461).

The Spinal Accessory Nerve. To expose the spinal accessory nerve, an incision about three inches in length is made downward from the tip of the mastoid process along the anterior border of the sterno-mastoid muscle; the cervical fascia should be divided and the muscle strongly retracted, to put the nerve on the stretch. The nerve should be found external to the jugular vein, about an inch and a half below the tip of the mastoid process, on the fascia covering the rectus capitis anticus major.

The Median Nerve. The median nerve may be exposed at the bend of the elbow or just above the wrist. To expose the median nerve at the bend of the elbow an incision is made about an inch and a half in length upon the inner edge of the biceps tendon; the bicipital fascia is divided and the nerve is exposed at the inner side of the brachial artery. The median nerve may also be exposed above the wrist by an incision two inches in length along the inner border of the tendon of the palmaris longus muscle.

The Ulnar and Radial Nerves. These nerves may be exposed by an incision similar to that employed for ligation of the ulnar or radial artery.

The Musculo-spiral Nerve. The musculo-spiral nerve is exposed by an incision on the outer side of the arm above the elbow, from the upper part of the supinator groove; the fascia being divided, the nerve is sought for at the bottom of this groove.

The Great Sciatic Nerve. To expose the great sciatic nerve, an incision three or four inches in length is made vertically downward from the gluteal fold at a point midway between the tuberosity of the ischium and the great trochanter; the skin and fascia being divided, the lower border of the gluteus maximus and the hamstring muscles are exposed; the nerve rests on the external rotators of the thigh just in front of the outer side of the hamstring muscles.

The Internal Popliteal Nerve. This nerve is exposed by an incision two inches in length in the middle of the popliteal space. The nerve is slightly external to the vein and artery, and is more superficially placed.

The External Popliteal Nerve. This nerve is exposed by an incision two inches in length, parallel and close to the inner side of the biceps tendon, and lies close behind and to the inner side of the tendon of the biceps muscle.

The Anterior Crural Nerve. This nerve is exposed by an incision about two inches in length, extending from Poupart's ligament downward, and about an inch to the outer side of the femoral artery.

OPERATIONS UPON TENDONS.

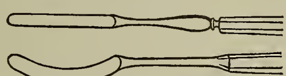
Tenotomy. This is an operation which consists in the division of a tendon, and it may be done subcutaneously

FIG. 462.

Sharp-pointed tenotome.

or by an open operation. The former method of tenotomy is to be preferred in most cases, but in certain tendons which lie in close proximity to important vessels and nerves it is safer to employ the open operation. In dividing tendons the parts should be placed in such a position as to put the tendon upon the stretch. The instruments required are a sharp and a blunt-pointed tenotome. The sharp-pointed tenotome (Fig. 462) is used to make a puncture down to the edge of the tendon, being entered flatwise; it is then withdrawn and a blunt-pointed tenotome (Fig. 463) is introduced through the puncture, passed under

FIG. 463.

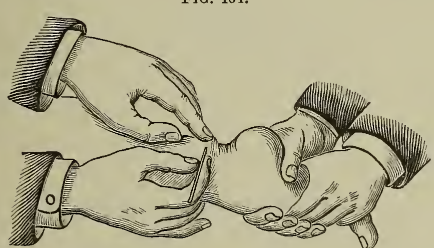


Blunt-pointed tenotomes.

the tendon, and turned so that the tendon rests upon its cutting edge; by a gentle rocking motion the tendon is then divided, and the tenotome should be turned flatwise and withdrawn.

The Tendo-Achillis. In dividing this tendon, a sharp-pointed tenotome should be entered at the inner border

FIG. 464.



Tenotomy of tendo-Achillis.

of the tendon about an inch above its attachment to the calcaneum (Fig. 464); the heel should be depressed as much as possible, so as to make the tendon prominent, and the sharp-pointed tenotome should be passed through the skin and behind the tendon; this is next removed and a blunt-pointed tenotome is introduced and the tendon is divided. The posterior tibial artery, nerve, and vein lie to the inner side, and are not likely to be injured if the tendon is divided from this point.

The Posterior Tibial Tendon. This tendon may be divided above the inner malleolus. The muscle is made tense by everting the foot, and the tenotome is entered at the inner side of the tendon and passed behind it. The posterior tibial tendon may also be divided upon the side of the foot; for this operation the foot is everted and the tenotome is passed from above downward and passed under the upper border of the tendon at a point half an inch below and in front of the tip of the internal malleolus.

The Anterior Tibial Tendon. This tendon is divided upon the dorsal surface of the foot, just below the annular ligament of the ankle, midway between the two malleoli.

The Peroneal Tendons. The peroneal tendons may be divided about an inch above the external malleolus, the tenotome being passed from before backward between the fibula and the tendons, or the tendons may be divided at a point midway between the end of the external malleolus and the tubercle of the cuboid.

The Hamstring Tendons. The inner hamstring consists of the tendons of the semi-tendinous, semi-membranosus, gracilis, and sartorius. The external hamstring consists of the tendon of the biceps. To divide either of these tendons the knife is entered at the inner side of the tendon. In dividing the external hamstring care should be taken to keep close to the tendon of the biceps, as the external popliteal nerve lies close to its inner border.

The Adductor Longus. To divide this tendon, abduct the thigh and make the muscle prominent near its insertion; then pass the tenotome from without downward and inward.

The Flexor Longus Pollicis. This tendon may be divided on the first phalanx or near the inner edge of the foot, where it may be made prominent by strong extension of the great toe, the tenotome being passed close to the border of the tendon.

The Extensor Longus Digitorum. These tendons are divided upon the dorsal surface of the metatarsal bones, where they are quite prominent. They may also be divided near the ankle.

The Extensor Proprius Pollicis. This tendon may be divided in the same incision used for division of the long flexor of the toes, the point of the knife being carried inward.

The Sterno-cleido-mastoid Muscle. In tenotomy of this muscle, the sternal and clavicular attachments are divided about an inch above the sternum and clavicle. A puncture is made to the outer side of the muscle with a sharp tenotome, and when the tendinous expansion of the muscle is reached it is withdrawn, and a blunt tenotome is substi-

FIG. 465.

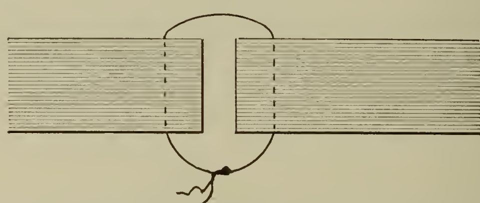
Tenotomy of sterno-mastoid.

tuted for it and the structure is divided. The sternal attachment is divided through a separate puncture in the same way. The external jugular vein is to be avoided at the outer border of the muscle. The division of the muscle, or its tendinous expansion by an open operation, is now very often practised, as there is less risk of injuring the vein by this procedure.

Suture of Tendons. In bringing together the divided ends of tendons primary or secondary sutures are employed; primary sutures are those introduced immediately after the injury, and secondary sutures are those introduced after retraction of the ends has occurred and the wound has healed.

