SURGICAL TECHNIC

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SURGICAL TECHNIC

A Text-book on

OPERATIVE SURGERY

BY

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"*Kurz und Bündig*"

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AND FIFTEEN COLORED PLATES

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SUMMARY OF THE PREFACES OF THE FIRST FIVE GERMAN EDITIONS

FOR promoting the interests of humanity in times of peace under the symbol of the Red Cross,

Her Majesty the German Empress,

on the occasion of the Vienna World's Exhibition, offered two prizes, one of them to be awarded for the best Handbook of Surgical Technic.

The regulations of competition were the following: "The book should present in as concise and intelligible a form as possible the various methods of bandaging and dressing, as well as all surgical operations; but above all it should comprise the present advanced status of Surgical Technic, in order to become the indispensable Guide Book and practical companion of every surgeon."

The jury selected to award the prize consisted of Professor *B. von Langenbeck* in Berlin, Professor *Billroth* in Vienna, and Professor *Socin* in Basle. Unanimously they awarded the first prize to the author of this Surgical Technic.

The author strictly fulfilled the requirements of the competition, but at the same time he purposed to make this handbook a practical aid to memory.

In his opinion this could be better accomplished by illustrations than by a cumbersome text. A glance at an illustration representing a dressing, an operation, or an anatomical preparation, enables one to recall to memory most rapidly all former knowledge concerning the same.

Hence the book contains many illustrations and as concise a text as possible. The author of course endeavored to incorporate all the extraordinary progress which Surgery, and especially Surgical Technic, has made during recent years.

At the end of the work three indexes of names, subject-matter, and illustrations will largely facilitate the use of this book.

FRIEDRICH VON ESMARCH.

SEPTEMBER 3, 1900.

PREFACE OF THE AMERICAN EDITOR

Professor von Esmarch, the senior author of this book, needs no introduction to the medical profession of this country. His name and fame are familiar to every educated physician. As an author and teacher he has few equals. During the last few years he has been ably assisted in his literary work by his former first assistant, Dr. Kowalzig.

It was a happy idea when the publishers decided to present the English reading profession with a translation of the great works of Professor von Esmarch in one volume. The translator had a difficult task. The motto, "Kurz und bündig," characterizes the text. No superfluity of words, the language is concise and precise. If there are any shortcomings in the translation, it is an attempt on part of the translator to reproduce the language of the authors as faithfully and as accurately as possible. The great feature of this book are the numerous excellent illustrations which embellish the text and which enable the reader to follow with his eyes every step of all minor and major operations. The American editor has added notes which appear in brackets in places where he deemed it necessary to add to the text or to indicate his own views or methods of practice.

N. SENN.

Chicago, 1901.

TRANSLATOR'S PREFACE

THE translator believes he is rendering an important service to American and English surgeons in presenting an English translation of von Esmarch's "Surgical Technic." Its excellence is acknowledged by all European surgeons, and now that it has received the careful revision and valuable notes from the hands of its learned editor, it may confidently be regarded as the best handbook on the subject of Surgical Technic in the English language.

L. H. GRAU.

SAN FRANCISCO, May, 1901.

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SURGICAL TECHNIC

THE TREATMENT OF WOUNDS

THE scope of this branch of surgery is **to keep off all injurious influences** that disturb the healing.

These deleterious influences are:—

1. Every **infection** of the wound through *micro-organisms*, since they decompose the secretions of the wound and produce wound-fever, inflammation, suppuration, and all traumatic diseases incident to wounds.

In fresh wounds, infection is *prevented* by the utmost *cleanliness* (**asepsis**), and is *overcome* in already unclean (infected) wounds by *destroying* the germs of infection existing in them (**antisepsis**).

2. The **collection** and **retention** of blood or lymph in the wound (*retention of the secretions of the wound*), since they force apart the margins of the wound and favor the development of any germs of infection that may be present.

These noxious influences are prevented by carefully **arresting hemorrhage**, by perfectly *draining* the secretions of the wound (by **desiccating the wound**), by avoiding dead spaces in the interior of the wound, and by practically applying good absorbent *dressings* (**compressive bandages**).

3. The **gaping** *of the wound*, because it prevents the healing by primary intention.

This is guarded against by a timely and exact *union* of the surfaces and the margins of the wound (**suturing of the wound**).

4. Every **disturbance** of the wound (movement, unnecessary handling, examination, squeezing), because it disturbs the healing and promotes the setting in of hemorrhage and inflammation.

The means of protection against these occurrences are:—

A copious dressing for the wound, the secure fastening of the dressings (**protective dressings**), the changing of the same as rarely as possible (**permanent dressings**), rest of the injured portion of the body (by suitable position, by bandages, splints, fixed dressings, protectors, etc.), constant *rest in bed* in cases of serious wounds, etc. "*Optimum remedium quies est*" (Celsus) (The best remedy is rest).

5. Every *obstruction* of the circulation of blood and lymph (**stasis**) which produces an increased flow of the wound secretions, even gangrene.

This is obviated by **elevation** of the injured parts and by avoiding all *strangulation* caused by clothing or dressings.

6. The **subsequent infection** by change of dressings.

This is prevented by changing the dressings *as rarely as possible*, and by applying aseptic dressings under strictly aseptic precautions.

7. **Inflammation** of the injured parts, and its consequences.

This is combated by **antiphlogistic** treatment, which tends to check inflammation by rest, elevated position, reducing the temperature, and, in inflammation of the joints, by distraction of the articular ends by extension.

ASEPSIS

Asepsis purposes to prevent infection of the wound by excluding or by destroying all pathogenic micro-organisms before they come in contact with it.

Since they are present *everywhere*, infection might take place through the air (**air-infection**) and through the objects that come in contact with the wound (hands, instruments, water, dressings) (**contact-infection**).

The prevention of wound-infection through the most painstaking *cleanliness* and disinfection constitutes the principal object in the following chapter.

PREPARATIONS FOR ASEPTIC OPERATIONS AND DRESSINGS

PURIFYING THE OPERATING ROOM

Lister believed the bacteria floating in the air could be destroyed by an atomized spray of antiseptic fluids (3% carbolic solution). During the operation and the dressing, he had a carbolic spray — created by means of an *atomizer* — directed upon the wound and upon the hands of the surgeon. He used either a small atomizer, operated by hand (Fig. 1), or a larger one, operated by steam.

If the carbolic spray had to be discontinued for some reason during the operation, *Lister* tried to protect the wound from the influence of the air by temporarily covering it with carbolized gauze.

The experience of many surgeons, however, has proved that, even *without* using the spray, wounds often heal very satisfactorily; hence, the carbolic spray, so greatly obnoxious to all who participate in the operation, may *be dispensed with.* It is now hardly ever used *during* an operation, though occasionally before an operation. The use of the spray is, however, no longer necessary, since we know that in still air micro-organisms are gradually precipitated to the floor, thus *leaving the air purified.* For this reason, for some time before the operation, care must be taken not to stir up the dust by cleaning and arranging the room; the necessary disinfection should be made on the day before the operation, and, in the meantime, no one should enter the room. The settled dust, however, may be removed slowly with a moist cloth.

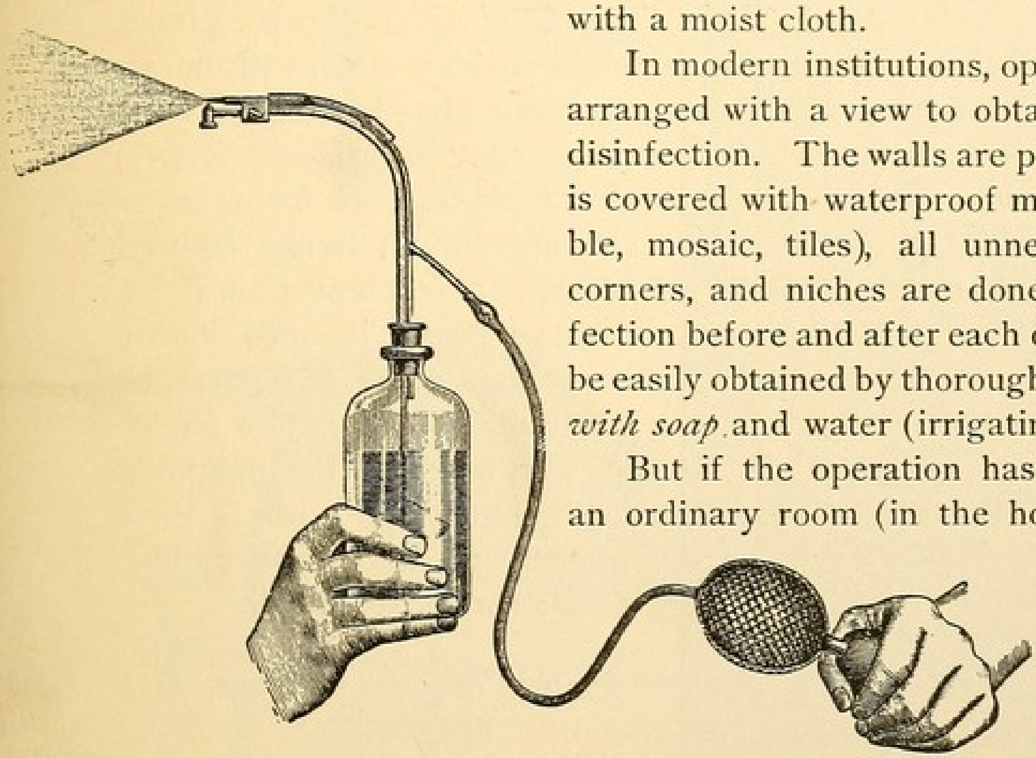


FIG. 1. ATOMIZER FOR CARBOLATED SPRAY

In modern institutions, operating rooms are all arranged with a view to obtaining safe and easy disinfection. The walls are painted in oil, the floor is covered with waterproof material (terrazo, marble, mosaic, tiles), all unnecessary decorations, corners, and niches are done away with. Disinfection before and after each operating session can be easily obtained by thoroughly *washing the rooms with soap* and water (irrigating walls and ceiling).

But if the operation has to be performed in an ordinary room (in the house of the patient), all unnecessary furniture and all "dust catchers" (curtains, carpets, upholstered furniture) are removed. The floor is thoroughly scrubbed, old wall papers are rubbed down with bread (*E. von Esmarch*), and the room is locked up until the operation, which is to take place about 10 or 12 hours afterward. Strongly infected rooms may be disinfected as follows: The doors and windows are closed as securely as possible, and a few sticks of *sulphur* are burned. Disinfection by means of sulphurous acid is thus created. (Formalin gas is more reliable.)

During the operation, the room should be warm (66° to 77° Fhr.).

The *utensils* used during the operation (tables, chairs, vessels) must be free from unnecessary decorations; they should be made of such material that they can without injury be cleansed by thorough soaping with potash soap, soda, and water — which should be as hot as possible; otherwise, they must be sterilized in a larger disinfection apparatus by means of a jet of steam. The most practical utensils are made of iron and glass (*e.g.* Figs. 2 and 3), and are constructed as simply as possible.

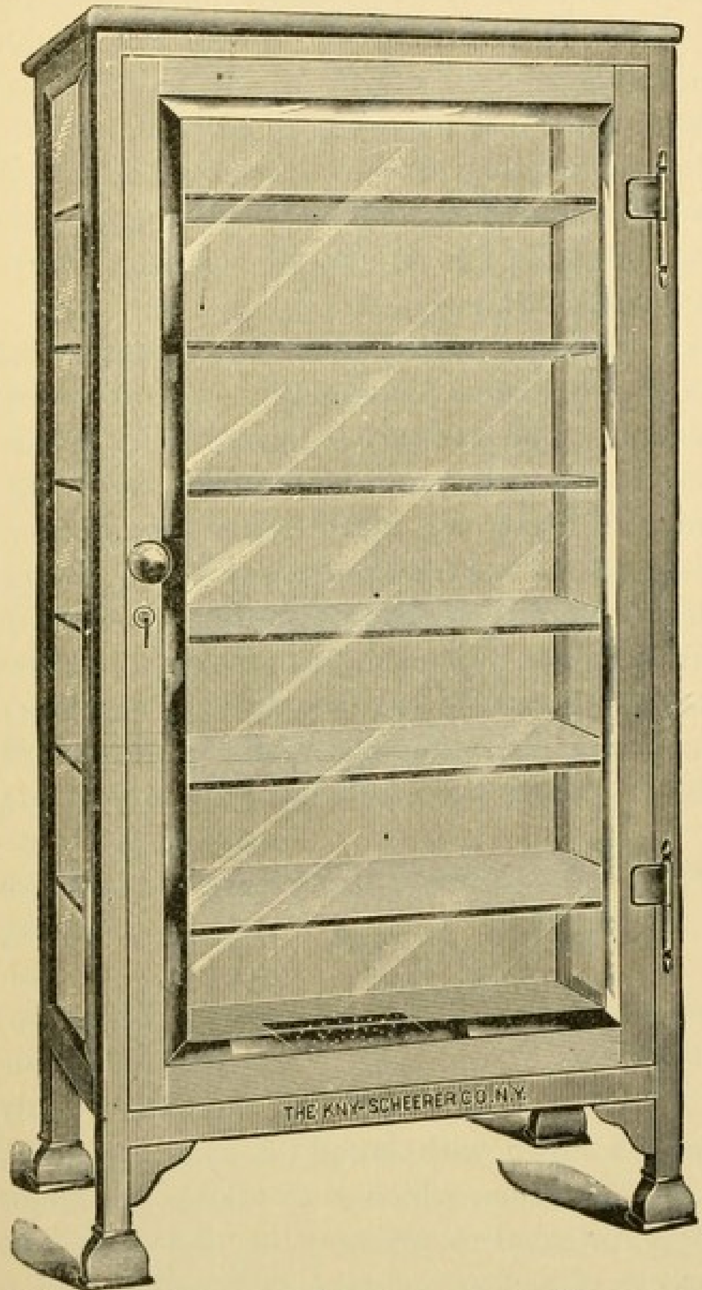


Fig. 2. Cabinet for Instruments and Dressings

The *operating table*, likewise, consists preferably of the same material, or of enamelled sheet-iron (Fig. 4). Considerably cheaper for practising physicians, however, is a strong, plain wooden table, with an arrangement for elevating the head (supporting board, see below); this table suffices for most of the operations; it can be well scrubbed; if at any time it becomes strongly infected, it can, on account of its cheapness, be easily replaced by a new one.

For padding, the operating table is covered with a thick woollen or felt cover, over which a *rubber sheet* is spread.

ASEPSIS OF THE SURGEON AND HIS ASSISTANTS

Always, before touching a wound (operation, changing of dressings), the hands and the forearms of the surgeon, as well as of all his assistants, must be disinfected (rendered free from germs) most carefully. Since the germs of infection are embedded in the many folds and furrows of the external skin and in the fatty secretions of the same (sebaceous glands), simply dipping the fingers into even strong watery antiseptic solutions or moistening them with it produces almost no effect. By an energetic wash-

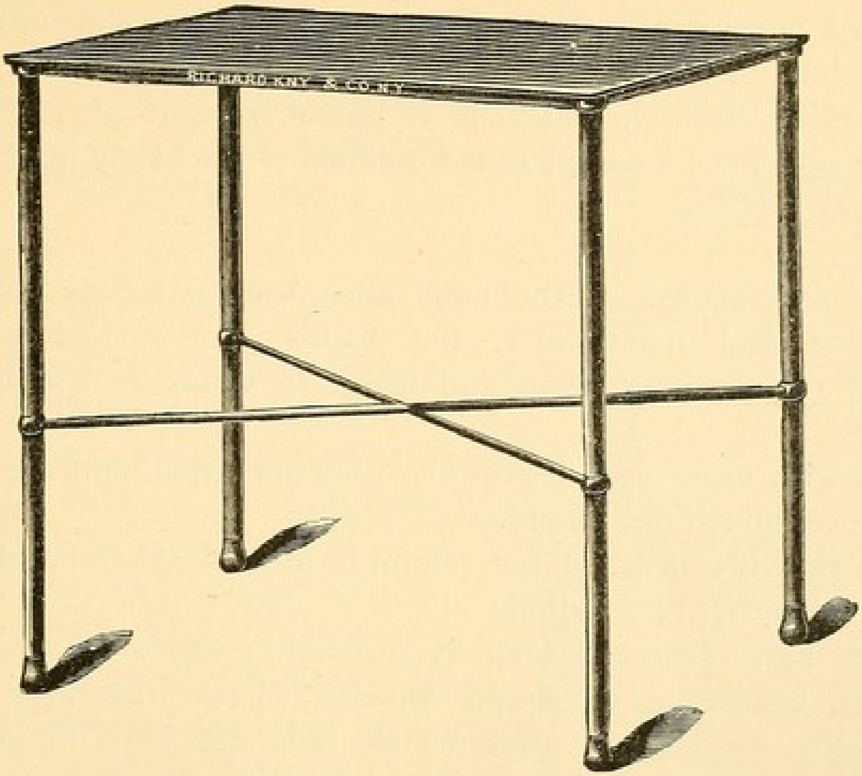


FIG. 3. SMALL DRESSING TABLE

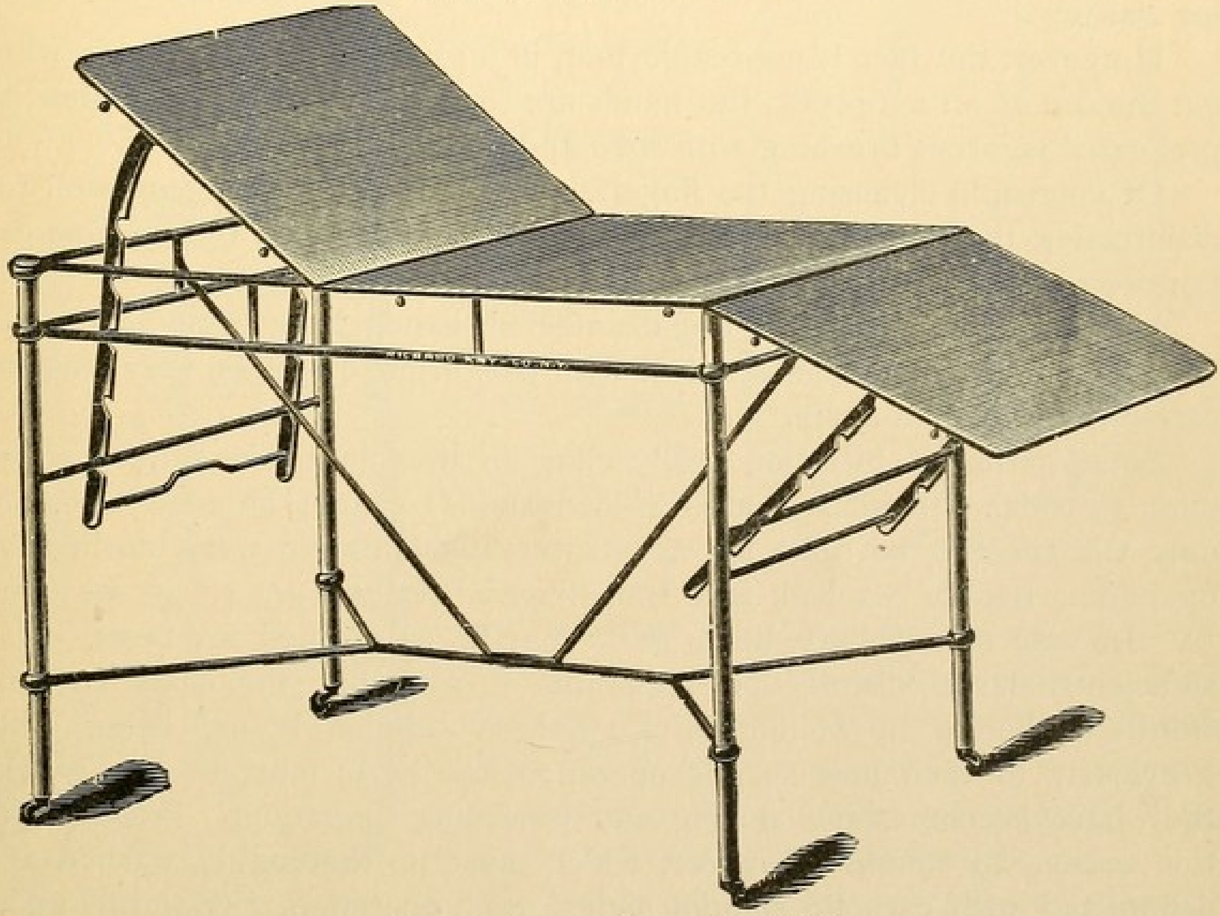


FIG. 4. ASEPTIC OPERATING TABLE

ing with soap, however, the fatty deposits and incrustations of dirt may be removed mechanically.