Primary Suture of Tendons. The material employed for sutures may be silk, silkworm-gut, catgut, or kangaroo-tendon, and one or more sutures may be employed, being passed through the substance of the ends of the tendon

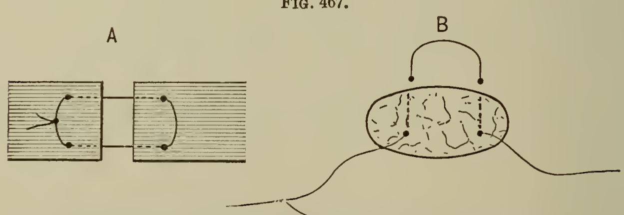
FIG. 466.



Suture passed through the substance of the ends of divided tendon.

and secured by tying; the divided sheath of the tendon, if possible, should be brought together by fine silk sutures (Fig. 466). Very marked retraction of the ends of the tendon is apt to occur, and a considerable dissection is often required to bring them into view.

FIG. 467.

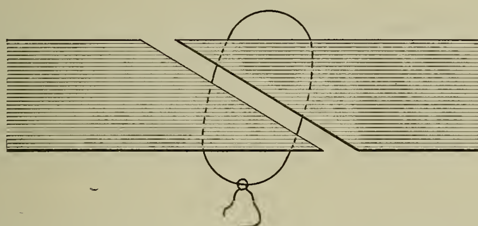


Tendon-suture which does not easily tear out. (STIMSON.)

When there is difficulty in bringing the ends of the tendon together, and the sutures are apt to cut out, the form of suture shown in Fig. 467 may be employed.

Secondary Suture of Tendons. In applying secondary sutures to tendons, the principal difficulty is often encountered in bringing the ends of the tendon in contact and in holding them successfully in this position. The ends of the tendon have first to be freshened, and this may be done by cutting them obliquely and introducing a suture as shown in Fig. 468. This method of section presents a large raw surface of the tendon for union.

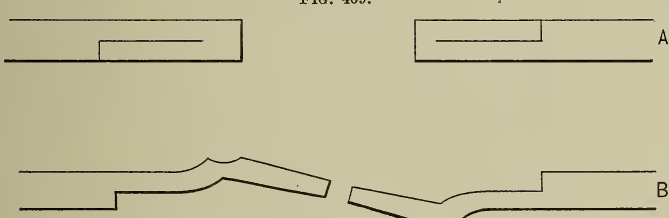
FIG. 468.



Oblique section of ends of tendon to increase surface of contact. (STIMSON.)

Lengthening of Tendons. When so large a gap exists between the ends of the tendon that they cannot be brought into apposition, a plastic operation may be performed upon their ends, which often overcomes the difficulty. This

FIG. 469.



Lengthening of retracted tendon by flaps. (STIMSON.)

consists in making a section half-way through the tendons, at some distance from their ends, and splitting them toward their divided extremities, and then turning out these flaps and securing their ends by means of sutures (Fig. 469).

When the ends of the tendon are so widely separated that they cannot be approximated, *sutures a distancé* may be employed. These consist of sutures of sterilized silk or chromicized catgut passed between the ends of the tendons and tied, the sutures acting as a scaffolding upon which reparative material forms between the separated ends of the tendons.

REMOVAL OF THE BREAST.

This may be accomplished by making a circular incision around the breast, or by an incision starting at the anterior edge of the axilla and carried around the breast and brought back to the point of starting. The incision is deepened and the muscles are exposed, and the breast is dissected free from the muscles and removed. The axilla is next opened and any enlarged glands are removed. The modern operation of removal of the breast for malignant disease is one which is similar to that employed by Kocher and Halsted, and consists in removal of the breast, with the pectoral muscles and the axillary glands and connective tissue, the incision being very extensive, and extended so as to permit of the removal of glands situated above the clavicle.

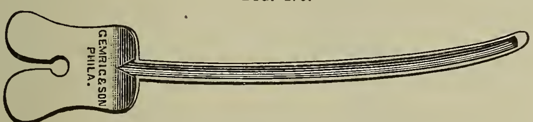
TRACHEOTOMY.

This operation consists in dividing the tissues over the trachea in the median line of the neck, and after the trachea has been exposed it is opened by dividing two or three of the tracheal rings.

The ease with which the operation is performed varies much in different cases; it is, as a rule, a much simpler operation in adults than in children. In the latter subjects the shortness of the neck, the relatively greater size of the thyroid gland, and the possible presence of the thymus body, the great vascularity of the parts, and the abundance of adipose tissue, render the trachea difficult to expose and open.

Under certain circumstances the operation may be performed with very few instruments; but if the surgeon has the choice he will find it convenient to have at hand two small scalpels, one short grooved director, a tenaculum, two aneurism needles, which may be used as retractors, one pair of artery forceps, hæmostatic forceps, two pairs of dissecting forceps, a pair of scissors, a sharp-pointed tenotome, a pair of tracheal forceps, a tracheal dilator, tracheotomy tubes, tapes, ligatures, sponges, a flexible catheter, and feathers. The *director* should be short; the ordinary grooved director is too long to use with satisfaction in operating upon the short necks of children; so that I use a shorter and somewhat broader one, which has a bevelled extremity, which allows it to be passed with ease between the different layers of the tissues (Fig. 470).

FIG. 470.



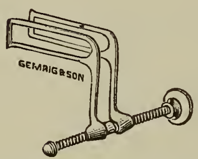
Author's tracheotomy director.

Hæmostatic forceps are also of great use in controlling hemorrhage during the operation in case of the division of vessels which bleed freely, when the operator from the urgency of the case does not think it justifiable to ligature them at the time of their division. They may also be employed under similar circumstances to clamp the isthmus of the thyroid gland on either side of the trachea when it becomes necessary to divide it to expose the trachea.

A sharp-pointed tenotome is the instrument I prefer to employ in opening the trachea, as its sharp point enables it to be easily thrust into the trachea, and its short cutting surface and the narrowness of the blade obscure as little as possible the line of incision, and thus enable the operator to see exactly where he is cutting.

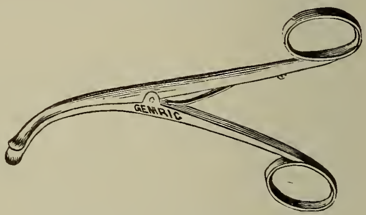
Tracheal dilators of various kinds are employed, but the most satisfactory tracheal dilator which I have employed is that of Golding-Bird (Fig. 471), which is a self-retaining instrument; the blades are slipped through the tracheal incision and are then expanded by turning the screw to which they are attached.

Fig. 471.



Golding-Bird's tracheal dilator.

Fig. 472.

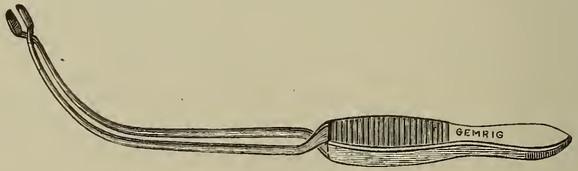


Trousseau's tracheal dilator.

Trousseau's tracheal dilator, the blades of which are introduced through the incision in the trachea and are expanded by bringing together the handles, is also a satisfactory instrument (Fig. 472), but is not so useful as the tracheal dilator previously mentioned, as it has to be retained in position by the hand. Tracheal dilators may be improvised from bent hair-pins or pieces of wire, which will often serve a useful purpose where ordinary dilators cannot be obtained.

It is also well to have at hand a number of pliable feathers to be used in cleaning the trachea or larynx of mucus or membrane after it has been opened, and by their use this object can be accomplished with little risk of injury to the mucous membrane.

Fig. 473.

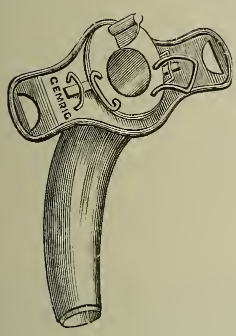


Tracheal forceps.

Tracheal forceps, which are constructed with a double spring and curved blades, are also useful in removing membrane or foreign bodies from the larynx above the wound or from the trachea below the tracheal incision (Fig. 473).

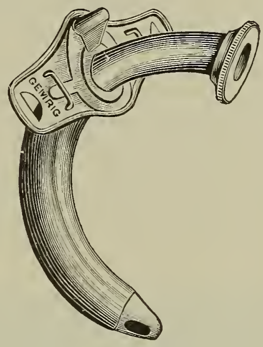
Tracheotomy-tubes of various shapes are made of silver, aluminum, hard and soft rubber, but the tube which I think is the most satisfactory for general use is a silver quarter-circle tube with a movable collar (Fig. 474), and provided with a fenestrated guide (Fig. 475). A good

FIG. 474.



Silver tracheotomy-tube.

FIG. 475.



Silver tracheotomy-tube with fenestrated guide.

tracheotomy-tube is one which inflicts the least possible injury upon the mucous membrane of the trachea, and to insure this object the part of the tube within the trachea should lie exactly in its axis, and its free extremity should be capable of as little movement as possible. The tracheotomy-tube is held in position after being introduced by means of tapes attached to the shield of the tube and tied around the neck.

Position of Patient for Tracheotomy. The best position in which to place the patient for this operation is that which brings the neck into the greatest prominence, and this can best be obtained by laying the patient upon his back upon a firm table and placing under the shoulders a round cushion; or an empty wine-bottle, or a roller-pin wrapped in towels, will answer the same purpose (Fig. 476). If an anæsthetic is not used, the arms should be held by an assistant, which is better than securing them by a binder fastened around the chest, which restricts respiratory movements.

Operation of Tracheotomy. The trachea may be opened above the isthmus of the thyroid gland or below it, and these operations constitute respectively the *high* and *low* operations.

The *high* operation is generally selected, because at this point the trachea is more superficial and is more easily exposed, whereas in the *low* operation the trachea is more difficult to expose by reason of its relatively greater depth, the large size and number of the veins, and its proximity to the large arterial trunks.

The patient being placed in position, and the best position is secured by placing a firm pad under the shoulders, or the head may be dropped over the edge of the table,

FIG. 476.

Position of patient for tracheotomy.

the object being to secure a free exposure of the neck and to render the trachea as superficial as possible. The operator stands at the head of the patient; this position I prefer, as it is easier from this point to keep the incisions exactly in the median line of the neck. The operator next makes himself familiar with the landmarks of the neck; locating the position of the *cricoid cartilage*, he makes an incision through the skin in the median line of the neck from one and a half to two inches in length, the position of the cricoid cartilage being the middle point. There is no disadvantage in making a longer incision if a freer exposure of the parts is required. Having divided the skin, the operator will often see a large vein lying in the superficial fascia—the *superficial anterior jugular;* this should be displaced and the fascia divided upon the director.

The surgeon should keep his incisions strictly in the median line of the neck, for this is the line of safety; and he should be careful, as the wound increases in depth, not to make the incisions too short, so that it becomes funnel-shaped.

When the deep fascia is exposed it should be picked up and divided upon the director, and any large veins in the line of the wound should be carefully displaced, or, if this is impossible, they should be ligated on each side and then divided between the ligatures.

The operator now looks for the intermuscular space between the *sterno-hyoid* and the *sterno-thyroid muscles*, which can generally be found without difficulty, and the muscles are now separated in this line, with the handle of the knife or with the director, and the *isthmus of the thyroid gland* will be exposed. The muscles should now be held aside by retractors placed on either side.

The operator should carefully explore the wound with the finger, to locate exactly the position of the trachea, and to ascertain, if possible, the presence of any anomalous arteries.

The isthmus of the thyroid gland having been exposed, generally occupying a position over the first three tracheal rings, the gland will be found surrounded by a plexus of veins, which should be displaced with the director, or, if this is impossible, they should be ligated on each side and divided between the ligatures. The thyroid isthmus is next displaced upward or downward, according as the surgeon desires to open the trachea below or above this body. This is often done without difficulty, especially its upward displacement; but when there is difficulty in displacing it downward, a procedure recommended by Bose may be employed, which consists in making a transverse incision across the cricoid cartilage to divide the layer of fascia by which the isthmus is bound down; a director is then passed into this incision and the isthmus is gently depressed without difficulty.

Having displaced the isthmus of the thyroid gland upward or downward, the trachea, yellowish-white in appearance, covered by the tracheal fascia, will be exposed; this fascia should next be thoroughly broken up with the

FIG. 477.

Opening the trachea. (LISTON.)

director or handle of the knife, so as to bare the trachea, and in doing this the operator can feel it crepitate under the finger from the suction of air drawn in with inspiration. The trachea is next fixed with a tenaculum, introduced into it a little to one side of the median line; an incision is made into it with a narrow knife from below upward, from one-half to three-fourths of an inch in length (Fig. 477), care being taken to see that this incision is in the median line, for if the trachea be opened by a lateral incision the wound does not heal so promptly and the tracheotomy-tube does not fit well, and its lower extremity may cause injury to the mucous membrane of the trachea. If the wound be a deep one, after fixing the trachea with the tenaculum the operator may lift it slightly from its bed, thereby bringing it more prominently into view and making it more superficial in the wound, thus facilitating its opening. As soon as the incision is made into the trachea there is a gush of air from the wound in the trachea, mixed with blood or membrane; this should be wiped away with a sponge and a tracheal dilator should next be introduced and the trachea should be cleared of membrane, if it is present in the region of the wound, with a feather or with forceps. The tracheotomy-tube is next introduced, and is secured in position by tapes tied around the neck.

If respiration has ceased, artificial respiration should be resorted to, or the use of a tube attached to a bellows, or Fell's apparatus, and these efforts should be continued for at least fifteen minutes, for I have seen resuscitation take place in patients who were apparently dead by a persistent employment of artificial respiration.

Laryngotomy. In this operation an opening is made into the air-passages through the *crico-thyroid membrane.* It is a simple operation, and one which is practically free from risk, and can, therefore, be performed much more rapidly and safely in urgent cases than tracheotomy.

The patient being placed in the recumbent posture, with the shoulders slightly elevated and the head thrown back, to make the neck as prominent as possible, the surgeon feels for the prominence of the *thyroid cartilage*, and steadying the larynx between the finger and thumb of the left hand, he makes an incision in the median line over the centre of the thyroid cartilage and extending downward for an inch or an inch and a half. The skin and superficial fascia being divided, the fascia between the *sterno-hyoid muscles* and the areolar tissue is exposed and divided, and the *crico-thyroid membrane* is exposed. The knife is then passed transversely through the membrane into the larynx, care being taken that both that membrane and the mucous membrane which covers its inner surface are divided at the same time. As soon as the knife enters the cavity of the larynx blood and mucus will be forcibly expelled.