By means of alcohol, which is a potent solvent of fat, *Fürbringer* succeeded in obtaining a complete **sterilization of the hands** by the following procedure: —

1. After the furrows of the nails have been carefully cleansed with the nail-brush and nail-cleaner, the hands are washed energetically from 3 to 5 minutes with soap and brush in water as hot as it can be tolerated.

2. Next, with clean (sterile) towels, they are dried, and the furrows of the nails are examined once more.

3. Then they are brushed for 1 minute in 80% alcohol and are finally dipped into an antiseptic solution.

The best and cheapest soap is a good *green soap* (potash soap). The brushes, consisting of simple wooden plates with bristles, can be sterilized easily by boiling, after which they are kept in an antiseptic solution (1‰ of sublimate) in a vessel near the apparatus that serves for washing.

Moreover, the fact is noticeable that, in a case of emergency even without the use of an antiseptic, the hands are rendered aseptic by a somewhat prolonged vigorous brushing with soap and hot water.

Of course, in cleansing the fingers, all jewellery is removed, as well for disinfecting the fingers more easily as for protecting the jewellery from the injurious influences of the chemicals.

If, during the operation, the disinfected hands have come in contact with some object not disinfected or with pus, urine, or fæces, they must be carefully disinfected again.

Since germs of infection easily cling to woollen cloth, and since, on dark material, infectious matter (blood stains) cannot be seen well, not only the surgeon but also his assistants should always wear, during the operation, freshly washed and ironed *white linen coats or gowns* (Fig. 5). In case of necessity, linen *shirts* may be substituted for them. If a sufficiently large disinfection apparatus is available, the coats may be sterilized therein by boiling in a 1% soda solution before being used. Previously to each new aseptic operation, the coats must be changed, if they have become soiled during any preceding operation. Practical for this reason are *aprons of rubber*, which must be thoroughly washed and disinfected with carbolic solution before each operation. The arms up to the elbow are always completely bare and are disinfected (or covered with disinfected rubber sleeves).

Since, in some operations, a great deal of irrigating fluid is used, rubbers may be put on over the shoes to prevent the feet from getting wet.

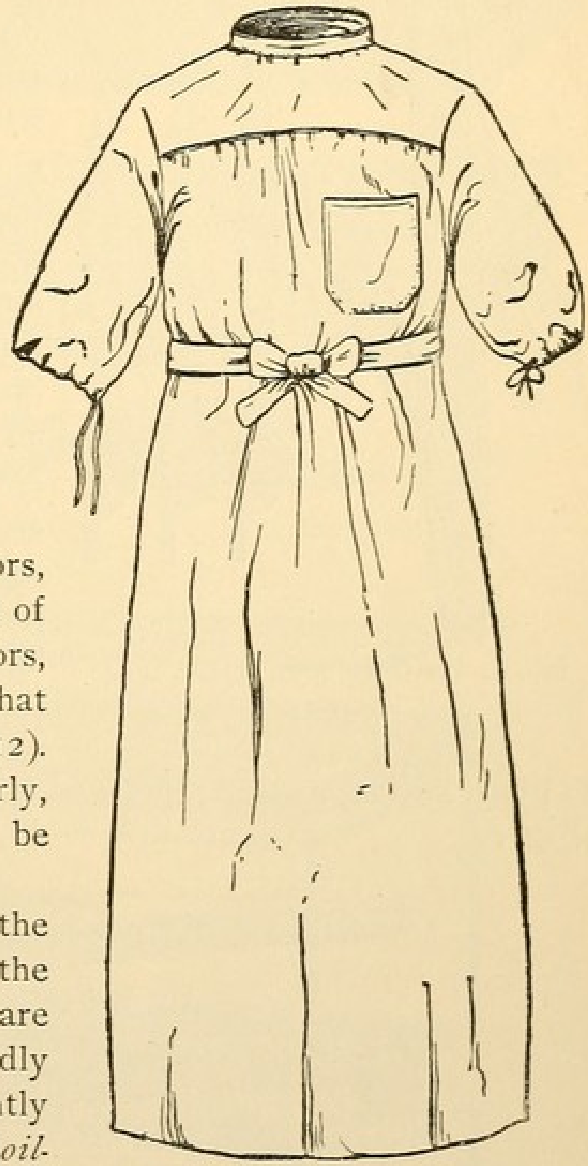
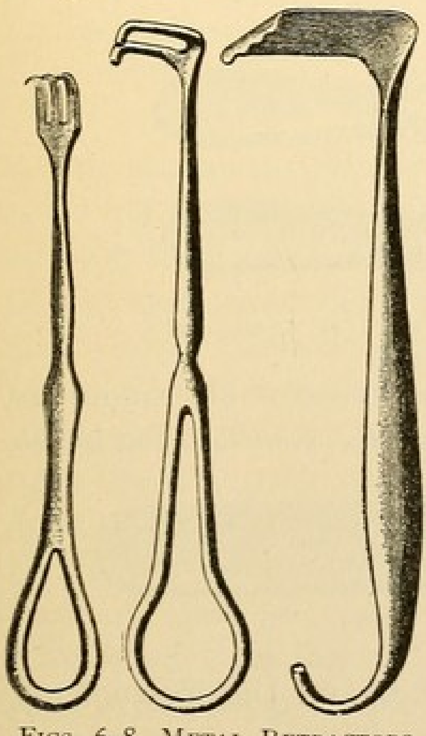


FIG. 5. SURGEON'S GOWN

STERILIZATION OF INSTRUMENTS

All instruments used in the operation and in applying the dressings must be most thoroughly cleansed and disinfected. In order to facilitate this, the instruments must be made as plain as possible; they should have few furrows, niches, or clefts, because dirt easily collects in them. Accordingly, all plain instruments (knives, retractors, etc.) ought to be made from one piece of steel; instruments with locks (scissors, forceps) should be so constructed that they can be taken apart (Figs. 6 to 12). Ivory and wooden handles, used formerly, should not be employed.



FIGS. 6–8. METAL RETRACTORS

Before the operation, the instruments are most rapidly and efficiently *sterilized by boiling*. In a suitable metallic vessel (sterilizer), common water is brought to the boiling-point; the instruments are placed in it for 5 minutes (*Davidsohn*). If common washing soda (1%) is added to the water, the steel is prevented from rusting and the disinfecting strength of the water is increased (*Schimmelbusch*).

By means of this very simple procedure, all pathogenic bacteria are absolutely destroyed. Even dipping the instruments for only a second into the boiling soda solution suffices to destroy the pus germs (staphylococci).

For surgical practice, it is best to use on a separate stand a somewhat shallow basin (a vessel of copper or nickel) filled with a solution of soda, which, by means of several flames, can be brought to the boiling-point (Fig. 13). The instruments are spread on a wire frame, fitting in the apparatus, and placed into the solution. After 5 or 10 minutes, the wire frame is lifted out, and the instruments are spread on a sterilized cloth with sterilized forceps. Now and then, during the operation, they are held with the forceps in the boiling solution. The instruments can also be placed in a flat, clean glass or china basin filled with a 3% carbolic solution. Since the edges of sharp instruments soon become affected by this solution, it is better to place knives, scissors, and needles into a smaller basin filled with alcohol (Fig. 14).

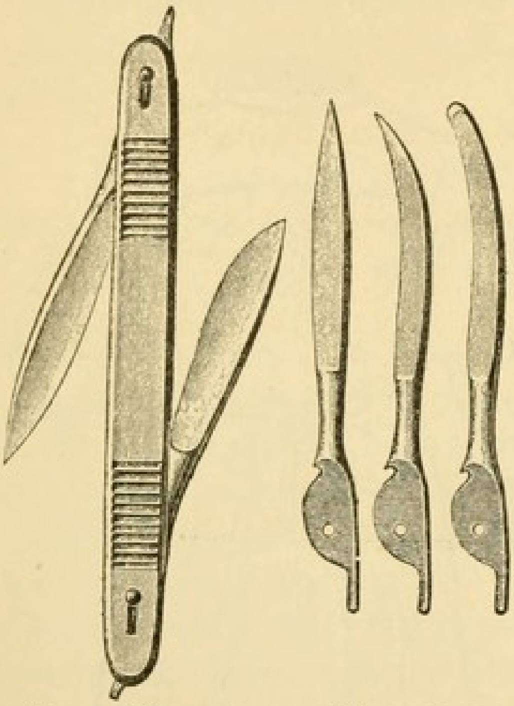


FIG. 9. BISTOURY WITH REMOVABLE BLADES

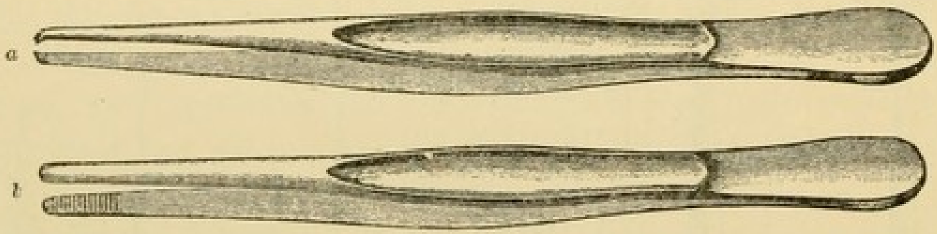


FIG. 10. FORCEPS WITH SMOOTH ARMS. (*a*) Surgical; (*b*) Anatomical

In the house of the patient, even under the most unfavorable conditions, the instruments may be sterilized as follows: a cooking utensil (a tea kettle,

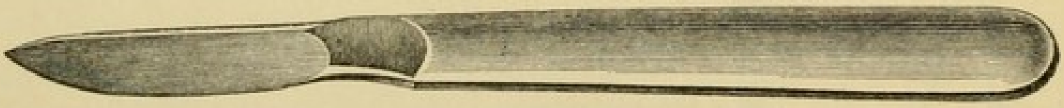


FIG. 11. ASEPTIC KNIFE

etc.), filled with the soda solution, is put on the fire, and the instruments, placed in a gauze bag, are boiled in it from 5 to 10 minutes.

If, for any reason, this boiling cannot be accomplished, the instruments are placed, for some time (half an hour to an hour) before the operation,

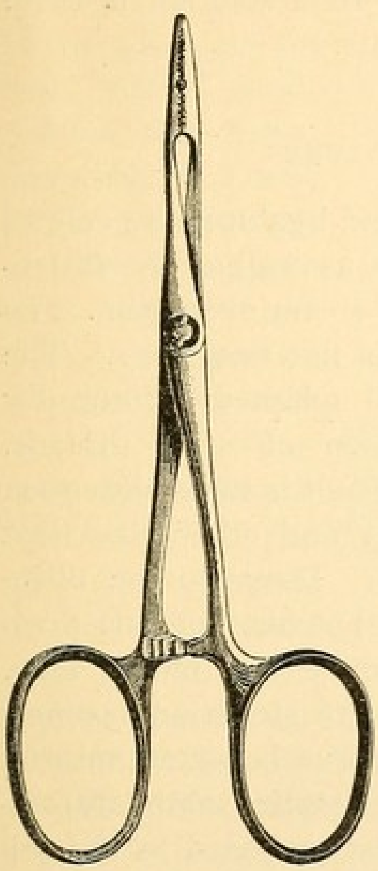


FIG. 12. FORCEPS WITH REMOVABLE LOCK

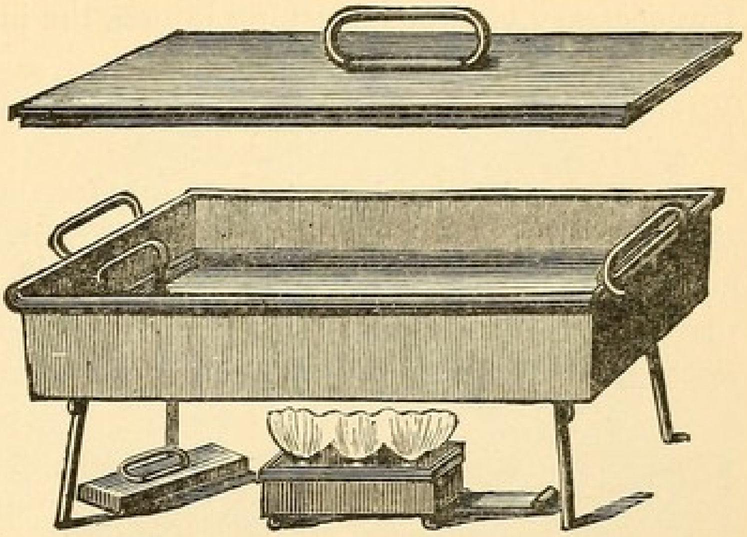


FIG. 13. INSTRUMENT STERILIZER

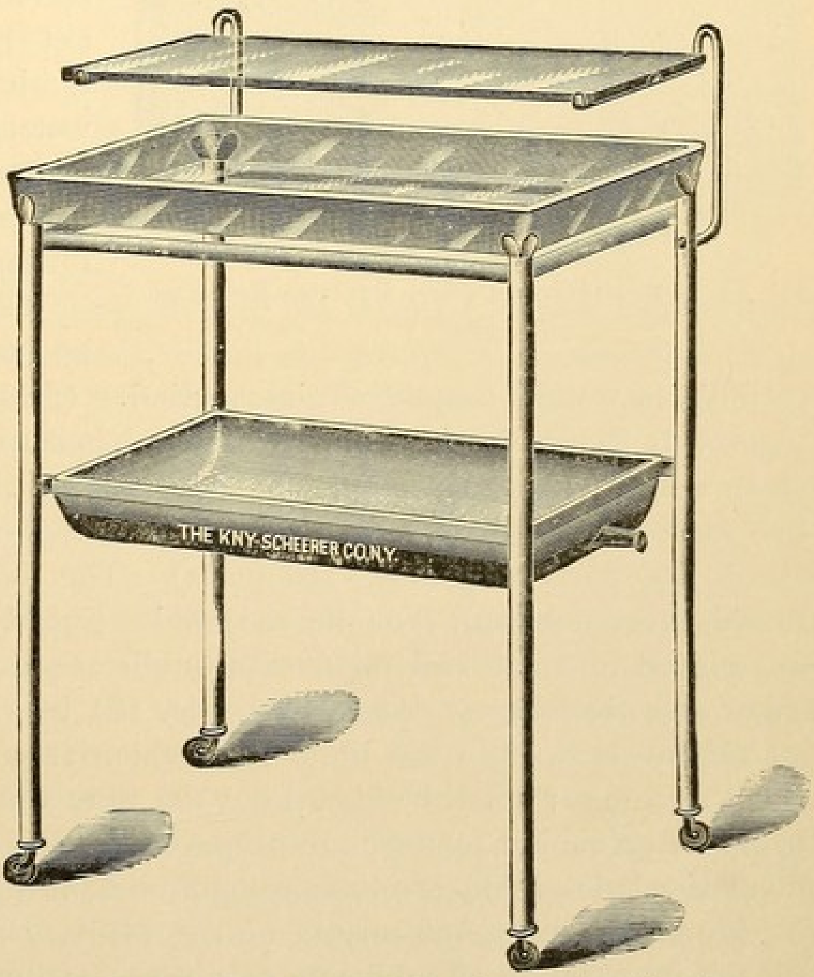


FIG. 14. INSTRUMENT TRAY STAND (OF GLASS)

into an instrument basin, and a 3% to 5% carbolic or a 1% lysol solution is poured over them. This disinfection, however, is not absolutely reliable.

After instruments have been used, they must be washed off with hot water, energetically brushed, and *mechanically* freed from the coagula of blood, from pus, etc., lodged in the corners; next, they are carefully dried with an aseptic cloth, and those which show any stains are polished with the finest emery paper and leather. This, however, hardly becomes necessary when the soda solution is used. Unnecessary vigorous brushing injures the instruments.