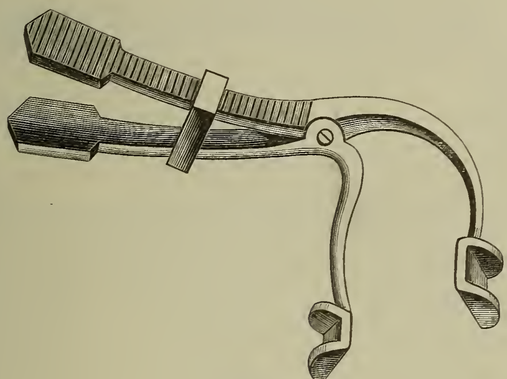
The wound should be carefully enlarged and a tube introduced, which differs from the ordinary tracheotomy-tube in being slightly flattened; this is secured in position by tapes tied around the neck, as in the case of the ordinary tracheal tube. The only bleeding which is likely to occur is from the *crico-thyroid arteries* or *veins*, and if these cannot be avoided, and are divided in the operation, they should be temporarily secured by hæmostatic forceps or ligatured, and if the case is not extremely urgent, all bleeding should be arrested before the crico-thyroid membrane is incised.

Laryngo-tracheotomy. This operation consists in making an incision into the air-passages by dividing one or two of the upper rings of the trachea, the crico-tracheal membrane, the cricoid cartilage, and the crico-thyroid membrane. This operation is employed in cases where, from the age of the patient, the crico-thyroid space is too small to admit of a sufficient opening, or in those in which, for any reason, the surgeon does not deem it advisable to attempt to open the trachea lower down. The incision in the skin and superficial fascia of the neck is made in the same manner as in the operation of laryngotomy, but is carried a little further downward. It may be necessary to displace the isthmus of the thyroid gland downward to expose the upper portion of the trachea, and when the trachea is exposed the incision should be made through this and the cricoid cartilage from below upward. A tracheotomy-tube is introduced through the wound and secured by tapes tied around the neck.

INTUBATION OF THE LARYNX.

This procedure, at the present time, is widely employed as a substitute for tracheotomy in the treatment of dyspnœa due to inflammatory affections of the larynx or trachea, or

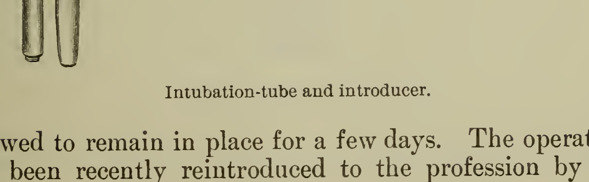
FIG. 478.



Mouth-gag.

stenosis of the larynx; it consists in the introduction of a metallic or hard rubber tube into the larynx, which is

FIG. 479.

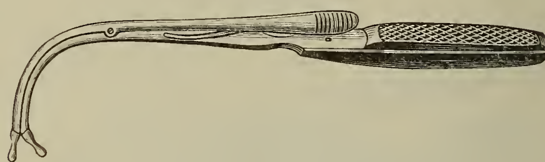


Intubation-tube and introducer.

allowed to remain in place for a few days. The operation has been recently reintroduced to the profession by the late Dr. O'Dwyer, of New York, who devised a set of ingenious instruments for the purpose of laryngeal intubation.

The instruments required are a mouth-gag (Fig. 478), with which the jaws are separated and held open; an in-

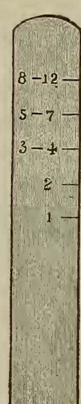
FIG. 480.



Intubation-tube extractor.

strument for the introduction of the tube, which is fastened to the obturator, which fills the cavity of the tube (Fig. 479), and an instrument for extracting the tube after it has been placed in the larynx (Fig. 480). The tubes are

FIG. 481.



Scale of intubation-tubes.

of metal or hard rubber, and have a collar which rests upon the false cords and bulge slightly toward their middle and again taper toward their lower extremity; at the collar of the tube there is a perforation through which a strand of silk is passed which is made into a loop; this is used to allow the operator to remove the tube if on its introduction it is found to have passed into the œsophagus instead of the larynx, and also is used to remove the tube if it becomes occluded with membrane while in the larynx. The intubation set now in common use is provided with a scale of seven tubes, ranging in size from such as are suited for a child of one year or less up to the age of twelve or fourteen years (Fig. 481).

Operation of Intubation of the Larynx. In performing the operation of intubation of the larynx, the child is placed upon the lap of the nurse or assistant, wrapped in a blanket, and the arms are secured by the nurse holding the elbows so as not to interfere with the respiratory movements. The patient's head is next secured by an assistant, and the position of the head, neck, and body should be as if he were hung from the top of the head, and this position should be firmly maintained during the insertion of the tube. The mouth-gag is next inserted upon the left side and the blades dilated so as to open the jaws widely, and as the gag is self-retaining, this position is easily maintained. The jaws being thus held open, the operator, sitting on a chair facing the patient (Fig. 482), next introduces the index finger of the left hand, protected by a strip of adhesive plaster or a metal shield, into the mouth and passes it over the tongue until he feels the epiglottis. The introducing-instrument, to which the tube is attached, is held in the right hand, and this is now introduced into the mouth, first seeing that the silken loop is free, and it is swept over the tongue and passed down until it touches the epiglottis; this is hooked up by the index finger of the left hand and the tube is passed into the larynx; the index finger of the left hand is then transferred to the edge of the tube, and by pressing upon the trigger of the instrument with the thumb of the right hand the obturator is detached and the instrument is withdrawn, and before removing the finger it is well to place it upon the head of the tube and to sink it well into the larynx. As soon as the obturator is removed there is usually a violent expiratory effort, which is accompanied by a gush of mucus, mucopurulent matter, or membrane from the tube, and

Fig. 482.

Intubation of the larynx.

after this escapes the breathing is usually satisfactorily established. If the operator has passed the tube into the œsophagus and has detached it from the introducing-instrument, no improvement in the respiration takes place; it should then be withdrawn by the silk loop and attached to the obturator, and another attempt should be made to introduce it into the larynx.

The mistake which inexperienced operators make in attempting to introduce the tube is in not hugging the posterior surface of the tongue closely, so that they pass the tube over the epiglottis into the œsophagus.

The silken loop may be brought out at one side of the mouth and adjusted around the ear or fastened to the side of the face by strips of adhesive plaster for a few hours, so that by drawing upon it the nurse or attendant is able to withdraw the tube instantly if it should become obstructed with membrane; or, if it is coughed up, by this means it may be withdrawn from the œsophagus if it has not been expelled from the mouth. Some operators keep the loop attached to the tube during the time it is retained in the larynx. I prefer to remove it after the tube is securely placed in the larynx and withdraw the tube by means of the extracting-instrument when required. The tube is removed at the end of the second or third day, and if the child is able to breathe comfortably for an hour or two it is not reïntroduced; if, however, the dyspnœa returns it is reintroduced and allowed to remain one or two days longer; several attempts may have to be made before the tube is permanently removed, but it is usually dispensed with from the third to the eighth day.

The most serious complication which is apt to occur during the introduction of the intubation-tube is the detachment and pushing of a mass of membrane in front of the tube into the trachea; if this is too large to be expelled through the tube the breathing is suddenly arrested. The tube should be removed at once, and if the mass of membrane does not escape upon the expiratory efforts of the patient, the trachea should be rapidly opened as the only means of re-establishing the respiratory function. So much do I dread this accident, which has occurred in a few cases, that I never introduce the intubation-tube without having at hand the necessary instruments to do a tracheotomy if it should be suddenly required, and, if possible, obtain the consent of the parents or friends to perform tracheotomy if it should be indicated.

One of the greatest troubles after intubation of the larynx is the satisfactory feeding of the patient; liquids, as a rule, are not swallowed well, a portion of them escaping into the tube, causing coughing and difficulty in breathing. The diet I usually order is of semi-solids, such as corn-starch, soft-boiled eggs, and mush; and if these are not well swallowed, it may be necessary to resort

FIG. 483.

Feeding a case of intubation of the larynx.

to nutritious enemata or the use of a stomach-tube to introduce food. Some patients swallow liquids and semi-solids quite well if the head is dropped a little lower than the body during the act of deglutition (Fig. 483).

OPERATIONS UPON THE KIDNEY.

Nephrotomy. In this operation an incision is made into the kidney. The incision for exposure of the kidney is four inches in length, and should be made from a point two and a half inches from the spine, half an inch below the last rib and parallel with it. The latissimus dorsi, external and internal oblique, and transversalis muscles are divided, and the lumbar fascia is opened, exposing the perinephric fat; the kidney is then reached by displacing this.

Lumbar Nephrectomy. The incision is the same as for nephrotomy, but the wound can be enlarged by another incision at right angles to the first, if more space is required. After the kidney is exposed its capsule is incised, and the finger is passed around the organ to separate it freely from the capsule. When the ureter is recognized it is brought into view, ligatured, and cut off. The pedicle containing the vessels is next tied, and it is then divided in advance of the ligature with scissors, and the kidney is removed.

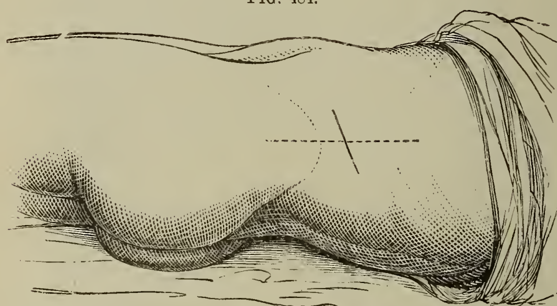
Abdominal Nephrectomy. To reach the kidney by abdominal incision, an incision four inches long is made at the outer border of the rectus muscle; the abdomen is opened and the viscera turned aside; the kidney is exposed and the capsule is opened; the ureter is ligated and the vessels are tied and the organ is removed, and a drainage-tube may be introduced or the wound in the abdominal walls may be closed without drainage.

Nephrorrhaphy. Nephrorrhaphy is an operation in which the kidney is exposed through the same incision as that for nephrotomy, with the object of suturing a movable kidney fast in its normal position in the back; when the kidney has been reached a number of sutures are introduced into the capsule of the kidney, and secured to the fibrous and muscular tissue of the incision. Many surgeons prefer to omit the introduction of sutures and simply scarify the capsule of the kidney or dissect off a portion of the capsule, and then pack the wound with strips of gauze and allow the wound to heal by granulation.

OPERATIONS UPON THE COLON.

Lumbar Colostomy. In performing lumbar colotomy, or colostomy, on the left side, the patient should be placed upon the right side, and a pillow should be placed under the loin to make the left side more prominent. An incision four inches in length is made midway between the last rib and the crest of the ilium, the centre of the incision corresponding to the point midway between the anterior superior and posterior superior processes of the ilium; the tissues are divided to the full extent of the wound,

FIG. 484.



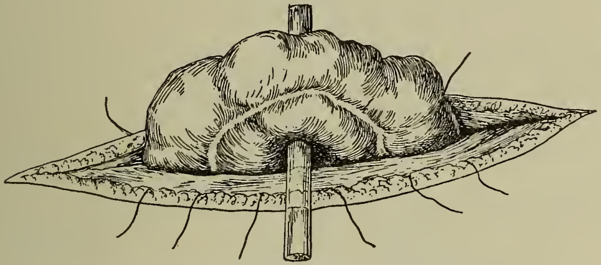
Incision in lumbar colotomy—dotted line shows situation of the colon. (BRYANT.)

until the lumbar fascia and edge of the quadratus lumborum muscle have been reached; the former being cut through and the edge of the muscle divided, the bowel is exposed, when it is brought to the surface and fastened by sutures to the skin and subjacent tissues and opened.

Inguinal Colostomy. In the operation of inguinal colostomy, an incision three inches in length is made on the left side parallel to and one inch above Poupart's ligament, with its centre on the level of the anterior superior spine of the ilium, or a little lower; or, as practised by Ball, the colon may be exposed by an incision two and a half inches in length, following the line of the linea semilunaris, stopping just short of Poupart's ligament; the tissues are divided layer by layer and the peritoneum is opened; the skin and parietal peritoneum may be united by a few sutures, and the gut is then brought out at the wound and fastened to its margins by fine sutures and is next opened.

Maydl's Operation. In this operation the colon is exposed as in the previous operation, and then drawn out of the wound until its mesenteric attachment is on a level with the external incision. A sterilized glass rod or piece of catheter, or a roll of gauze three inches in length, is slipped through a slit in the mesocolon close to the gut.

FIG. 485.



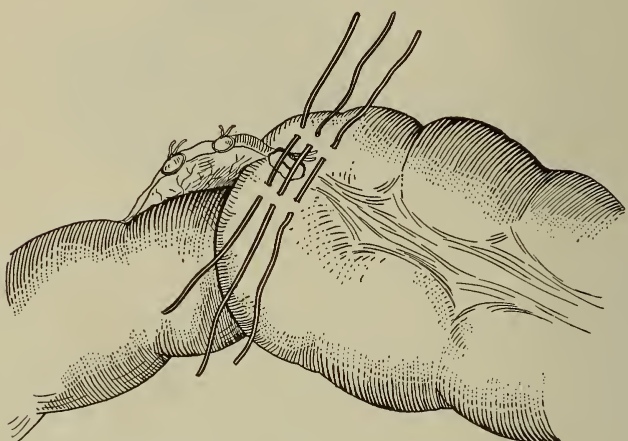
Colon held in wound by glass rod. (PILCHER.)

This holds the intestine in the wound and prevents its return to the abdominal cavity until adhesions have formed. The two limbs of the flexure of the gut exposed in the wound should be united by sutures beneath the support. If the gut is to be opened immediately it should be stitched to the parietal peritoneum of the abdominal incision. If the opening of the bowel can be postponed for twenty-four or forty-eight hours the introduction of sutures is not required. The bowel may be opened by a transverse incision with a knife, or by the thermo-cautery, to avoid bleeding.

REMOVAL OF THE APPENDIX VERMIFORMIS.

To expose the appendix, an incision three to four inches in length at the outer border of the right rectus muscle is made, with its centre on a line drawn between the umbilicus and the anterior superior spine of the ilium; the tissues are divided layer by layer and the peritoneum is picked up and opened; the anterior longitudinal band is recognized and traced down to its origin at the appendix. When the appendix is found the meso-appendix is ligatured and the appendix is removed. In removing the appendix a circular incision may be made around it near its base, and the cuff may be turned back; the body of the appendix is then ligated, and the turned-back cuff is then brought forward and united by fine silk or catgut sutures. The appendix may also be ligated and cut off

FIG. 486.