STERILIZATION OF SUTURES AND LIGATURES

The materials used most constantly for suturing and ligatures are catgut, silk, silkworm gut, and metal wire. The last three, as well as the instruments, are sterilized in boiling water, or by passing steam over them. To place them subsequently into an antiseptic solution is not necessary. The apparatus of *Schimmelbusch* (Fig. 15) is very well adapted for the dry preservation of such threads. More difficult is the disinfection of catgut and other absorbent materials. They can be disinfected in hot air, but this process requires too much time. Subjected to steam and boiling water, catgut becomes entirely useless. **Aseptic (sublimate) catgut** is best prepared in the following manner: —

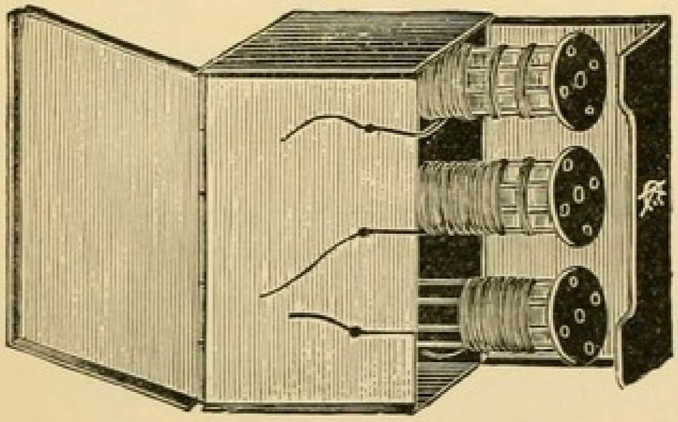


FIG. 15. SCHIMMELBUSCH'S TIN BOX FOR STERILIZED SILK

Common catgut, which can be purchased anywhere (raw catgut), is wound around a glass cylinder (flasks) in a single layer and vigorously brushed with potash soap and hot water. Next, it is rinsed in clean water, wrapped around smaller glass spools, and placed for at least two entire days into a 1% sublimate alcohol (sublimate, 10 parts; alcohol absol., 800 parts; aq. dest., 200 parts). The fluid, which at first becomes turbid, must now and then be renewed. Shortly before using, the spools are placed into a vessel filled with sublimate alcohol, 1 : 2000 (*e.g.* in the *glass case according to Hagedorn* — Fig. 16), in which a second smaller case stands inverted, from the bottom of which threads are drawn out through small openings; small ball-bearing valves prevent the threads from slipping back. In a similar manner are prepared the other absorbent materials (tendons of whale-, reindeer-, kangaroo-parchment and leather).

Moreover, the requirements of the Military and Sanitary Regulations for the preparation of sublimate catgut are easily carried out. Raw catgut is immersed for from 8 to 12 hours in a $5^0/_{00}$ watery sublimate solution, and is afterward preserved in alcohol until used.

The treatment of catgut with *carbolized oil*, first recommended by *Lister*, does not secure perfect sterilization, and hence is hardly ever used at the present time.

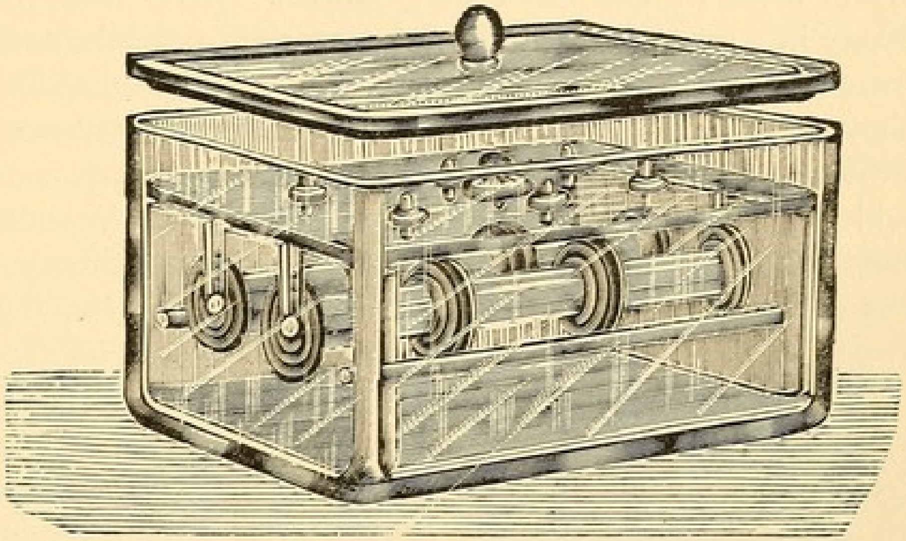


FIG. 16. GLASS BOX FOR CATGUT LIGATURES

The chromic acid catgut, however, introduced afterward by *Lister*, is very strong and resists absorption better than the sublimate catgut, for which reason it is preferable in some operations. Catgut is placed for 48 hours in a 10% carbolized glycerine and then for five hours in a watery 0.5% chromic acid solution.

Kocher's **juniper catgut** is durable and aseptic. Catgut is immersed for 24 hours in oil of juniper (Oleum juniperi), and is afterward preserved in alcohol.

For more convenient handling, outside the hospital, catgut and silk are wound around smaller glass spools, which are placed in a row on a glass staff; these spools are kept in small boxes or test-tubes, which can be closed by means of a screw apparatus, and easily carried in the pocket.

STERILIZATION OF SEA AND GAUZE SPONGES

Sea Sponges. For wiping off the blood, sponges cannot be dispensed with in many operations, especially when it is desirable by a single stroke quickly to wipe the surface of the wound perfectly clean. But they ought to be used only after all impurities contained in them have been most carefully removed, and after they have been rendered free from germs.

Sponges can *not* be sterilized in the disinfection apparatus, because they become thereby hard and friable. Keeping them for weeks in strong antiseptic solutions (5% carbolic acid, $1^0/_{00}$ sublimate) does not, according to experiments that have been made, disinfect them perfectly.

For perfect sterilization of sponges, it is necessary to beat them first in a dry state with a wooden mallet, between cloths, until the sand is completely removed. Next, they are repeatedly kneaded in clean boiled lukewarm water (in hot water they shrink). After that, they are placed for 24 hours in a cold $1^{0}/_{00}$ solution of potassium permanganate, which is renewed once after 12 hours. After they have been rinsed in boiled lukewarm water, they are placed into a solution of sodium hyposulphite (1%), to which the fifth part of a mixture of concentrated hydrochloric acid and water (8%) is added. In this they are well stirred with a wooden staff for several minutes, until their brown color disappears. (If they remain too long in the solution, they become too friable and tear easily.) Finally, they are rinsed in clear water until they become perfectly odorless.

For 25 large sponges, about 5000 grams of the sodium hyposulphite solution and 1000 grams of the hydrochloric acid mixture are required (*Keller*).

For destroying the dry spores, after their germination, — for by this treatment they have by no means been rendered innocuous, — the sponges are placed in lukewarm water and kept there from three to five days in a warm place (95° to 100° Fhr.). The water is changed daily.

Not until then are they placed in a 5% carbolic or a $1^{0}/_{00}$ sublimate solution, which after 2 days is changed once more. In this they remain until used. Every fortnight the solution is renewed, and the sponges must have been kept in the solution at least 8 days before they can be safely used.

Less complicated and more rapid is the procedure of *Schimmelbusch*.

After the sponges have been thoroughly cleansed by beating and freed from sand and fragments of shells, they are thoroughly washed with water and kneaded. Next, well wrung out, they are placed into a gauze bag, which is dipped for half an hour into a vessel containing a hot soda solution (1%), nearly reaching the boiling-point. Previously, the flame under the vessel is turned off; for in a *boiling* solution the sponges would be rendered useless. Finally, they are vigorously wrung out, and are kept in a sublimate solution ($0.5^{0}/_{00}$). This procedure seems to be safe; for, after remaining in the hot solution only 10 minutes, sponges infected by pus or fæces are sterilized perfectly.

Sponges which, during the operation, have become bloody, are rinsed in clear water, after which they are dipped again into the carbolic or sublimate solution, before they are wrung out and handed to the operator.

Sponges that have been used in aseptic operations must first be cleansed from coagula and fatty matter by repeated washing in soap, water, and solution of soda. They must then be kept for 8 days in a 5% carbolized water solution before they can be again safely used in an operation.

Sponges used in infected, sanious, and gangrenous wounds should be burned at once.

For cleansing the surrounding portions of wounds and for wiping off the pus in changing dressings, sea sponges should be discarded, and gauze sponges and the wound douche should be used instead.

Gauze sponges are loose balls of prepared absorbent cotton, cellulose, jute, etc., wrapped in aseptic gauze (Fig. 17).

Prepared absorbent cotton (from which all oily matter has been extracted) absorbs very rapidly. When the fluid is pressed out of it, however, the cotton is compressed into a compact and poorly absorbent mass. For this reason, it is practical to use cellulose for the central portion of the gauze sponge, since the elasticity of the fibre prevents the compression of the cotton.

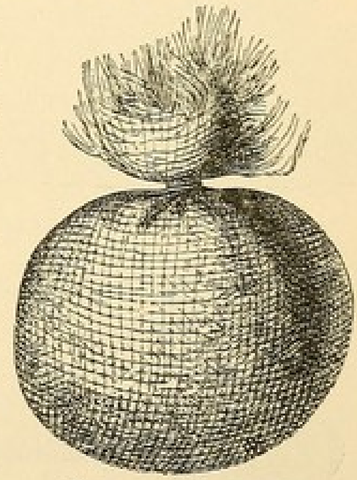


FIG. 17. TAMPON

Sponges made of other material do not absorb so well.

The gauze sponges, together with the materials for dressing, are sterilized by steam in the same apparatus. On account of their inexpensiveness and sterility, they can be used everywhere; but especially in operations for septic conditions, since it is not desirable to infect sea sponges. After being used, they are destroyed (by burning).

A still simpler material for sponges, and one that possesses still greater absorbent power, is a small compress of loose gauze, fastened together by a few stitches (*Gersuny*); or pieces of gauze as large as the hand, between which a thin layer of cotton or common compressed crinoline gauze is inserted. The quantity of gauze used thereby is considerable. The plain gauze sponges are cheaper.

DISINFECTION OF THE PATIENT

Before each operation of any importance, and before dressing a fresh wound, if possible, the whole body of the patient should be washed thoroughly in a **full bath** with potash soap and brush. For this purpose, the portable Hospital Bath on rollers is especially well adapted (Fig. 18), because, with a comfortable position of the patient, the tub requires comparatively little water to fill it. For cleansing a single limb, and especially for permanent baths, are used the *arm and foot tubs* (Figs. 19 and 20)

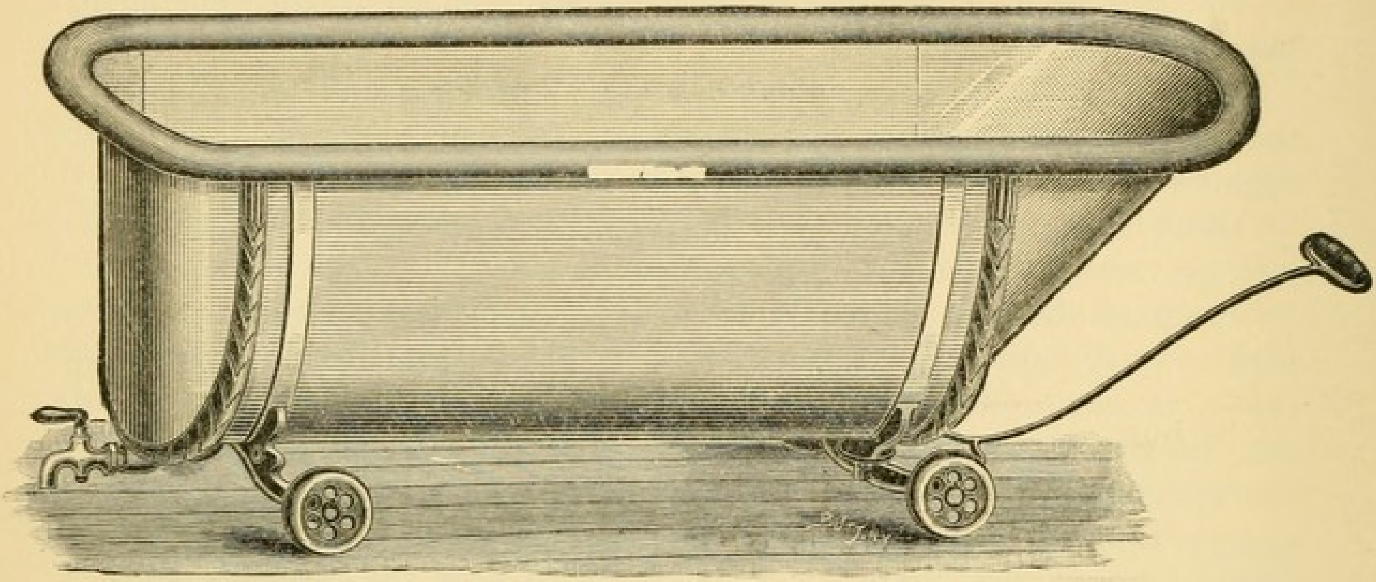


FIG. 18. PORTABLE HOSPITAL BATH (AM. MODEL)

made of zinc, the covers of which have openings at one side. At the two length-sides are fastened handles, to which bandages supporting the limbs may be tied.

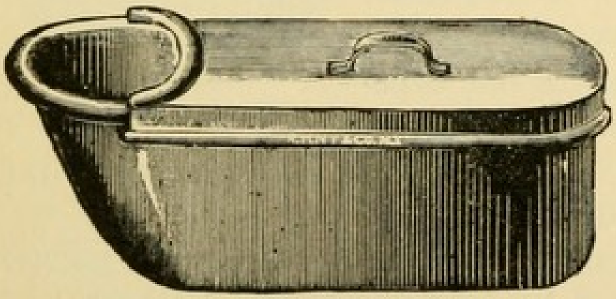


FIG. 19. ARM BATH OF SHEET ZINC

To cleanse the region of the pelvis, sitz baths in sitz tubs are used.

Immediately before the operation, the field of operation, the whole neighborhood of the wound, is once more thoroughly cleansed and disinfected on the operating table.

First, all the hair in the region of the wound is *removed by shaving*, because pathogenic germs are especially liable to settle upon it and in the hair follicles; on the head, the hair should be shaved off at least 4 centimeters beyond the margin of the wound. In larger operations (trephining), it is best to shave the whole scalp.

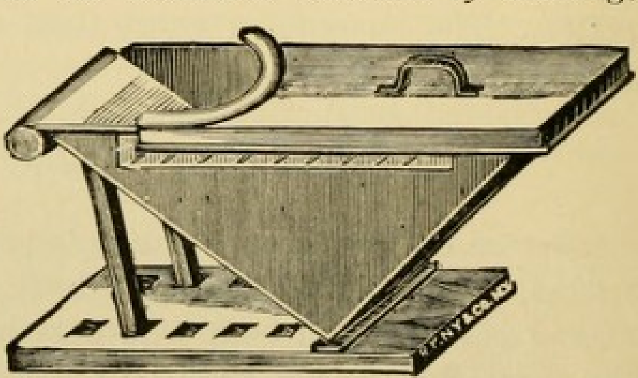


FIG. 20. FOOT TUB, TRIANGULAR SHAPE, ADJUSTABLE

Next, the region of the wound is rubbed down with a piece of cotton that has been dipped in ether or spirits of turpentine, to dissolve and remove the grease of the skin. Thereupon follows a thorough washing with soap and brush, and finally the disinfection with sublimate solution. Last of all, the whole field of operation may be rubbed down with iodoform ether (1 : 7).

Before operations on the *hands* and the *feet*, the thick upper epidermis layers, after they have been softened by means of soap baths, must be removed as far as possible with stiff brushes; especially must the dirt between the toes and under the nails be carefully removed. It is safer to wrap all these parts with sterilized bandages, since they have to be touched often during the operation. (A thin pellicle of collodium and cotton furnishes the best protection.)

Before operations *on the mouth* and *in the mouth*, the teeth must be cleansed very carefully with brush and tooth soap; tartar, as well as carious teeth, must be removed, and the mouth must be rinsed repeatedly with a solution of acetate of aluminium, boric solution, or potassium permanganate.

Before operations in the *abdominal cavity*, it is advisable to cover the abdominal walls for several hours (during the night) with a moist antiseptic compress.

Several days previous to operations in the region of the *anus* and the *sexual organs*, the intestines, if possible, must be thoroughly evacuated by means of purgatives, enemata, and irrigations. At the beginning of the operation, the mucous membrane is wiped off dry, and then boric solution is applied. Mucous membranes cannot be disinfected completely. Very active poisonous remedies (carbolic acid, sublimate), on account of the danger of being absorbed in toxic quantities, must not be used for disinfecting mucous membranes.

If, on the field of operation, crusts or scabs are present, they are rubbed off with a ball of absorbent cotton saturated with turpentine oil; ulcerations or granulations must be scraped off with the sharp spoon; next, the wound surface is disinfected with iodoform ether, solution of chloride of zinc (8%), iodoform powder, or with the thermo-cautery. Since this procedure is painful, it is not performed until the patient is under the influence of the anæsthetic.

The patient, preferably *perfectly naked*, is placed upon the operating table covered with a rubber sheet, with his head and thorax slightly raised. In long-continued operations (laparotomies), the patient is protected from *taking cold* by a hot-water cushion placed beneath him, or by having his legs wrapped with cotton bandages (perineal operations). He may also be clothed with freshly sterilized woollen jackets or trousers. If, during the operation, a great deal of irrigating fluid is used, the wet sheet under the patient should be changed. For this purpose, operating tables provided in the middle with clefts or drainage funnels are very practical (*Juillard, Hagedorn, von Bergmann*).

After disinfecting the field of operation, the patient is completely covered with freshly sterilized linen cloths, so that only the operating field is exposed.

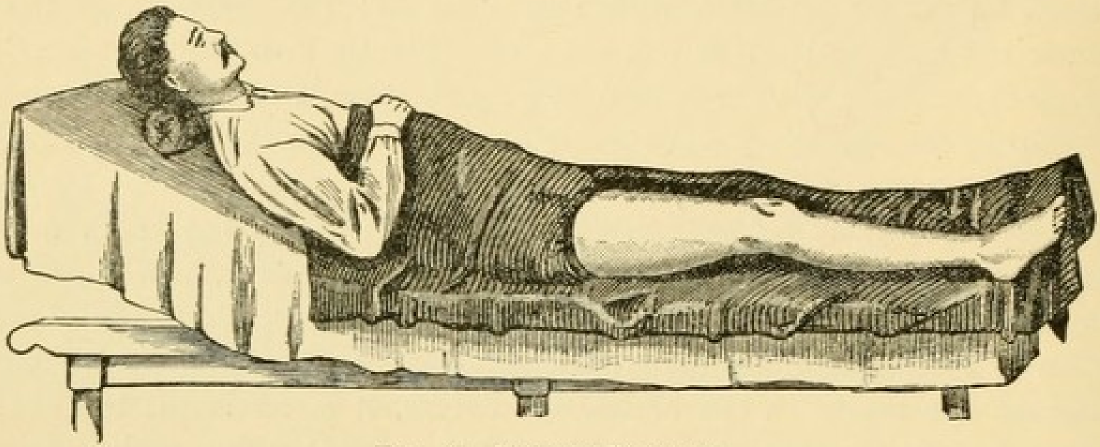


FIG. 21. RUBBER BLANKET

For this purpose may also be used large rubber blankets, which have been previously washed thoroughly with carbolic solution. For operations on the extremities, the blanket has a hole through which the limb is placed (Fig. 21). In operations on the face and the neck, the hair of the head is covered with a bandage or a rubber bath cap.