Method of burying the stump of the appendix. (RICHARDSON.)

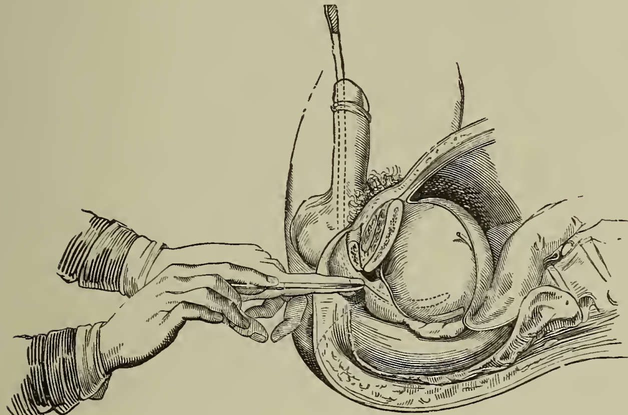
close to the gut or removed by cutting it off close to the gut and then inverting its stump into the colon, and subsequently suturing the walls of the colon together over the position of the stump of the appendix by a few Lembert sutures (Fig. 486).

McBurney's Operation. When the appendix is removed for chronic cases of appendicitis this procedure may be employed with advantage. It consists in making the ordinary incision, and when the external oblique muscle is exposed its fibres are cut or separated in the direction of their length; the edges of the wound are next dilated, and the fibres of the internal oblique and transversalis muscles are separated in the same manner. After the operation is completed the fibres of the muscles may be sutured, and as they cross each other, firm support is given to the abdominal contents, and there is little chance of a hernia forming at the site of the incision.

LITHOTOMY.

Left Lateral Lithotomy. In performing this operation, the patient is placed upon his back, the hands and feet are secured together, and the bladder is injected with a few ounces of boric solution. A grooved staff is introduced into the bladder, and the operator first passes one finger into the rectum, to locate the position of the staff

FIG. 487.



Deep incision in lateral lithotomy. (FERGUSSON.)

as regards the prostate. An incision is then made a little to the left of the raphe of the perineum, a quarter to half an inch in front of the anus, and is carried downward by careful strokes of the knife until the staff is reached, about half an inch in front of the prostate. When the point of the knife enters the groove in the staff it is pushed backward, keeping it well in the groove until the prostate is incised and a gush of fluid escapes along the knife, when it is removed and the index finger is then introduced and the stone located; lithotomy forceps are next introduced and the stone is removed (Fig. 487).

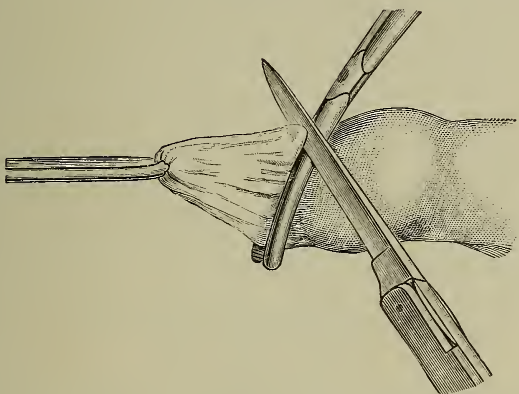
Suprapubic Lithotomy. The operation of opening the bladder above the pubes may be performed for the removal of stone from the bladder, or for the extirpation of growths, or for drainage of the bladder. The hair on the pubes should be shaved off, and the bladder should be injected with a few ounces of fluid and a rubber band tied around the penis; a small rubber bag is then introduced into the rectum empty and filled with air or water. An incision two or three inches in length is made in the median line of the abdomen just above the symphysis pubis, and is deepened gradually until the deep fascia is reached; this is divided and exposes the prevesical fat; when this is displaced the wall of the bladder is exposed to view. A tenaculum is next introduced into the highest part of the vesical wall, to fix it, and a knife is then thrust through the wall of the bladder and the incision is carried downward about an inch. After the bladder is opened forceps are introduced and the calculus is removed. If opened for calculus and the bladder-walls are healthy the wound may be sutured with stitches which do not pass through the mucous coat. The external wound is then sutured and the bladder is drained by a soft catheter passed by the urethra. If the bladder-walls are much diseased the wound is left open, and drainage is effected by a rubber tube passed through the suprapubic wound into the bladder.

CIRCUMCISION.

Circumcision is performed by drawing the prepuce forward and then enclosing it in a pair of clamp-forceps placed obliquely just in front of the glans (Fig. 488).

The prepuce is next divided with a straight bistoury, the forceps are removed, and the skin and mucous membrane retract. The mucous membrane, if adherent, is dissected loose from the glans, and, if redundant, is trimmed off

Fig. 488.



Circumcision.

with scissors, to make it correspond to the line of skin incision, and the cut edge of the mucous membrane is next fastened to the cut edge of the skin by a few sutures of silk or catgut.

REMOVAL OF THE TESTICLE.

In removing the testicle, a longitudinal incision is made over the upper part of the gland and spermatic cord and the envelopes of the testicle and cord are divided; the cord is then exposed and ligatured, or the different elements of the cord may be separated and tied independently; it is divided in advance of the ligatures and the gland removed.

OPERATION FOR VARICOCELE.

In operating for varicocele, the dilated veins of the spermatic cord may be ligatured by a subcutaneous ligature passed around the cord, care being taken to see that the vas deferens is not included. Or the veins of the cord are exposed by an incision an inch and a half or two inches in length, at the upper part of the scrotum, over the cord. The veins are exposed and the larger portion of them are isolated, and two ligatures are passed around the mass of veins about an inch or an inch and a half apart and firmly tied. The portion of the cord between the ligatures is excised and the divided ends of the veins are brought in contact by tying together the ends of the ligatures upon the proximal and distal ends of the veins; the wound is then closed with sutures.

CHOLECYSTOTOMY.

An incision three or four inches in length is made vertically downward from the lower border of the liver opposite the tip of the lower border of the tenth rib; the tissues are divided and the peritoneum is opened. The gall-bladder is then exposed, opened, and sutured to the edges of the wound. If the gall-duct is to be explored, this is done with the finger from without or by a probe. After the gall-bladder has been opened and the stone removed, it may be closed by sutures, or it may be left open, its edges being sutured to the external wound.

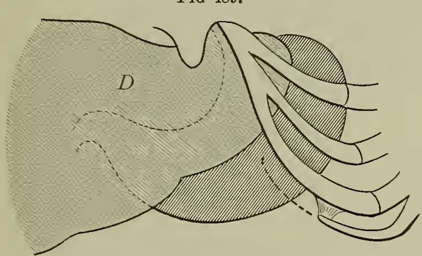
EXTERNAL ŒSOPHAGOTOMY.

A sound is passed through the mouth into the œsophagus until its point comes in contact with the stricture of the œsophagus or the foreign body which requires removal. An incision is then made from a point one inch above the sternum to the line of the upper border of the thyroid cartilage on the inner side of the sterno-cleido mastoid muscle; the anterior jugular vein is displaced, the fascia is divided, the omohyoid muscle is drawn aside, the sterno-mastoid muscle and the vessels are drawn to the outer side with blunt hooks, then by dissecting down with the finger the œsophagus is exposed; the sound which has been passed into the œsophagus can easily be felt, and the œsophagus is incised upon the point of this sound. If a permanent opening is desired the edges of the œsophagus are sutured to the skin.

GASTROSTOMY.

An incision one and a half to two inches in length is made parallel to and a finger's breadth from the border of the left costal cartilage, ending opposite the border of the tenth rib; the tissues are divided layer by layer until the peritoneum is reached (Fig. 489). The latter membrane should be pinched up and opened; the stomach is recognized and

Fig 489.



Anatomical relations of stomach. (Stimson.)

brought out of the wound; the parietal peritoneum is stitched to the skin around the wound, and a fold of the unopened stomach is brought out of the wound and sutured to the parietal peritoneum and the abdominal wall. The opening of the stomach is delayed for twenty-four hours, if possible, to allow of the formation of adhesions between its surface and the parietal peritoneum.

Ssabanajew-Frank Method. A curved incision, three or four inches in length, is made at the margin of the costal cartilages of the left side, and the surface of the stomach is exposed. A cone of the stomach wall is then grasped by forceps, pulled out of the wound (Fig. 490), and passed

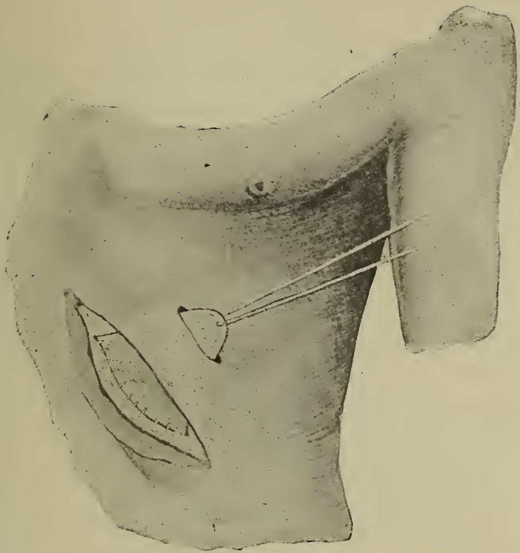
Fig. 490.

Ssabanajew-Frank method; first stage. (Richardson.)

under a bridge of skin and connective tissue, and made to project from a separate wound made about one and a half inches above the original wound (Fig. 491). The wall of the stomach is fastened in the original wound by sutures and the wound closed, and the projecting portion of the stomach in the upper wound is secured by sutures, and the stomach can be opened at any time.

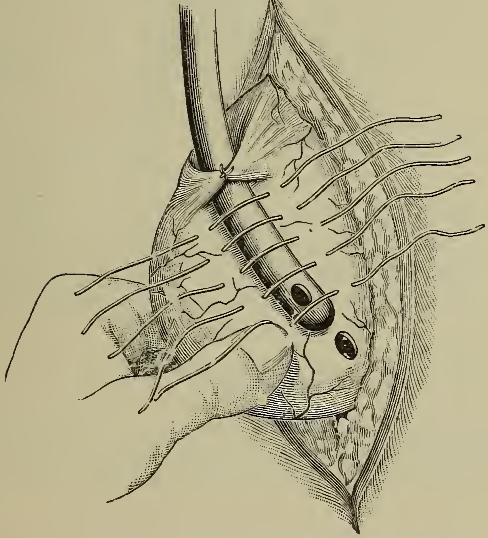
Witzel's Method. This method of gastrostomy also prevents leakage, and is accomplished by making an incision and exposing the wall of the stomach. A small incision is

FIG. 491.



Ssabanajew-Frank method; second stage. (RICHARDSON.)

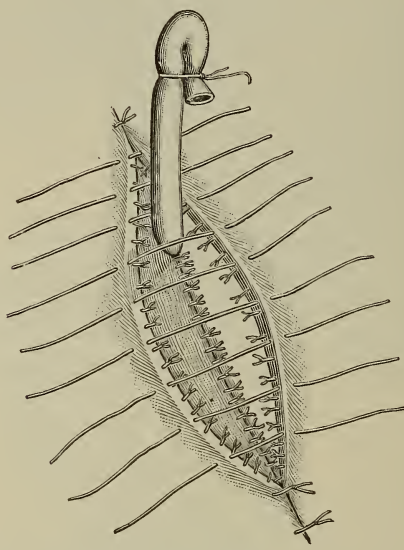
FIG. 492.



Witzel's method; infolding the tubes. (RICHARDSON.)

made in the wall of the stomach, and a rubber tube or catheter is introduced; the portion of the tube in contact with the stomach external to the wound is then infolded by peritoneal approximation, as shown in Fig. 492. The stomach is then stitched to the abdominal wall and the

Fig. 493.



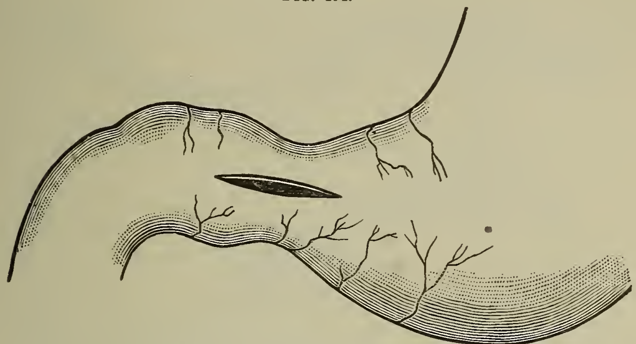
Witzel's method; tube infolded and sutures introduced to close the wound. (Richardson.)

external wound closed (Fig. 493). The tube should not be removed for a week, but feeding may be begun through the tube immediately. Contraction of the fistula may be prevented by the occasional introduction of the tube or catheter.

PYLOROPLASTY.

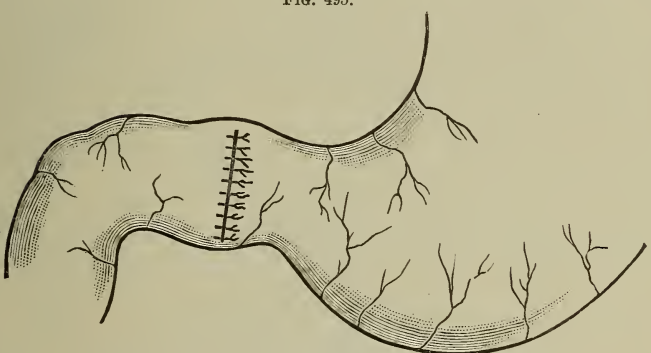
This operation is practised in the case of non-malignant strictures of the pylorus. The pyloric extremity of the stomach is exposed by a median incision, and a longitudinal incision is then made through the anterior surface of the constricted pylorus (Fig. 494), and the incision closed by sutures introduced transversely, as shown in Fig. 495.

FIG. 494.



Incision in pyloroplasty. (RICHARDSON.)

FIG. 495.