STERILIZATION OF THE DRESSING MATERIALS

As everything that comes in contact with the wound should be sterilized, so likewise **the dressings** that are applied at the end of the operation must be **free from germs**. Concerning the various kinds of material used for dressings, see below.

Sterilization is most rapidly and safely obtained by a **current of saturated steam.** Many kinds of apparatus for sterilizing have been devised for this purpose. The sterilizer of *Rietschel and Henneberg* answers the greatest requirements. For smaller requirements, a more practical and convenient apparatus has been invented, in the construction of which it is chiefly important that the steam have a certain *pressure*, and that its density be everywhere uniform. In this way, excessive saturation of the materials for dressings is avoided (Fig. 22, *a*, *b*, and *c*). If, in this apparatus, the materials to be sterilized are penetrated by steam from half an hour to an hour, all pathogenic germs are destroyed with certainty. For small requirements, moreover, a common steam cooking apparatus, according to *Koch*, is perfectly sufficient. This consists of a cylindrical vessel, holding 1 or 2 liters of water. About a hand's breadth above the surface of the water is a wire net, in which the materials for dressing are placed. The instruments may be boiled at the same time with the dressings. Since the pressure of steam in this apparatus is not very great, after the apparatus is completely filled with steam, the sterilization must be continued *at least* from a quarter to half an hour.

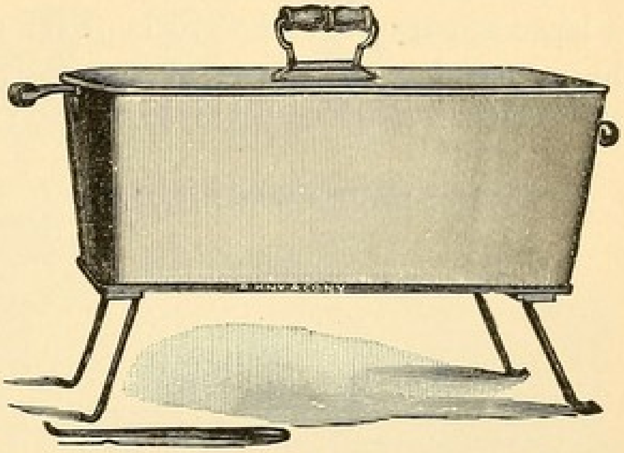
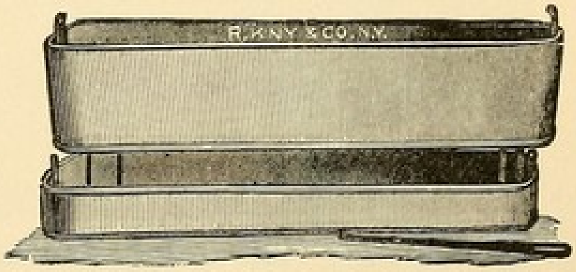
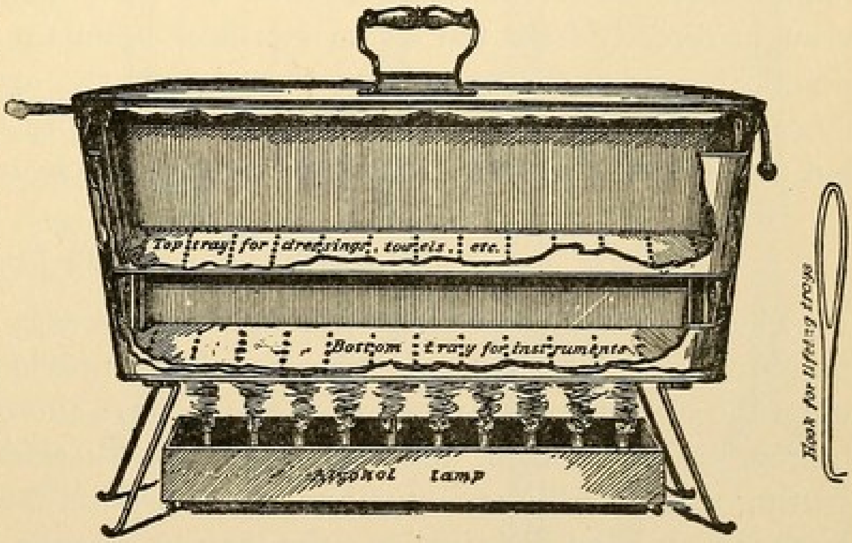


FIG. 22. COMBINATION STERILIZER. (*a*) Closed



(*b*) Open

C. Beck's Portable Compact Sterilizer (Fig. 23), for boiling instruments and sterilizing dressings by steam, is very practical. The apparatus consists of a series of telescopic, square copper boxes which can be set into each other, and thus occupy but very little space. The lower box measures 6 × 12½ inches, and is 2 inches deep. It is provided with a perforated tray for immersing and lifting out the instruments which are to be boiled in it. For the simultaneous sterilization of dressings, a series of three copper boxes without bottoms is provided, each fitting on the top of the next smaller size, the smallest fitting on the instrument tray.



(*c*) Sterilizer in operation

Likewise, **The Kny-Sprague Perfection Surgical Dressing Sterilizer**

(Fig. 24), a combination dry-oven with a steam-pressure sterilizer, is excellent.

Until recently, all materials were sterilized in considerable quantities in a large apparatus, and were kept for some time in well-closed glass closets in a special room. It is much safer, for the purpose of securing perfect sterilization, and but little more inconvenient, to sterilize in the operating

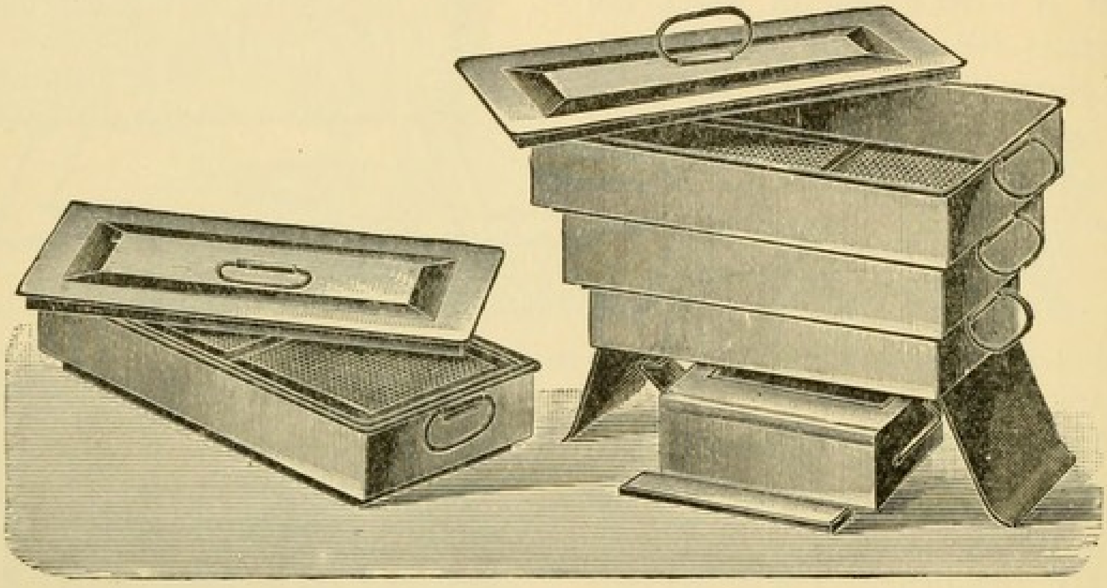


FIG. 23. BECK'S PORTABLE COMPACT STERILIZER

room before each operation, so that all the materials to be used can be brought directly from the steam sterilizer upon the wound. For the most practical results, the apparatus, placed near the operating table, should be large enough to contain not only the gauze compresses, pads, and bandages, but also the tampons and the cloths serving to cover the patient.

ASEPTIC OPERATIONS

The performance of an aseptic operation is very simple after the above preparations. The patient, who has been previously bathed, is brought upon the operating table and narcotized; next, the operating field is shaved, thoroughly disinfected, and surrounded on all sides with sterilized cloths. During this time the operator and his assistants have prepared themselves by thorough hand disinfection; the instruments are taken out of the boiling water and spread on a sterilized cloth. The compresses and sponges intended for the operation are placed at the side of the assistant in a large basin filled with sterilized salt water (0.6%). The surgeon selects the most convenient position for himself, the assistant stands opposite to him, another assistant hands the required instruments and threads the needles. After the external incision has been made, the operator advances by layers. In doing this, it is of the greatest importance to the surgeon that **the blood be wiped off skilfully** for the better inspection of the field of operation.

If the operation is performed under elastic constriction of the limb (the "bloodless method"), the sponging of the blood is very rarely required. In less vascular regions on the trunk, it is sufficient to wipe off the blood now and then; but in very difficult operations in vascular regions — for instance, enucleation of glands on the neck — the sponging must be done with especial care, if the surgeon is to be assisted in distinguishing easily the important parts involved. After each incision, as well as when it is important to survey the whole surface of the wound, the blood must be wiped off by a rapid *stroke* with the sponge. On the other hand, by *sponging*, smaller places are rendered free from blood, as the progress of the operation requires it. It is the principal duty of the assistant in using the sponge to see to it that he does not obscure the field of operation. "Good sponging distinguishes the good

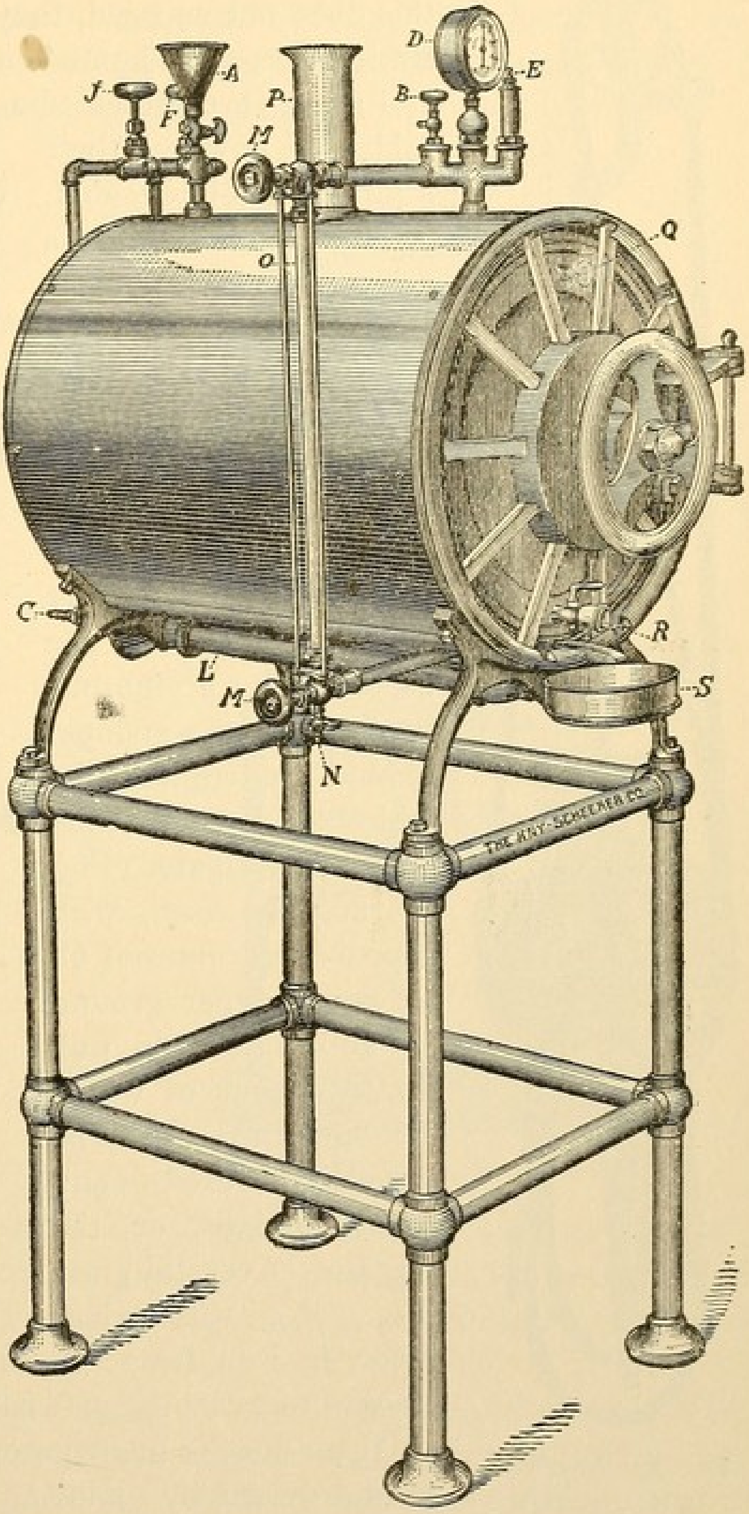


FIG. 24. KNY-SPRAGUE PERFECTION SURGICAL DRESSING STERILIZER

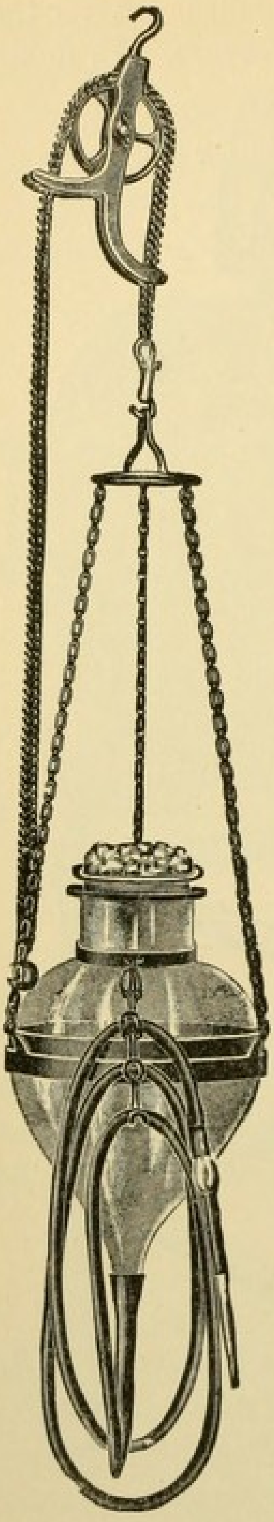


Fig. 25. Improved Irrigator

assistant." Hemorrhages from smaller vessels are arrested mostly by prolonged pressure with the sponge; if this does not succeed, they must be grasped with hemastatic forceps and ligated on both sides. Muscles, tendons, and nerves are protected as much as possible and pushed aside. If, however, their injury cannot be avoided, the corresponding ends are sewed together after the operation.

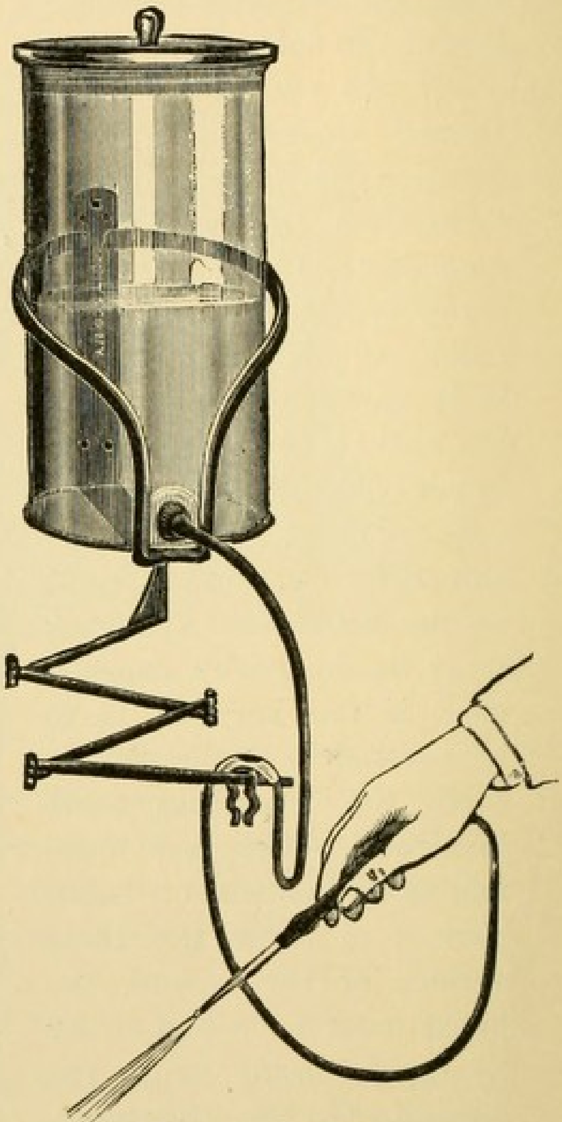


Fig. 26. Irrigator

Irrigation is not performed at all, since, in by far the majority of cases, no infected fluids have to be removed from the wounds. Larger quantities of blood are wiped off by a vigorous stroke with the sponge. Should an irrigation be desirable, however, the **improved irrigator** (Fig. 25) may be used, with improved germ-proof filter cup stopper ground in, and automatic pulley, by means of which the apparatus can be raised or lowered to any desired height, or the irrigator of crystal glass (Fig. 26), with glass cover, in iron frame to suspend from wall, with folding bracket to carry the soft rubber tubing.

If no douche or irrigator is at hand, an apparatus can be improvised by removing the bottom from a wine bottle, inserting a rubber tube through the perforated cork, and filling the inverted bottle from the bottom (Fig. 27). "Irrigateur à vide bouteille."

A more simple apparatus is a common glass pitcher, from the spout of which the fluid is allowed to trickle slowly over the wound.

For irrigating fluid, *sterilized* (boiled) *water* is used, to which some salt (0.6%) has been added. For the use of larger quantities of sterilized water, the apparatus of *Fritsch* (Fig. 28) recommends itself.

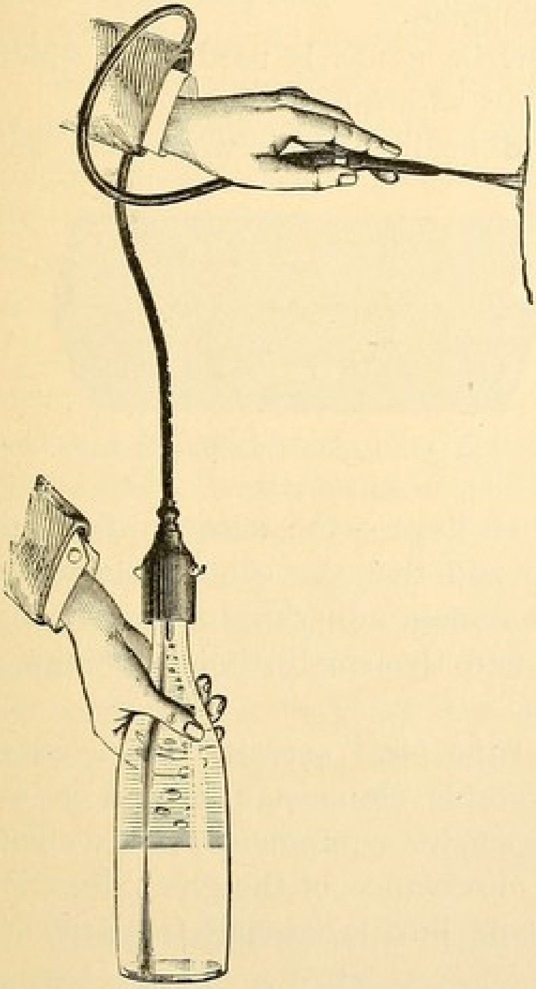


FIG. 27. "IRRIGATEUR À VIDE BOUTEILLE"

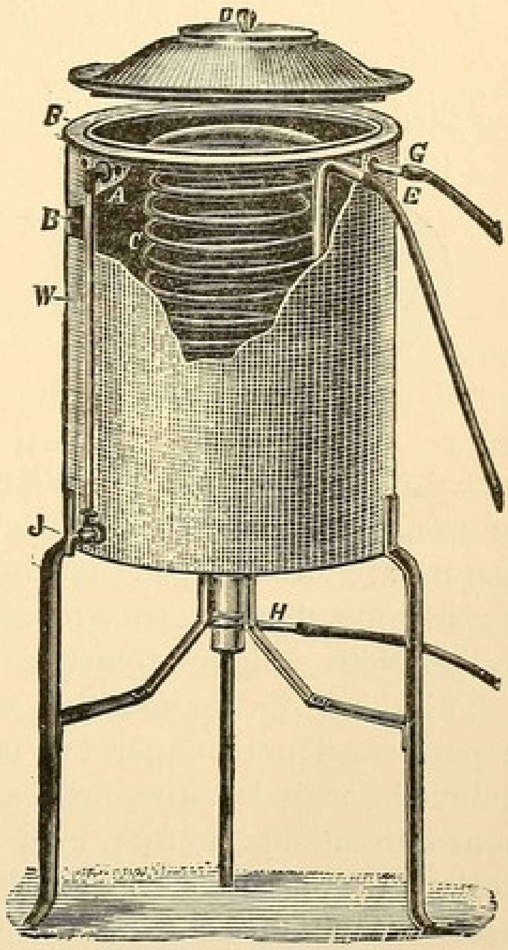


FIG. 28. FRITSCH'S WATER STERILIZER

To receive the water that flows off there may be used variously shaped dressing basins (pus basins) of tin, hard rubber, or glass, the margins of which apply themselves accurately to the surface of the body (Figs. 29 and 30).

When the dressing basins are changed, the empty one is placed under the full one, that the latter may always be seen and that none of its contents be spilled. The contents of the full basin must be emptied at once into a pail.

A rule to be observed, however, is that the surgeon **use irrigating fluids as little as possible.** Last of all, the whole wound surface must be examined once more with reference to small overlooked blood vessels, and every hemorrhage must be carefully arrested before the wound is sutured. In most cases, *drainage is unnecessary* if all the above precautions have been observed. Large cavities of the wound are diminished by the use of *buried sutures*, and, if necessary, temporary tamponade is resorted to.

The wound of the skin is *sutured* throughout.

For *dressing*, a compress of loose sterile gauze is used, over which a layer of cotton or a pad of gauze is fastened with a bandage.

This dressing remains undisturbed until healing of the wound has taken

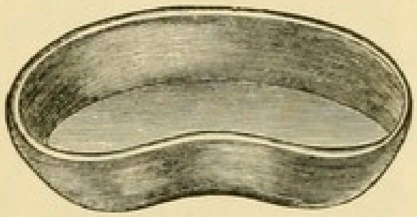


FIG. 29. DRESSING BASIN

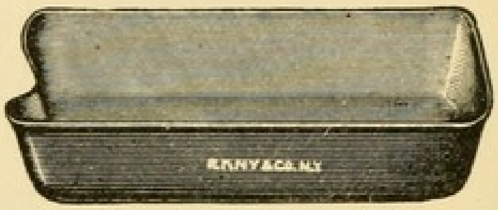


FIG. 30. LARGE DRESSING BASIN

place. On removing it — after 10 or 12 days — the surgeon finds that the wound has healed with a linear scar and that the catgut sutures have been mostly absorbed, so that their knots remain adhering to the dressings; silk and metallic sutures are removed, and the small stitch openings are covered with a light protective dressing.

This kind of treatment of wounds, "**the ideal asepsis**," however, can be performed only under the most favorable circumstances and in well-equipped hospitals; it requires a very expensive equipment and excellently trained attendants, so that, by a minute observance of the given directions, a complete guarantee can be given that no link is missing from the long chain of aseptic precautions.

Hence, in order to produce a good healing of the wound, even under less favorable circumstances, not only aseptic but also *antiseptic* measures are employed.

ANTISEPSIS

Antisepsis purposes to destroy all infectious germs that settle in the wound and produce fever, suppuration, and putrefaction — or at least to arrest their development.

The use of antisepsis, therefore, presupposes the presence or at least the suspicion or the possibility of an infection of the wound.

There are many substances that will destroy infectious germs and remove the consequences caused by the same (**Antiseptics**).

The merit of having first used intelligently and methodically, in operations and dressings, one of these substances known before — namely, carbolic acid — is due to *Joseph Lister*, the founder of the *antiseptic treatment of wounds* (1865–1870). It is this treatment that has brought about the great change in modern surgery. Its brilliant and *safe* success has encouraged surgeons to undertake the *bold* procedure of treating surgical affections formerly considered beyond the reach of human aid.

Whilst aseptic treatment can be carried out successfully only under very specially favorable external conditions, the antiseptic treatment of wounds meets with success everywhere, even under the most unpromising conditions. By it, the practising physician, even in the country, can obtain good results in cases that, without it, would be considered hopeless or which, in order to save life, would necessitate amputation.

Lister used carbolic acid almost exclusively; in the course of time, however, by indefatigable research, there has been found a whole series of similar or of still more effective substances that possess the specific virtue of destroying micro-organisms and also their spores, or at least of arresting their development to such an extent that they cannot injure the wound. Many of these substances possess additional properties poisonous to man; some are absolutely non-poisonous; some are adapted for being used in solutions, others in powder form for saturating the materials for dressing, for irrigating or rubbing the surface of the wound, for preparing the material for suturing, for disinfecting the skin, etc.

ANTISEPTIC SOLUTIONS

Carbolic acid, *phenylic acid*, C_6H_6O (*Lister*), a very effective antiseptic, appears in the anhydrous state as colorless crystalline needles, is volatile, and acts as a powerful caustic; hence, it must be used only in solution. By long-continued action, an aqueous solution of 1 : 1000 arrests the development of schizomycetes; their development is perfectly arrested, however, only after the concentrated solution of 5 : 100 has acted upon them for 24 hours; but the spores are not destroyed thereby. Solutions in oil or proof spirits, according to *Koch*, have no antiseptic effect.

Carbolic acid is used: —

(*a*) As a *weak* carbolized solution (3 : 100) to disinfect the hands, the instruments, the skin in the neighborhood of the wound, the wound itself, the sponges, and the air (carbolic spray).

(*b*) As a *strong* solution (5 : 100) to disinfect septic wounds; by its cauterizing quality, however, a slight whitish film is formed, and a more profuse secretion is produced.

(*c*) As a *carbolized glycerine* (5%–10%) to disinfect instruments.

(*d*) To saturate materials for dressing, especially mull (Lister-gauze, carbol-mull).

Since carbolic acid is very volatile, and since, by evaporation, its strength very rapidly decreases in impregnated materials, it is best not to impregnate them until shortly before using the dressings thus prepared.

Carbolized gauze, according to *von Bruns*, is made in the following manner : —

To 400 grams of finely powdered colophonium, 100 grams each of proof spirits and carbolic acid, and 80 grams of oleum ricini (or 100 grams of melted stearine) are added in succession. The mixture is stirred until it possesses the uniform consistency of an extract (which easily crumbles when handled); it is preserved immediately in a closed air-tight vessel. On being used, the mixture is dissolved in 2 liters of proof spirits under continuous stirring. Next, the gauze is saturated by pouring the mixture over one kilogram of mull loosely spread in a flat basin; the mull readily absorbs the mixture. For the purpose of uniform distribution, the gauze must be wrung out two or three times from one end to the other from 3 to 5 minutes, or it must be passed through a wringing machine. Finally, the material for dressing is hung up to dry; it should remain, however, only as long as is absolutely necessary,— that is, until the larger portion of the spirits has evaporated. Accordingly, in summer and in the open air, it is exposed about 5 minutes; in winter and in a moderately warm room, from 10 to 15 minutes. The material for dressings is kept in closed tin boxes.

Carbolic acid, however, is poisonous, not only when used internally, but also when used externally, since it is quickly absorbed even through the intact skin.

The *symptoms of poisoning* in mild cases are headache, dizziness, fainting, ringing in the ears, vomiting, irregular respiration, small pulse, olive-green coloring of the urine (carbol-urine from phenol-sulphuric acid). In serious cases, unconsciousness sets in, combined with muscular contraction; the pupils become contracted and no longer react; the pulse is scarcely perceptible; moreover, urinary troubles (dysuria, anuria, and albuminuria), intestinal hemorrhages, etc., are present. When the use of the acid is continued, even in small quantities, *marasmus* combined with headache, faintness, and decreased appetite are produced. The acid, moreover, causes a violent irritation of the skin, producing erythema and eczema, often with fever; thus the neighborhood of the wound may still be greatly affected by the carbolic acid, whilst the wound itself has already healed. Especially obnoxious and disagreeable is the irritation of the skin on the fingers and the hands of many surgeons who largely employ this remedy.

Strong solutions produce a cauterizing effect on the surfaces of the wound and irritate them, causing an increased wound secretion.

Test: Carbol-urine with chloride of iron yields a violet color; by heating with *Millon's* reagent, a purple-red; with a solution of chlorinated soda, a dark blue color; with bromine water, a precipitate of tribromphenol; or, the carbolic acid is extracted from the urine with ether; the ether extract, floating on the surface, is poured off, and a stick of soft wood (for instance, fir wood) is dipped into it. The stick is afterward placed into a solution of hydrochloric acid (acid. mur., 50 parts; aq. dest., 50 parts; cal. chlor., 0.20 parts); it is then exposed for some time to sunlight. Even in a 1:6000 carbolic strength, the stick is colored blue (*Hoppe-Seyler*, *Tomasi*).

The *treatment* for carbolic poisoning consists above all in the immediate discontinuance of the remedy, if it has been used as a dressing for the wound. Sugar of lime, albumen, milk, sodium, and magnesium sulphate (5%) are given internally. Against the several symptoms, the physician has to prescribe symptomatically analeptic and stimulating remedies.

In spite of its many unpleasant properties, however, carbolic acid, up to the most recent time, has maintained itself as the most reliable antiseptic at the head of all.

There are two other remedies that are said to produce a similar or even better effect; namely, *creolin* and *lysol*, both prepared from coal tar. Both contain as effective ingredients a series of cresol; but they are not pure preparations. **Creolin** forms with water a milky solution, and has about three times the strength of carbolic acid. It is used in 1%–2% solutions, and visibly promotes granulation and healing. **Lysol** is a soapy liquid, containing about the same ingredients as creolin; it yields with water rather clear solutions, which, even at 0.3%–2%, produce an antiseptic effect. Both remedies, notwithstanding their high antiseptic qualities, are *non-poisonous*, and are, therefore, especially suitable for cases where the surgeon is compelled temporarily to intrust the treatment of the wound to laymen. *Solveol* (*Hammer*), a cresol compound, even in 0.5% solution, produces a stronger effect on bacteria than a 5% carbolized solution. It is used in solutions of 37:500–2000.

Sublimate (*Hydrargyrum bichloratum corrosivum*, $HgCl_2$ — *Koch*, *von Bergmann*) is the most powerful but also the most poisonous of all disinfectants. According to *Koch*, the spores of the anthrax bacillus are killed by a solution of 1 : 20,000, whilst their development is arrested by a solution of even 1 : 300,000.

It is white, crystalline, odorless, and inexpensive.

Since sublimate is at once decomposed by coming in contact with metals, it can neither be kept in metal vessels nor be used for disinfecting instruments. Hence, the irrigators for sublimate solutions must be made of glass; and the basins, of glass, enamel, china, or varnished pasteboard.

Sublimate is used: —

(*a*) As a weak aqueous solution of 1 : 5000, for disinfecting the hands and the region of the wound, for impregnating sponges, and for irrigating the wound by means of the wound douche before the suture is applied.

(*b*) As a strong watery solution of 1 : 1000, for the energetic irrigation of septic wounds, in which case it acts much more effectively and is less dangerous than the 5% carbolic solution.

(*c*) As an alcoholic solution of 1 : 1000, for preserving catgut, silk, sponges, and drainage tubes.

(*d*) For preparing the materials for dressings. The materials are saturated with a solution of 1 part of sublimate, 100 parts of chloride of sodium, in 40 parts of glycerine and 1000 parts of water; the excess of the fluid is pressed out with the hands or with the wringing machine, and the material is allowed to dry in a moderate heat; or, gauze is saturated with a solution of 10 parts of sublimate, 500 parts of glycerine, 1000 parts of alcohol, and 1500 parts of water (*sublimate gauze, von Bergmann*). *Schede* uses a solution of 1 part of sublimate, 10 parts of glycerine, and 90 parts of water. According to the Military and Sanitary Regulations of 1886, there should be used for the preparation of sublimate gauze a solution of 5 grams of sublimate, 500 grams of proof spirits, 750 grams of water, 250 grams of glycerine, and 0.05 grams of fuchsine; this is sufficient for forty meters of gauze.

Since watery solutions and materials saturated with them sometimes greatly irritate the skin, and since the sublimate, after some time, evaporates from the material impregnated therewith (*Lazarski*), *Lister* suggested mixing the sublimate with the serum of the blood of horses (1 : 100) and saturating the gauze with it (*sublimate-serum gauze*). It loses thereby its irritating but not its antiseptic properties.

Sublimate combines with the albumen of the alkaline secretions of the wound and forms *albuminate of mercury*. Thereby the strength of the solution is considerably impaired. To prevent this and to preserve the sublimate in solution, small quantities of acids have been added (for instance, tartaric acid). The solution (1 part of sublimate, 5 parts of tartaric acid, 1000 parts of water) is used for saturating the gauze (*sublimate-tartaric gauze*, *Laplace*).

But if the poisonous effect of the sublimate is to be decreased, then chloride of sodium is added to the solution. This promotes the formation of albuminate of mercury, but, at the same time, considerably increases the absorbent strength of the materials used for dressings. *Maas* prepares the *sublimate-sodium gauze* by saturating 1000 grams of gauze with 500 grams of sodium, 150 grams of glycerine, and 1 gram of sublimate.

Sublimate, moreover, combines very readily with the earthy constituents always present in plain water, but the addition of chloride of sodium *prevents* this precipitate. Hence, it is necessary always to use *distilled water* for the solutions. For this reason in practice, for the rapid preparation of sublimate solutions at a patient's house, very convenient and exceedingly practical are the **sublimate tablets** of *Angerer*, prepared with the aid of chloride of sodium (they contain one gram of sublimate and one gram of chloride of sodium). To prevent mistakes, they are colored with eosin. It is advisable to make all sublimate solutions recognizable by some definite color; otherwise, through error, poisoning may easily be caused. (In the Rush Medical College clinic the sublimate solution is stained blue, carbolic solution red, saline solution yellow.)

The *symptoms of intoxication* by this, the most poisonous of all mercurial compounds, manifest themselves locally in itching, burning, and irritation of the skin (eczema, rhagades); this is especially the case when the poisoning is due to dressings that have been applied in a moist condition; other symptoms are: dizziness, restlessness, languidness, vomiting, inflammation of the mucous membrane of the mouth with salivation and bleeding from the gums, intestinal hemorrhages, bloody diarrhœa, colitis, proctitis, tenesmus, inflammation of the kidneys, and fatty degeneration and calcification of the uriniferous tubules; often causing death.

The *treatment* for sublimate poisoning, apart from the immediate discontinuance of the remedy, consists in administering milk, albumen, and baths; further than this, it is symptomatic — gargles of a saturated solution of potassium chlorate being used to combat oral symptoms; stimulants, in cases of depression.

Chloride of zinc, $ZnCl_2H_2O$ (*Lister*), is a moderately strong antiseptic, does not attack the uninjured epidermis, has a *caustic* effect upon the other tissues of the body, is odorless, non-poisonous, and inexpensive.

It serves: —

(*a*) As a strong (8%) watery solution (*Lister*), for the energetic disinfection of septic tissues that are in a state of disintegration or in an existing purulent and putrid condition, etc.

(*b*) As a concentrated solution (aa. with water), with which the cotton tampons are saturated, as an excellent caustic in gangrene (*König*).

(*c*) As a weak solution (0.2%) for antiseptic compresses and for impregnating material for dressings (jute, gauze).

(*d*) As a dry chloride of zinc jute (5%–10% — *Bardeleben*), for antiseptic dressings, which are very cheap. In a hundred parts of chloride of zinc dissolved in 1250 parts ($1\frac{1}{4}$ liters) of hot water, 1000 parts of jute are kneaded until all the fluid is absorbed. Next, the jute is spread out and dried in the air or on a stove.

Boric acid, BO_3H_3 (*Lister*), is a moderately strong antiseptic, which in a dilution of 1 : 136 arrests the development of schizomycetes, irritates tissues little or not at all, and does not possess any poisonous properties. It is not very soluble in cold water (1 : 30), but readily in hot water.

It is used: —

(*a*) As a *watery solution* (3.5 : 100), in place of carbolic and sublimate solutions, in operations in the abdominal cavity, on the rectum, etc.; also, according to *Thiersch*, for the same purpose, with the addition of salicylic acid (2 grams of salicylic acid, 12 grams of boric acid, 1000 grams of water).