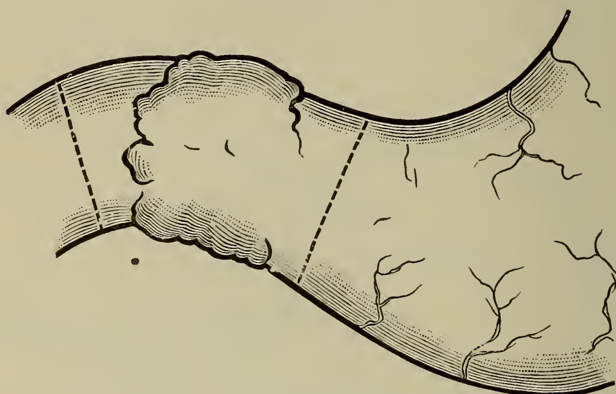


Incision closed transversely by sutures. (RICHARDSON.)

PYLORECTOMY AND GASTRO-DUODENOSTOMY.

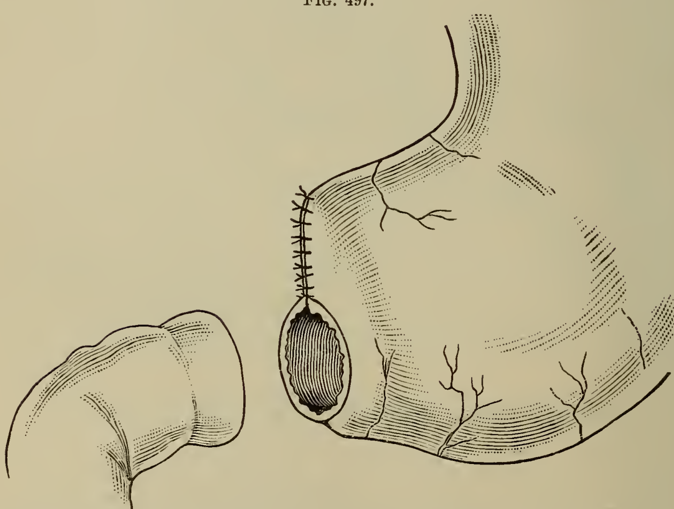
This operation is practised in malignant strictures of the pylorus. It consists in exposing the stomach and duodenum by a median incision; the upper portion of the duodenum and the stomach are next drawn out through the incision, and resection of the diseased portion is accom-

Fig. 496.



Lines of incision for excision of pylorus. (Richardson.)

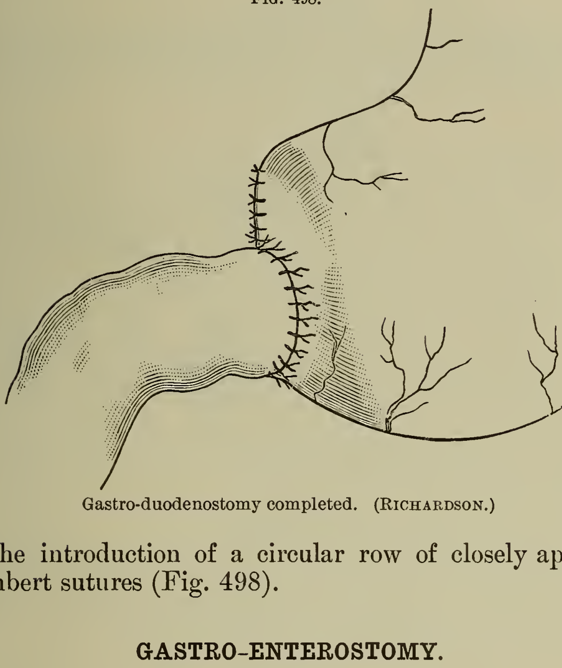
Fig. 497.



Pylorus excised and opening into the stomach partially closed. (Richardson.)

plished (Fig. 496). The opening in the stomach being much larger than that resulting from resection of the duodenum, the wound in the stomach should be partially closed by Lembert sutures (Fig. 497); and when it has been reduced to a proper size to fit the free end of the duodenum, they are fitted together and held in position

Fig. 498.



Gastro-duodenostomy completed. (Richardson.)

by the introduction of a circular row of closely applied Lembert sutures (Fig. 498).

GASTRO-ENTEROSTOMY.

This operation may be combined with pylorectomy, or in cases where it is inadvisable to resect the pylorus, a lateral anastomosis between the stomach and a coil of small intestine near the stomach may be made, so that the contents of the stomach find their way into the intestine through this artificial opening. Where resection of the pylorus is combined with gastro-enterostomy the method of closing the duodenum and stomach and of anastomosis between the intestine and the stomach are shown in Fig. 499.

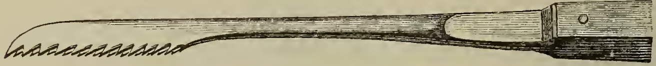
Fig. 499.

Pylorectomy and gastro-enterostomy. (Richardson.)

OSTEOTOMY.

This operation consists in dividing the bones with a saw or osteotome, and is employed to correct deformities of the bones.

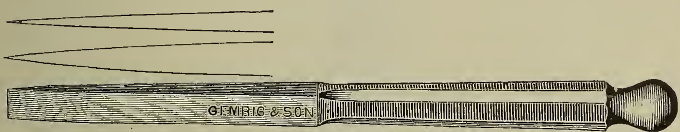
Fig. 500.



Adams' saw.

The instruments employed are a saw with short cutting surface, Adams' saw (Fig. 500), or osteotomes (Fig. 501); a heavy mallet is used to drive the osteotome through the bone. Osteotomy is often employed to correct deformities of the hip following coxalgia, and here the femur is divided either at the neck, Adams' operation, or just below the trochanters, Gant's operation.

FIG. 501.



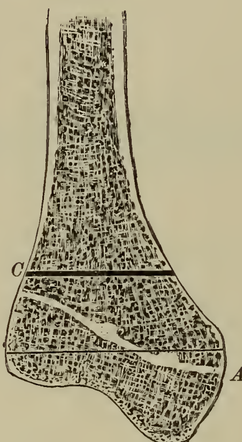
Macewen's osteotome.

Osteotomy of the Femur below the Trochanters. A puncture is made with a bistoury on the outer side of the femur just below the great trochanter, and is carried down to the bone; the blade of the saw is then introduced and the femur is divided by the saw from before backward. The femur may also be divided in this position with an osteotome.

Osteotomy for Knock-knee. The operation employed to correct this deformity is a transverse section of the femur above the condyles (Fig. 502). In the operation of supra-condyloid osteotomy the knee is flexed and supported on a sand-bag. A longitudinal incision one inch in length is made half an inch anterior to the tendon of the adductor magnus and a finger's breadth above the internal condyle; the knife is carried down to the bone, and before it is withdrawn an osteotome is introduced and its edge turned so as to divide the bone transversely. The section of the bone is accomplished by the use of the osteotome and mallet. After the bone has been divided the deformity is corrected, the wound is closed, and the limb is put up in a plaster-of-Paris dressing in the corrected position.

Osteotomy for Bowlegs. To correct this deformity, the tibia and fibula are divided at the point of greatest bowing with an osteotome. The fibula is divided first at the point of greatest bowing by an osteotome entered through a puncture over the fibula, and next the tibia is divided in the same manner. The bones being divided, the deformity is corrected and the limb is put up in a

FIG. 502.



A. Epiphyseal line. *C.* Line of bone section in supra-condyloid osteotomy.

plaster-of-Paris dressing in the corrected position. Osteotomy may also be employed to correct deformities in other bones, or for the deformity resulting from fractures united in faulty position.

INDEX.

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