(*b*) As *boric lint*, to cover small wounds; for this purpose it is especially useful on the face. It is prepared by dipping English lint into a solution of 1 part of boric acid in 3 parts of boiling water; in the same way, boric cotton and boric gauze are prepared.

(*c*) As *boric salve*, to cover sutured wounds on which a large antiseptic dressing cannot be well used; for instance, after plastic operations on the face; also to cover small granulating wounds.

Lister's boric salve is prepared thus: acid. borici pulv., ceræ alb., aa. 5 parts; oleum amygd. dulc., paraffini, aa. 10 parts. Still better, because simpler and more easily preserved, is a mixture of 20 parts of boric acid with 100 parts of vaseline or ung. glycerini, or the *boro-glycerine-lanolin* (*Graf*).

Tetraboric sodium (borax) (*Jänicke*) is more easily soluble and therefore more effective than boric acid, and can be used in solutions of 15%–70%. It is non-irritant and non-poisonous.

Aluminium acetate (*Burow*) is a very powerful antiseptic. In a 2.5% solution, it not only arrests the development of the schizomycetes, but, after acting 24 hours, destroys their power of propagation (*Pinner*). It quickly removes offensive odors of wounds and secretions of the skin, and is non-poisonous and inexpensive; it can be used, however, only in fluid form, because the acetic acid evaporates in drying, and only the ineffective aluminium hydrate remains. Since it injures the instruments and makes the hands rough, its application in operations is not practical; but, as a powerful astringent, it restrains the capillary hemorrhage, and is therefore suitable for saturating tampons.

A 1% solution is prepared by mixing 24 parts of alum and 38 parts of sugar of lead with 1 liter of water. This is allowed to stand for 24 hours, and is then filtered.

It is used as a watery solution of 0.5%–1% for saturating gauze compresses, for poultices, for purifying warm baths, in suppurating and sanious fetid wounds and ulcers, in eczemas, and fetid perspirations (axilla, anus, scrotum); and, of all antiseptics, is most suitable for *permanent irrigation* in progressive phlegmonous inflammation and gangrene.

A still more powerful effect has *aluminium acetico-tartaricum*, which is a more fixed chemical compound, and only slightly cauterizes the surfaces of the wound. It is used in 1%–3% solutions.

Lead acetate, an antiseptic of moderate potency, which in a solution of 1 : 20 kills the spores, is less frequently used at the present time than formerly. As *aqua Goulardi* (subacetate of lead solution), it was once used largely in the treatment of wounds and inflammation.

Salicylic acid, $C_7H_6O_3$ (*Thiersch*), a strong antiseptic, irritates the wounds little, is non-poisonous, easily evaporates from the materials for dressings, produces coughing and sneezing, and is expensive.

It is used in solutions (1 : 300) to irrigate wounds, preferably mixed with boric acid, whereby its solubility is increased. It acts as an emulsion (1 : 5 water), or, as salicylic salve (10% with vaseline or glycerine salve), in an excellent manner in eczema caused by carbolic acid and sublimate.

As salicylic cotton and jute (3% and 10%), freshly prepared, it was once largely used. It cannot, however, be recommended for practice, since during transportation the salicylic acid falls out of the meshes of cotton, and materials saturated with it do not absorb well.

Chromic acid, Cr_2O_3 (*Lister*), is a very strong antiseptic and twenty times more effective than carbolic acid; but it is very poisonous and is a powerful cauterizer. It is, therefore, not used at all in the treatment of wounds, but only in the preparation of catgut, which *Lister* placed in a solution of 1 part of chromic acid, 200 parts of carbolic acid, and 4000 parts of water.

Thymol, $C_{10}H_{14}O$ (*Ranke*), is a good antiseptic, since an emulsion of even 1 : 200 kills the schizomycetes, and a solution of 1 : 2000 arrests their development. It has a pleasant odor, irritates the skin but little, limits the secretion of wounds, and is but little poisonous, though expensive.

It is used as a watery solution of 1 : 1000, with the addition of 10 parts of alcohol and 20 parts of glycerine. As thymol gauze, it is prepared by saturating 1000 parts of gauze with 500 parts of cetaceum, 50 parts of resin, and 16 parts of thymol.

Used in burns, 1% of thymol should be added to the liniment generally used (oleum lini and aqua calcariæ, aa.); it alleviates the pain and is antiseptic. A 1 ‰ solution is also to be recommended as a mouth wash.

Potassium permanganate is easily soluble, inexpensive, and non-poisonous, and is a moderately strong antiseptic, since even in a 5% solution it destroys resting spores, and, after a short irrigation, entirely removes the fetid odor of putrid wounds. But its effect is only of short duration, because it is speedily decomposed by the wound secretion, and is precipitated in the form of a mucous brown deposit, which at once causes again the offensive odor.

It is used as a watery solution of a color from claret to dark red (1 : 1000–100), according to the degree of putrefaction (*Condy's* fluid). It is largely used also as a mouth wash for deodorizing and disinfecting the buccal cavity and carious teeth.

Benzoic acid (*Kraske*) is a good, apparently non-poisonous, antiseptic. It is used as a solution of 1 : 250, and does not irritate the wound. As an alcoholic solution, as a tincture (*Tinctura benzoes*) its good effect has long been known. In preparing cotton or jute as materials for dressings, 5%–10% of the acid is used for saturating them.

Resorcin, prepared from benzoic acid, is used in 1%–2% solutions as a good and effective irrigating remedy (especially in cystitis). **Benzosol** is said to be a better substitute for it.

Trichloride of iodine (*Langenbuch*) is a non-poisonous antiseptic, effective in even a 1 ‰ solution, in destroying schizomycetes. In the dilution given above it has the effect of 4% of carbolic acid.

Trichlorphenol (*Butschik*) is effective in 1%–10% solutions, but is used only in Russia. **Creosote** also is now but little used, though formerly as *aqua Binelli*, a 1% solution, it was used in fetid suppurations, in empyema, etc.

Chlorine is a very powerful antiseptic, and, long before *Lister*, was used as **chlorine water** (*aqua chlori*) for cleansing sponges and for irrigating wounds. The compounds of chlorine also have antiseptic properties; thirty years ago **hydrochloric acid** in a 1% solution was used by me in permanent dressings.

Chloride of lime (*Semmelweiss*), even in a twenty-fold watery solution, disinfects very energetically. It was used for disinfecting material for dressings and linen wear, for cleansing gangrenous ulcers, and for white-washing infected rooms and objects.

Chlorinated soda is used in 5%–6% solutions in decomposing wounds (*Verneuil*). *Natrium chloroborosum* and *chloroboricum* are recommended in solutions and in powders.

Chloride of sodium has been known for a long time for its effects in arresting putrefaction (pickling). In strong solutions it irritates the wound and causes pain. In about 1%–2% solutions it can be used for cleansing, especially wounds that discharge a great deal of pus. For irrigating fresh aseptic wounds, a 0.6% solution of chloride of sodium is now generally used (*von Esmarch*). Its strength corresponds to that contained in the healthy tissues, and therefore, so to speak, represents a *physiologic irrigating fluid*. *Maas* utilizes the great absorbing power of chloride of sodium in the preparation of sublimate gauze (see page 27).

Chloral hydrate, in a 1%–2% solution, in connection with chloride of sodium, is a remedy much esteemed by many for disinfecting septic wounds, since chloral has to a great extent the power to prevent the decomposition of putrefying substances.

Ferrum sesquichloratum (*ferric chloride*), formerly almost exclusively used as a remedy for arresting hemorrhages, has strong antiseptic properties, but cauterizes, and forms a crust on the surface of the wound. In weak solutions it can be used for saturating cotton. In very greatly diluted form it was used by *Köberle* for cleansing the abdominal cavity.

Some *sulphides* are also good antiseptics. *Sulphurous acid*, even in a dilution of 1 : 500, is effective and non-poisonous. In 5% solutions it is used for permanent irrigation, and as a gas for disinfecting infected rooms.

Alum, aseptin (1 part of alum, 2 parts of boric acid, 18 parts of water), **cuprum** and **zincum sulphuricum** (zinc sulphate), are serviceable in 1% solutions for irrigating and cauterizing ulcerating wounds. **Zincum sulphocarbolicum** (zinc sulphocarbolate) has been recommended in recent times by *Bottini* as a good and non-poisonous antiseptic (5%). **Aseptol,** even in 2% solutions, is effective. It is non-irritant and non-poisonous, and is used mostly in 10% solutions. **Aseptinic acid** (*acidum asepticum*), a powerful, non-poisonous styptic remedy, is used in 5%–10% solutions. It promotes granulation and cicatrization.

Rotter prepared a very powerful but non-poisonous antiseptic by combining several antiseptic remedies into one solution, too small a quantity of each being used to produce any poisonous effects. This **Rotterin,** which can be had also in pastils, contains in one liter of water: sublimate, 0.05; chloride of sodium, 0.25; acid. carbolic., 2; zinc. chlorat. and zinc. sulphocarbolic. aa. 5; acid. boric, 3; acid. salicyl., 0.6; thymol, 0.1; acid. citric., 0.1. These tablets are prepared now also without carbolic acid and sublimate.

Volatile oils, balsams, etc., have been also used as antiseptics — such as camphor, styrax, balsam of Peru, aloe, turpentine, terebene, tar, and petroleum. More frequent use is made of eucalyptus oil, in which the effective ingredient, **eucalyptol,** operates antiseptically in a very energetic manner. *Lister* used it as a substitute for carbolic acid. *Eucalyptus gauze* is prepared with 1 part of the oil of eucalyptus, 2 parts of gum dammar, and 3 parts of paraffin. In an alcoholic solution or in a mixture (0.3%) — to be shaken before use — for irrigation and for compresses, it produces a rapid reduction of temperature (*Schulze*). **Oil of juniper,** a very powerful antiseptic, is used by *Kocher* in preparing catgut. Having placed it in oil for 24 hours, he keeps it until used in 95% alcohol.

Hydrogen peroxide (*Trommsdorff*) is a very powerful antiseptic, non-poisonous, and, even in a 3% watery solution, is very effective for disinfecting putrid wounds as well as sick-rooms. It is an excellent styptic remedy.

Absolute alcohol is a moderately strong antiseptic, useful for disinfecting instruments, especially knives and scissors, the edges of which are not affected by it. *Aniline dyes* are likewise strongly antiseptic. Of these, methyl violet was for a time very much recommended in the form of **pyoctanin,** by *Stilling;* but it seems not to have met with success.

ANTISEPTIC POWDERS

Iodoform, CHI_3 (*von Mosetig-Moorhof*), a lemon-yellow crystalline powder of peculiar odor, insoluble in water, easily soluble in alcohol, ether, and oils, is, properly speaking, not an antiseptic, since it does not destroy the bacteria directly, but, by means of the decompositions produced by them (ptomaines, toxalbumin) it is broken up, and the liberated iodine neutralizes the products of metabolism in the micro-organisms, rendering them harmless, and arresting their further development.

It irritates the surface of the wound and its surroundings, produces good granulations, especially in fungous diseases, and very considerably limits secretion; but it is poisonous, especially to old people and to those who suffer from heart and kidney diseases. Its unpleasant odor may be mitigated or entirely avoided by the addition of cumarin, oil of bergamot, oil of sassafras, or by a mixture with powdered coffee.

Iodoform is used:—

(*a*) As a *powder to sprinkle fresh* wounds, such as contusions and gunshot wounds, where healing by primary intention cannot be expected. It is especially useful also in the neighborhood of the natural orifices of the body (mouth, anus, vagina), where infection cannot be avoided.

(*b*) As *iodoform ether* (1 : 7) to disinfect the field of operation.

(*c*) As *iodoform ether-alcohol* (1 : 2 : 8) (*de Ruyter*) to be rubbed on poorly granulating, especially tubercular wounds.

(*d*) As *iodoform glycerine* (10–20 : 100) for injecting punctured cold abscesses.

(*e*) As *iodoform collodion* (1 : 9) for protecting small completely sutured wounds (for instance, as a dressing after herniotomy — *Küster*).

(*f*) As *iodoform pencils* (iodoform, 20 parts; gummi Arab. glycerini, amyli, aa. 2 parts) for the treatment of fistulous canals and cavities difficult to disinfect.

(*g*) As *iodoform gauze*, applied in a single layer below the other dressings, for covering fresh wounds united by suturing, and for insertion into wounds of the mucous cavities that remain open (mouth, nose, pharynx, rectum, vagina, bladder, and urethra), where thorough antisepsis is impossible.

Iodoform gauze is prepared by sprinkling in a clean basin 10 meters of gauze with 100 grams of iodoform, and by rubbing the same with clean hands until it has become uniformly yellow.

Iodoform gauze, useful for all purposes, can also be made very rapidly by sprinkling iodoform ether upon the gauze, and by rubbing it until the ether has evaporated. Iodoform is then distributed uniformly in the gauze in very fine crystals. Saturating with the following mixture is more practical: 50 grams of iodoform, 5 grams of glycerine, 20 grams of colophonium, 1,000 grams of proof spirits, and 500 grams of gauze. Iodoform adheres better to this material, and does not fall out from its meshes so easily. These procedures are of course more expensive than the one described above.

Billroth's adhesive iodoform gauze is most suitable for the mucous cavities, because it firmly adheres to the surfaces of the wound, preventing putrefaction for weeks. It is prepared by drawing through a solution of 100 grams of colophonium in 50 grams of glycerine and 1200 grams of alcohol (95%), 6 meters of gauze, which, after drying, is rubbed with 230 grams of iodoform.

The Military and Sanitary Regulations prescribe the following preparation: Eight meters (250 grams) of gauze are spread on a clean plate and irrigated from a flask with a narrow neck, containing a mixture of 600 grams iodoform, 250 grams of alcohol, and 250 grams of glycerine, until the gauze has turned uniformly yellow. It is then passed several times through a wringing machine, and the fluid that has been wrung out each time is poured over it again.

The *symptoms of iodoform poisoning* which manifest themselves are as follows: In mild cases, redness of the skin, headache, languor, loss of appetite, nausea, and vomiting; in severe cases, loss of sleep, increased frequency of the pulse, fever, restlessness, delirium, attacks of mania, coma, and twitchings of the muscles of the face and of the trunk. If these latter symptoms have occurred, death generally follows in a short time, even when the remedy is discontinued.

The *presence* of iodine in the urine is ascertained by the addition of dilute sulphuric acid and fuming nitric acid, with a few grams of chloroform; the mixture is vigorously shaken, when the same will turn red violet, if any iodine is present.

After discontinuing the remedy, *the treatment* consists in thoroughly irrigating the surface of the wound, especially in administering alkalies (potassium bicarb., etc.), and in infusing chloride of sodium; further than this, the physician must combat the symptoms as they appear.

Bismuth, $NO_3[OH]_2Bi$ (*Kocher*) (Bismuthum subnitricum, Magisterium Bismuthi), a white crystalline powder, only slightly soluble in water, is a good antiseptic. It has a strong drying effect on wounds, but is not entirely non-poisonous. It is used in a 1% solution for the wound and the materials for dressings; 5%–10% emulsions produce a more caustic, but also a more poisonous, effect (stomatitis, enteritis, nephritis).

Naphthalin (*E. Fischer*) is a very good antiseptic; it does not irritate wounds, is non-poisonous and very cheap, but has a very unpleasant penetrating odor. As a powder, sprinkled on open wounds, it disinfects them rapidly and permanently. Gauze, rubbed with naphthalin, furnishes a very useful antiseptic material for dressings.

Oxide of zinc (*Petersen*), a moderately strong, non-poisonous antiseptic, is used as a powder in a 1%–10% mixture (thin and thick milk of zinc); it is also used for saturating materials for dressings. For covering sutured wounds, *Socin* used a paste of 50 parts of oxide of zinc, 5 parts of chloride of zinc, and 50 parts of water.

Iodol (*Ciamician*), a yellowish, odorless, non-poisonous powder, is said to possess all the good qualities of iodoform. It is used as a powder, in a 10% glycerine emulsion, and as iodol gauze, which is prepared in the same manner as iodoform gauze.

Sozoiodol (*Trommsdorff*)—as well as its compounds, especially with sodium, quicksilver, and zinc—through its constituents, iodine and carbolic acid, also produces an antiseptic effect. It is non-poisonous, and, as a powder and in solutions and in the form of gauze and salve, is used with very great success in the treatment of wounds, ulcers, and catarrhs.

Dermatol, prepared in most recent times, is said to produce a still more favorable effect, and is especially useful in diseases of the skin. **Aristol** also, used like the latter, is greatly praised for its properties in promoting granulation and in healing ulcerated surfaces. In effectiveness, however, it is said to be surpassed by **diiodothioresorcin**. **Sulfaminol**, a non-irritant, odorless drying powder, that produces antiseptic effects, is suitable for the after treatment of wounds, especially in the buccal cavity and in the nares. **Salol**, consisting of carbolic and salicylic acid, in the form of a powder, is used with great success in the treatment of chronic ulcers.

Likewise **charcoal, sugar**, and **coffee** have recently come into limited use. Pulverized charcoal and coffee (*Oppler*) are used especially in gangrenous ulcers; in consequence of their action, the fetid secretion of the wounds soon becomes odorless. Sugar (*Lücke*), in spite of its tendency to ferment, is efficient in preventing decomposition (sour reaction of secretions of the wounds). In a very thick layer, it is used as a powder on sutured wounds (*Fischer*). Since, moreover, it produces a powerful drying effect, the dressings can remain in position from 8 to 14 days.

(The editor has used for years with the most satisfactory results, both in military and civil practice, as a drying and antiseptic powder, a combination of boric and salicylic acid in the proportion of 4 : 1.)

Of this large number of antiseptic remedies, the enumeration of which is by no means exhausted, only comparatively few are *universally* used. They are principally: **carbolic acid, sublimate, boric acid**, and **iodoform**; the first two, because they are among the most powerful remedies for disinfection; boric acid, because, notwithstanding its great colyseptic qualities (preventing putrefaction), it is non-poisonous and can, therefore, be used where (for instance, in mucous membranes and in large serous cavities) toxic remedies, by absorption, might easily cause poisoning; finally, iodoform, because it is the most excellent remedy for preventing a subsequent decomposition of the secretions of aseptic wounds (or wounds rendered aseptic). As long as only a few of its crystals are present in the wound, it is still safely effective, and is, therefore, apart from its good services in tubercular diseases, especially suitable for permanent dressings.

In the *antiseptic* treatment of fresh wounds, not made by the surgeon himself (**primary antisepsis**), after a most careful cleansing, antiseptics are used, only in *weak* solutions, to destroy the germs of infection that have entered the wound, or to remove them by irrigation. For irrigating the field of operation, the following are suitable: sublimate, 1 : 5000; carbolized solution, 2 : 100; boric solution, 3 : 100; in these solutions, likewise, the sponges are wrung out. Too large quantities of poisonous antiseptics should be avoided on account of their accompanying effects, and irrigation should be performed only when it seems necessary — hence, especially at the end of an operation, before applying the suture. The danger of absorption, moreover, is considerably decreased if the operation is performed under elastic constriction of the limb; under such conditions the application of even stronger solutions is admissible, because absorption cannot take place, and hence the antiseptics affect merely the surface of the wound. After such irrigations, the whole wound should be carefully dried. After application of the suture and after drainage, the wound is once more irrigated with an antiseptic solution, and is firmly pressed together with a large sponge or tampon, that the fluid still remaining in it may be squeezed out. This pressure is continued until the sponge is exchanged for the first piece of dressing (pad or crinoline gauze), which should likewise be pressed firmly on the wound by the fixation bandage (Fig. 37).

Wounds that can be united by means of the suture are covered with sublimate gauze or iodoform gauze. This is firmly pressed on by a cushion of moss or a thick layer of cotton, and the whole is fastened with a bandage.

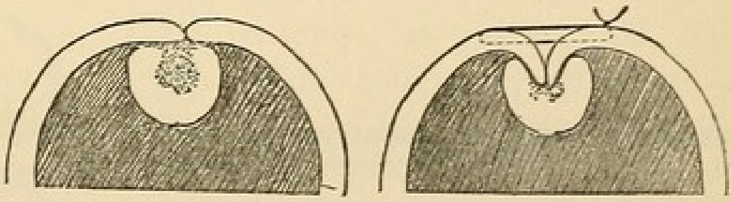
If the surgeon does not succeed in suturing the wound completely, or if, in a diseased appearance of the same, he prefers not to apply the suture at all, then on the whole surface of the wound iodoform powder is sprinkled, in the form of a thin film, preferably with a brush; after this the wound is covered with gauze. The dressings of wounds that heal by granulation must be renewed oftener — every 2–6 days, according to the amount of their secretion; while the dressings on sutured and drained wounds can, in most cases, remain in position until they are healed. The drainage tubes also need not be removed until after this period. By the agglutination of their walls the canals formed by the tubes close in a few days after their removal.

Small wounds that neither bleed nor suppurate can be hermetically sealed in a very simple manner with *adhesive plaster*, English plaster, *zinc paste*, *photoxylin*, *traumaticin*, or *collodion*. It is necessary, however, to cleanse them previously with antiseptic remedies, and also to moisten the English plaster with a disinfecting solution (not with saliva); very useful, indeed, is the application of *iodoform collodion* (with an addition of ricinus oil or of turpentine); this produces an antiseptic effect, keeps the wound securely covered, and contracts it moderately. Such plasters, however, adhere only to a dry skin. Even if a slight hemorrhage occurs, they are raised from the skin and fall off; under these circumstances, in the majority of cases, they have done more harm than good.

THE DRYING AND THE DRAINING OF THE WOUND

In wounds which have been treated aseptically and which have been irrigated, if at all, only with a solution of sodium chloride, the secretion is usually very moderate, since the surfaces of the wound have not been unnecessarily irritated. In order to limit the secretion even more, it is important: first, to *arrest* as carefully as possible the *hemorrhage* from even the smallest vessels; next, not to *suture* the wound too tightly to prevent any secretions from filtering through the interstices of the sutures; finally, to apply a firm, well-absorbing *compressive bandage*, which closely approximates the surfaces of the wound and accomplishes healing by agglutination.

Cavities should be *avoided* as much as possible; or they should be removed by suturing their walls in layers (*buried suture*, "**etagen**" *suture*), and by deep-reaching sutures of the skin.



FIGS. 31–32. INVERSION SUTURES

Rigid walled cavities in the bone, after having been scraped out with the sharp spoon or chiselled out, or irregularly formed cavities of the wound after the removal of tumors, can be allowed to fill with blood after an exact suturing of the margins of the skin. If no infection has taken place, this blood, in the course of time, becomes organized into cellular tissue (**healing under the scab**, *Lister*, *Cheyne*, *Schede*). (The blood clot is never converted into connective tissue, but simply serves the purpose of an absorbable temporary scaffolding which is removed by the granulations which invade it from the walls of the wound cavity.) The formation of cavities, however, may be entirely avoided by drawing over the cavity the margins of the skin in a lateral direction, fastening them in this position, and covering the groove of the bone with them ("**Einstülpungs**"-**suture**, inversion sutures — Figs. 31–32).

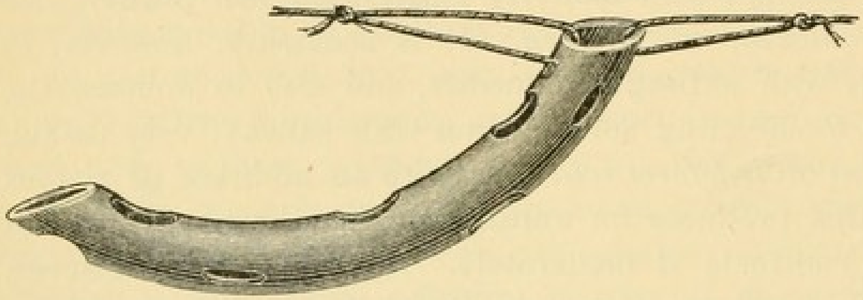


Fig. 33. Rubber Drainage Tube

If it is to be expected that either through the irritating effect of the powerful antiseptics or through infection, considerable quantities of secretions will collect in the wound, care must be taken that the same are not retained, but have free exit. **Drainage** by means of perforated rubber tubes effects this (*Chassaignac*) (Figs. 33–34). The tubes are introduced into the wound in such a manner that they occupy the most dependent part of the cavity, projecting only a little beyond the surface; the rest of the wound is sutured. In this position, the tubes are fastened by safety pins placed transversely or by an interrupted suture at the margin of the wound. For the insertion of drainage tubes into narrow cavities, *Lister* uses special dressing forceps (Fig. 35). In most cases, however, moderately strong dressing forceps, somewhat bent, render the same service.

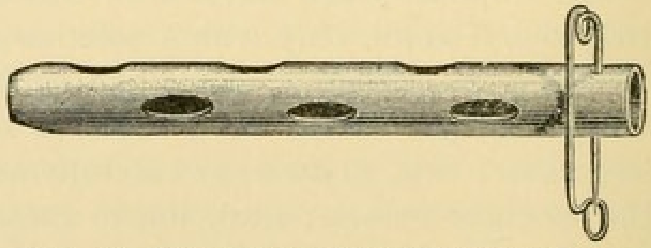


Fig. 34. Decalcified Bone Drainage Tube

Sometimes in **large cavities of wounds**, special openings (*counter openings*) must be made in the skin at the most dependent part to secure a free escape for the secretions and furnish space for the drainage

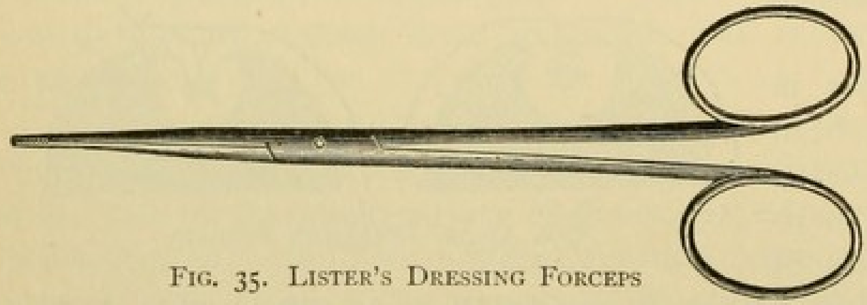


Fig. 35. Lister's Dressing Forceps

tubes. This is done in the simplest manner, from without, upon the skin, projected by means of dressing forceps pushed through the tissues from within, outward. *Chassaignac* used a *drainage trocar* (Fig. 36), which he pushed from within through the most dependent portion of the wound. To the barbed hook of the point, he fastened the drainage tube and then withdrew the instrument together with the tube.

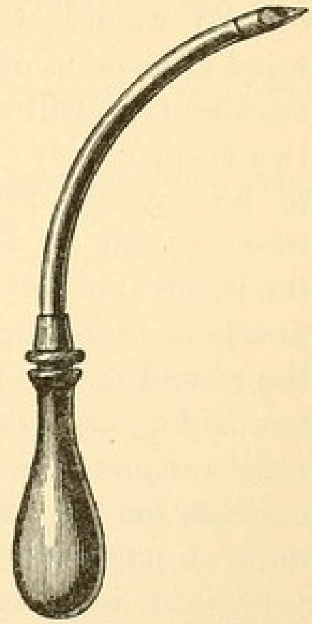


Fig. 36. Curved Drainage Trocar

Instead of rubber tubes, there have been used also *glass tubes*, *metal tubes*, decalcified *bone tubes;* also *wicks* of gauze, wool, catgut, spun glass, wire, and horsehair, which by means of their *capillarity* become strongly absorbent. (*Nussbaum* used for drainage small strips of protective silk.)

Boiling these substances for some time disinfects them. Rubber tubes cannot stand prolonged boiling; but they become completely sterilized by being placed, even for a minute, in a boiling soda solution. They are preserved in a 5% carbolic solution.

In order to avoid introducing foreign bodies into the wound, the drainage, moreover, may be so established that the wound can be sutured loosely and that the lower angle of the wound especially is to be left *open*. Into this angle, a bunch of gauze from the dressings is loosely inserted, so that the secretions can flow out from the opening by the force of gravity; or, at the dependent portions, the skin is perforated parallel to and along the suture of the skin. The *perforations* thus made, from the margins of which the protruding fat is cut off, are made gaping by tension on part of the suture, and serve as openings for the escape of the discharge (see Fig. 37).

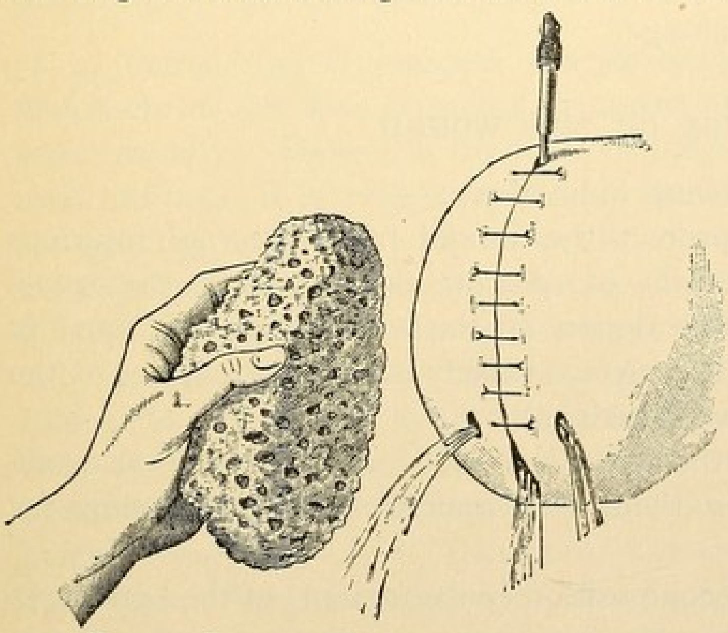


Fig. 37. Drainage Openings in the Skin
Last irrigation

In large wounds, which may eventually cause considerable bleeding or which had to be made in pathologically suspicious tissues (tuberculosis, œdema, sepsis), it is safest, not to apply any suture nor to insert any drainage, but to leave the margins of the wound wide open, and to *pack* the whole cavity of the wound with gauze (**tamponing**). By this procedure, the most rapid absorption of the secretions is procured. In spite of the tamponing, healing may still take place by primary intention, if, after the course of two or three days, when the gauze has been removed, the wound appears to be covered with good granulations. It can then be closed in its whole extent by deep and superficial sutures (**secondary sutures**). If, on the removal of the tampon, a bad condition of the wound, with profuse suppuration, is found, the surgeon has to dispense with the suture and allow the wound to heal by means of granulation and continued tamponing. For tamponing, especially if the gauze is to remain in position for some time, *iodoform gauze* is almost universally preferred. In the case of very large cavities, too large quantities of the gauze might occasionally produce symptoms of poisoning. Under such circumstances it is advisable to use either very weak iodoform gauze or sterilized gauze for the upper layers of the tampon; or else the walls of the cavity are covered with a single or a double layer of iodoform gauze; into the remaining part of the cavity sterilized gauze is packed. This is removed layer by layer, and thus the cavity gradually decreases in size (*Miculicz*).

But if it becomes necessary to remove very infectious secretions of the wound, permanent *immersion and irrigation* (see below) often render better services than tamponing and drainage.

DRESSINGS OF THE WOUND

These have to fulfil the following indications: —

1. They are intended to protect the wound from external injurious influences, especially from bacteria of putrefaction entering the same. Hence they must cover the whole region of the wound liberally, must fit well everywhere, and must hug the surface closely along the margins of the wound (**cover dressings, protective dressings**).

2. They must readily *absorb* the secretions (blood, serum, pus) that exude from the wound, and must allow them to evaporate rapidly (**dressings for drying the wound**).

3. They must prevent the decomposition (putrefaction) of the secretions (**antiseptic dressings,** *Lister*).

The **materials for dressings** that are to cover the wound: —

1. Must be absolutely pure (aseptic).

2. Must contain the agents that destroy the germs of putrefaction (antiseptics).

3. Must be soft and elastic, so that, under moderate pressure, they can be well fitted to the surface of the body.

4. Must readily absorb fluids of all kinds — must possess great absorptive capacity.

5. Must be freely pervious to air, in order that the absorbed fluids may evaporate rapidly and combine with the oxygen of the air.

Materials most frequently in use are the following: —

1. **Gauze** (muslin for dressings), a loosely woven cotton cloth that has been rendered hygroscopic (that is, all oily substances have been removed from it) by boiling in a solution of caustic soda. It is used: —

(*a*) For the immediate covering of the wound, either in layers, folded repeatedly smoothly upon one another, as a *compress* (*Lister*), or in pieces loosely and carelessly folded, as "*kruell*" *gauze* (loose or lost gauze) (*von Volkmann*).

(*b*) Made into *sacks* of different sizes, filled with other materials for dressings (peat, moss, sawdust, cellulose, etc.), and laid as a *cushion* or a *pad* over the few layers of gauze directly over the wound.

(*c*) Cut into *bandages* from 6 to 12 centimeters wide, which, sterilized or dipped into an antiseptic fluid (carbolized, sublimated water), serve for fastening the protective dressings.

2. **Cotton.** (*a*) *Hygroscopic* **charpie-cotton** (*wound cotton*, — *Bruns*), from which *the oil has been extracted* by means of a caustic soda solution, absorbs water rapidly. Hence, in the form of tampons or gauze balls that are to be used but once, it is very suitable for washing soiled parts of the body and for packing secreting surfaces (axilla, etc.); but it should not be applied directly upon the wound itself, because with the admixture of the secretions a hard, compact, and impermeable layer or crust is formed. Hence, it is used only for the second layer of dressings over the gauze (the layer should be somewhat thick), and is restricted to smaller wounds in which there is but little secretion. In larger wounds, the dressings must be changed oftener, because the cotton, once saturated with pus, etc., becomes hard and is no longer absorbent. It is, therefore, not especially suitable for permanent dressings. For these, *cushioned dressings* are preferable.

(*b*) The **common** non-absorbent **cotton** is used for upholstering splints, and especially, in the form of **cotton bandages** from 10 to 15 centimeters wide, for padding and covering the margins of the dressings, since cotton, as we know, is the best filter for the germs of infection suspended in the air.

3. **Lint**, a cotton tissue with a rough surface, similar to parchend, is mostly employed for covering small wounds, especially after previous saturation with a hot boric solution (*borated lint*). It is frequently used as a means of applying salves.

To fill the above-mentioned gauze bags for cushioned dressings, the following more or less hygroscopic materials are used: —

1. **Peat** coarsely powdered, as peat mull (*Neuber*). The light brown variety (peat moss) absorbs very well (nine times its weight), if somewhat moistened before application; **black peat** absorbs less, but possesses antiseptic qualities, owing to the humic acid it contains.

2. **Peat moss** (sphagnum). This can be found everywhere in forests and bogs; it can easily be made aseptic by washing and subsequent sterilization. It is very compressible, an excellent absorbent, and cleaner than peat turf. *The needles of sphagnum* are finer and absorb better.

3. **Sawdust, wood wool, and cellulose.** These are good materials for dressings, because they are all elastic, absorb fairly well and rapidly, are easily rendered aseptic by the different methods of sterilization, and are not expensive.

Sawdust (*Porter*) can be had everywhere. The dust of poplar absorbs best of all; that of fir has also antiseptic qualities. *Wood wool* and *cellulose* are made in factories, and can be had reasonably cheap. The latter are especially suitable for artificial sponges to be used in operations in the place of sea sponges, and for filling the pads of splints. *Cellulose cotton* made of fir wood fibre is also manufactured in sheets, is very soft, and a rapid absorbent.

Pine wool, oakum, jute (Araucan hemp), flax, blotting paper, sand, and ashes are less generally used, partly because they are not soft enough, partly because they are not sufficiently absorbent.

It may be stated here that the power of absorption of all of these substances may be considerably increased by the addition of agents that quickly absorb water, such as *chloride of sodium*, glycerine, etc. They also absorb more actively if they are previously moistened before applying them.

Owing to the manufacture of these cushioned dressings on a large scale, their use has been rendered so convenient that they can be used now almost everywhere. *Leisrink* and *Hagedorn* had **sphagnum pasteboard** manufactured, by strong compression, in sheets of various sizes. These are very clean for usage, and need only to be wrapped in gauze to furnish an excellent sphagnum pad. They can also be purchased already sewed up in gauze coverings. They occupy very little space, but swell up very considerably when moistened. Just as useful are compressed pine wool and wood cotton (*wood cotton sheets* —"*Holzwattetafeln*").

Formerly many various sizes were mentioned for the pads of very large dressings; for instance, pads — large, 50–70 centimeters square (Fig. 38); small, 5–10 centimeters square. It is simpler and more practical, however, even in large wounds, to apply several *smaller* pads. It is necessary, therefore, to keep on hand only about two or three sizes — 5, 10, 30 square centimeters.

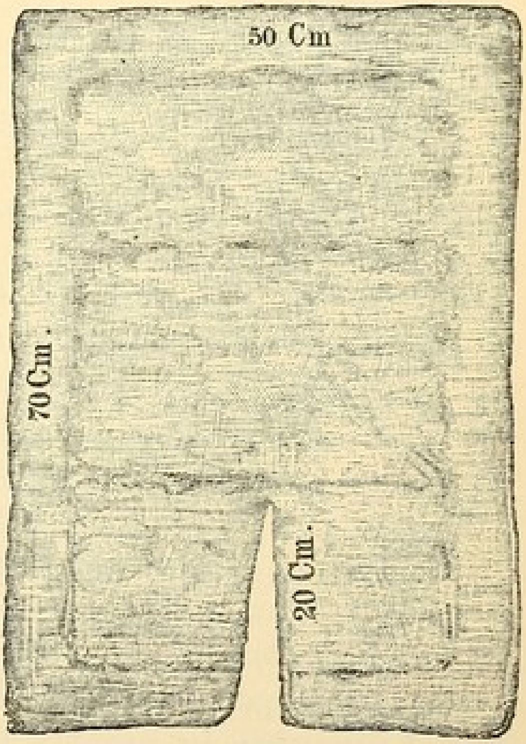


FIG. 38. LARGE DRESSING PAD

Pads 50 centimeters long and 15 centimeters wide are suitable for padding the splints.

Before applying these pads, their contents are so displaced by shaking that they apply themselves well to all the irregular surfaces of the region of the wound, so as to exert a uniform pressure upon the whole wound, and also that the principal mass comes to lie on the most dependent part of the wound — for instance, upon the back, in dressings of the breast and the region of the axilla. By turning over the edges — for instance, in the case of amputation stumps — the surgeon should attempt to exclude the wound completely by the dressing.

First of all, the pad is wrapped with a gauze bandage in such a way that it applies itself uniformly and firmly to the portion of the body; over this, another layer of cotton may be applied, and the whole then fastened with a cambric or gauze bandage.

All cavities and lacunæ — for instance, the axillary region — are carefully packed with cotton or "krüll" (loose) gauze before the bandage is applied.

Finally, in cases where the operation has been performed on the extremities under elastic constriction, an elastic bandage of thin rubber is placed over the whole dressing, in order to add to the compression during the first two or three hours; and in operations near the anus, such a bandage is placed around the marginal portions of the dressings, in order to prevent the entrance of intestinal secretions into the dressings (Fig. 39).

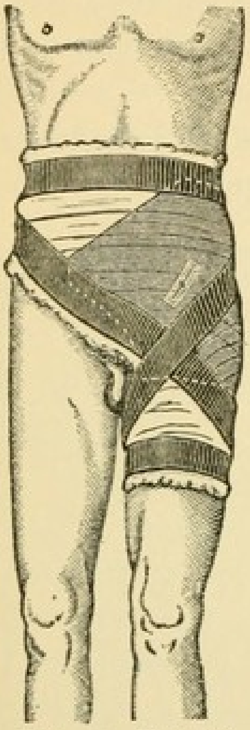


Fig. 39. Elastic Bandage

Waterproof materials are only rarely used in dressing wounds, since it has been found that they do more harm than good, preventing the secretions of the wound from evaporating. Among these materials is *Lister's* **protective silk** (*protective taffeta*), which he used directly on the wound, to protect it from the irritating effect of carbolic acid, etc. If the materials for dressings possess sufficient power of absorption, this protection is just as little needed as the spun *glass wool*, recommended for the same purpose by *Schede*.

The same must be said, also, of the expensive **mackintosh** which, in the original Lister dressings, was placed between the seventh and the eighth gauze layer, to prevent any of the secretions of the wound from reaching the surface of the dressing. If something of this kind is to be applied, the less expensive **glazed paper** is preferable. This can be prepared by the physician himself in the following manner: —

Brush silk paper with linseed varnish to which 3% of siccative or varnish extract has been added. Hang up the saturated sheets on threads in an airy room for 48 hours, until they are completely dry. To render the paper antiseptic, add to the varnish 1% of thymol. The varnished paper is quite suitable, also, for covering the compresses and keeping them moist (*Priessnitz's* compresses, cataplasms); for this purpose, moreover, parchment paper, oil cloth, and gutta percha may be used.

Stronger waterproof materials, such as cotton cloth saturated with oil or caoutchouc varnish (for instance, *Billroth's batiste*, *oil cloth*, etc.), are used to protect the bed linen in changing the dressings, in permanent irrigation, etc.

The **pure caoutchouc materials** of raw brown caoutchouc are very suitable for covering the operating table, for protecting other portions of the body during operations and dressings (see Fig. 21), and for aprons of the surgeon and his assistants. From the same material the caoutchouc bandages 5–10 centimeters wide are made.

Bandages serve to keep in contact with the surface and hold in position the dressings and splints, to cover, support, and fix in an immovable position injured portions of the body. They are manufactured: —

(*a*) Of **gauze**. These apply themselves well if previously moistened. When they have been saturated with starch (*organtine*) they become agglutinated in drying, so that the dressings can be no longer displaced (*agglutinative bandages*). They are chiefly used for fastening antiseptic dressings and for plaster of paris dressings.

(*b*) Of **cambric**. These are very soft and pliable, and can be fitted to the surface of the body as well as flannel bandages; they are less expensive than flannel, are very durable, and can be easily washed. They are especially suitable for applying difficult dressings and for the fixation of splints.

(*c*) Of **cotton**. These are very soft and compressible, and are, therefore, quite suitable for the first layer in antiseptic wound dressings and for padding splints and plaster of paris dressings.

(*d*) Of **linen**, preferably torn or cut in the direction of the threads from old, soft linen that has been often washed. Bandages of *new* linen cannot be well applied, because they are too stiff.

(*e*) **Flannel**. These are soft and elastic, and can be well applied; they are especially suitable for bandaging entire limbs and for surface layers in starch and plaster of paris dressings.

(*f*) Of **shirting** or **stouts**. These are cheaper than linen, and are well adapted to starch dressings.

(*g*) Of **tricot** ("*tricot schlauch*"). These are highly elastic and pliable, and are especially suitable as a substitute for cambric bandages.

(*h*) Of **caoutchouc**, either pure, as brown caoutchouc bandages, or of materials woven with caoutchouc threads. These, aside from their great elasticity, have the advantage of allowing the air to pass through, so that the moisture and the heat of the skin, so annoying in using pure rubber bandages, are avoided.

They are used: —

1. For bandaging limbs in procuring local anæmia.

2. As bandages over the whole dressings of the wound after bloodless operations on the extremities, in order to increase the compression during the first two hours until the danger of after-bleeding is passed.

3. For compressing the margins of the dressings (Fig. 40), in order that no air may penetrate the protective layer of the dressings; for instance, during the movements of the breast in breathing, or of the abdomen; or in order that no fæcal matter may enter it, as after operations on the perineum.

In applying aseptic or antiseptic dressings, great care should be taken that the materials for dressing safely cover the region of the wound and *its neighborhood*, in order that no infection may occur after the dressing has been applied by the entrance of microbes between the dressing and the surface of the body. For this reason, dressings of the present day, compared with those of former septic times, are very large and *extensive*. In operation wounds — for instance, on the neck — the turns of the bandage, for a firm support and for a good adaptation of the dressings, must be carried, not only around the head, but also around the chest (Fig. 40). In wounds of the thigh, the region of the pelvis must at the same time be included by the bandage (Fig. 41). Whether in this case the rules of the former art of bandaging are minutely followed is of little consequence, with the soft and elastic materials for dressings of the present time (agglutinative dressings), provided the dressings are *kept in contact with the surface* and are *firmly applied.*

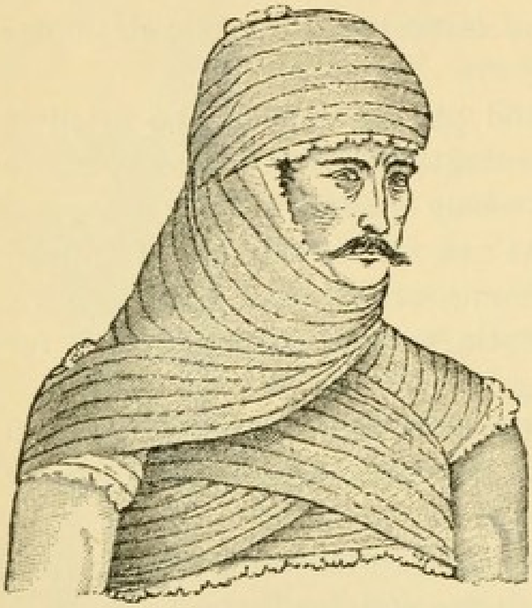


FIG. 40. ANTISEPTIC DRESSING OF LARGE LATERAL WOUNDS ON THE NECK

As mentioned above, the very first condition for a good dressing is its sterility — namely, that it be *absolutely free from all living germs.* Although this sterilized dressing can be easily obtained in larger institutions having steam sterilizers, it is difficult, and perhaps inconvenient, for

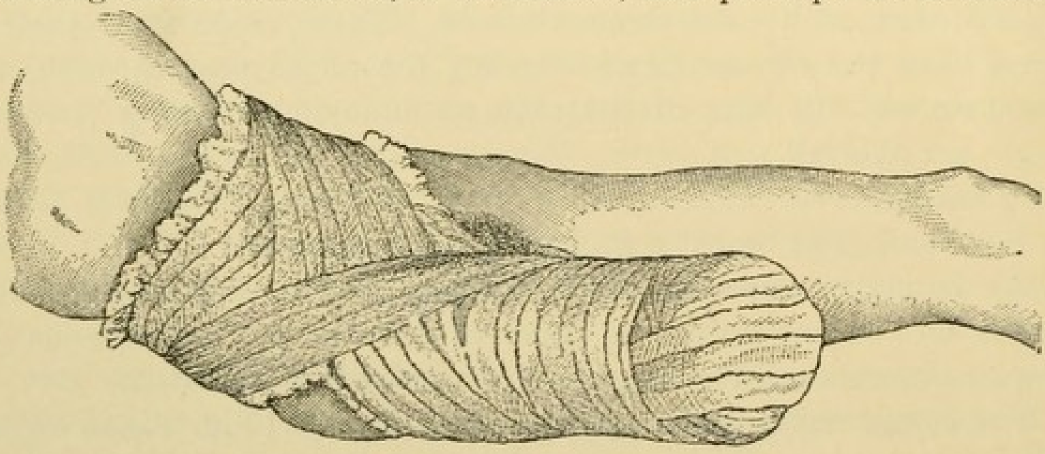


FIG. 41. ANTISEPTIC CUSHIONED DRESSING OF STUMP AFTER AMPUTATION

the practising physician to procure for himself the necessary smaller quantities in a perfectly sterile condition. For when the materials for dressing from larger sterilized packages are not entirely used, the rest no longer remains absolutely aseptic.

Very useful in practice, therefore, are the **dressing boxes** mentioned by *Dührssen* — boxes of tin containing everything needed for the dressings of a certain portion of the body, in simple, sterilized antiseptic materials, and in quantities no greater than will be needful in a single operation. The boxes contain, according to the size of the dressings to be made, various quantities of sterilized iodoform gauze, absorbent cotton, cambric and starch bandages. These boxes containing a few grams of iodoform powder, in addition, can be purchased.

By using these dressing boxes, which are prepared in factories, the physician, apart from the inconvenience of personally sterilizing the materials, has the best guarantee of the aseptic condition of each dressing.

CHANGING THE DRESSINGS

The dressings of purely aseptic wounds should, if possible, remain in position until the wound is completely healed; or, at least, they should be changed as rarely as possible (*permanent dressings*).

But in order not to miss the right period for changing the dressings, the physician must frequently examine and inspect them, especially at their most dependent portion. Moreover, he must take the temperature of the body by means of a thermometer, and observe carefully the general condition of the patient.

When secretions from the wound penetrate the dressings and reach their outer surface, they begin at once, through the influence of the air, to decompose; and this decomposition spreads rapidly, through the layers of the dressings, to the wound.

To prevent this, it is above all necessary that these secretion stains should *dry up* rapidly. If this occurs, the development of the germs of infection, which thrive especially in a moist nutritive soil, is most effectively prevented. If the drying up does not proceed rapidly enough (for instance, in larger hemorrhages), the uppermost layers of the dressings, at the place where the secretions made their appearance, must be disinfected at once with a sublimate solution or with iodoform powder, and then must be covered with an absorbent pad extending far beyond the stain. (The best method to proceed in such cases is to dust the moist surface freely with boro-salicylic powder and apply a thick cushion of absorbent cotton.)

If the stain of secretion is larger than the hand, it is better to remove the uppermost layers of the dressings down to the gauze that lies directly upon the wound, and to substitute for them new, sterile, dry dressings (pad, cotton).

A change of the whole dressing becomes necessary : —

1. If a violent pain in the wound sets in.

2. If there is fever with such disturbances of the general condition of the patient that sepsis of the wound appears probable (septic fever). But if, notwithstanding an increased temperature (up to about 102° Fhr.), the general condition remains good, the skin and the tongue moist (aseptic fever), then sepsis of the wound need not be apprehended.

3. If an unpleasant odor emanates from the dressing.

4. If drains have been inserted in the wound. Then the dressings must be changed, after a few days, in order that the drainage tubes may be removed. If the same remain in position longer than necessary, they sometimes produce a more copious secretion of the wound, and the canals created by them close only very slowly.

A change of dressings must be made as rapidly as possible. It is, therefore, necessary to have in readiness everything that might be required in making the change.

Before removing the dressings, the patient is placed so that a new dressing can be applied conveniently. The bed is protected from being soiled and saturated by a rubber sheet, placed under the patient.

If the uppermost layers of the dressings consisted of agglutinative bandages, they must be previously moistened, if tearing off the agglutinated turns should be painful to the patient; cambric bandages can be unrolled more easily. But if it is not necessary to be economical with the dressings, they may be removed most rapidly by being cut lengthwise with a large pair of strong scissors (**dressing scissors** — Fig. 42). Care must be taken that the scissors do not grasp the layer of cotton that may have been placed under the bandages; for cotton is hard to cut, and is more easily *torn* apart with the fingers.

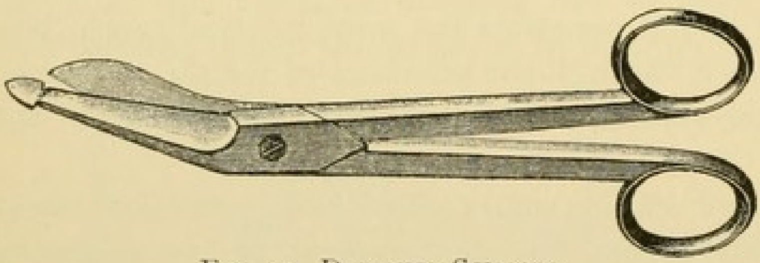


Fig. 42. Dressing Scissors

If the wound is found to be aseptic and dry, it is entirely *unnecessary* to irrigate it. The surroundings alone are cleansed by wiping off with tampons or wads of cotton, and then a new dressing is rapidly applied.

If rubber drainage tubes have been inserted, they are extracted, cleansed from blood clots or pus, and placed again in position only if, under pressure, secretions are still discharged from the depth of the wound.

If the wound in healing shows superficial granulations, a little borated lint or a piece of gauze covered with boric vaseline is applied to it.

Cicatrization proceeds still more rapidly under a very light dusting with iodoform powder. Prolific hypertrophic granulations that project beyond the surrounding margins of the skin, and thereby prevent cicatrization, are dealt with by light cauterization with a lunar caustic pencil or by the application of a 2%–3% salve of zinc sulphate (zincum sulphuricum). The cauterization is perfectly painless if the physician is careful not to cauterize the tender epithelial margin. Flaccid, glassy, hypertrophic granulations are best removed with the sharp spoon; afterward the wound is dusted with iodoform. (It has been found that dusting such surfaces with aristol or dermatol is more conducive to improve the granulating process and epidermization than the use of iodoform.) The surgeon may proceed in a similar manner if the formation of granulation is scanty and the wound does not heal. In such a case, the surface of the wound may also be painted with a tincture of iodine or with some irritating salve. (Balsam of Peru is one of the most potent tissue stimulants known.)

If eczema is found in the neighborhood of the wound, the irritated place is thickly painted with salicylic glycerine salve, boric vaseline, lanolin, or *Lassar's* paste (zinc. oxydat., amyl. tritic. aa. 10 parts; acid. salicyl., 1 part; vaseline, 20 parts).

If the healing has not taken place by first intention, an antiseptic dressing is again applied, and is as often changed as the secretion of the wound demands.

But if the wound has become septic, if inflammation, suppuration, lymphangitis, phlegmon, or erysipelas has set in, all sutures must be removed immediately; the wound must be opened sufficiently, and must be thoroughly disinfected and drained as described further below (see secondary antisepsis).

In applying the first dressings after the operation, or in changing larger dressings,

THE POSITION OF THE PATIENT

is of especial importance.

The patient must be placed in such a position that the portion of the body to be dressed is freely accessible from all sides, and that the whole body may retain this position unchanged while the dressings are in position.

For the support of the body serves partly the operating table or the bed, partly the *adjustable* **telescopic hip rest** (Fig. 43). For adults, this support should be 20 centimeters in height, and in many cases two of them are required. The hands of the assistants or of the nurses hold the body firmly in the position indicated. In many cases of dressings on the leg, good use can be made also of a **support for the heels** (see below).

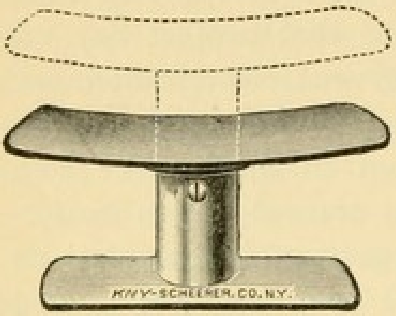


Fig. 43. McBurney's Adjustable Telescopic Hip Rest

Dressings on the head are best applied when the patient is sitting or is held in a sitting position; likewise, in the case of dressings on the thorax; if the patient is still under anæsthesia, he is placed across the operating table, while his arms are moderately drawn aside. In dressing the region of the pelvis, a pelvic support is placed under the sacral region, or the patient is placed in a lateral position on two supports. In abdominal dressings (after laparotomies), two supports for the back are very convenient. In dressing the leg, the pelvic support is not placed transversely, but parallel to the axis of the body, under the healthy side of the pelvis, so that the diseased leg can be held in a free suspended position. The assistants should always take such a position that they do not obstruct the manipulations of the surgeon; their hands should render the necessary aid in such a manner that, notwithstanding the resting position of the limb, they cause no obstruction. For this reason, the assistant should observe the rule of rendering assistance with outstretched arms and of holding the limb to be bandaged far from his person, so that the surgeon can conveniently carry the bandage through the loop of the arms thus formed. If the hand is to be dressed, the assistant grasps the four fingers with one hand and the thumb with the other. If the foot is to

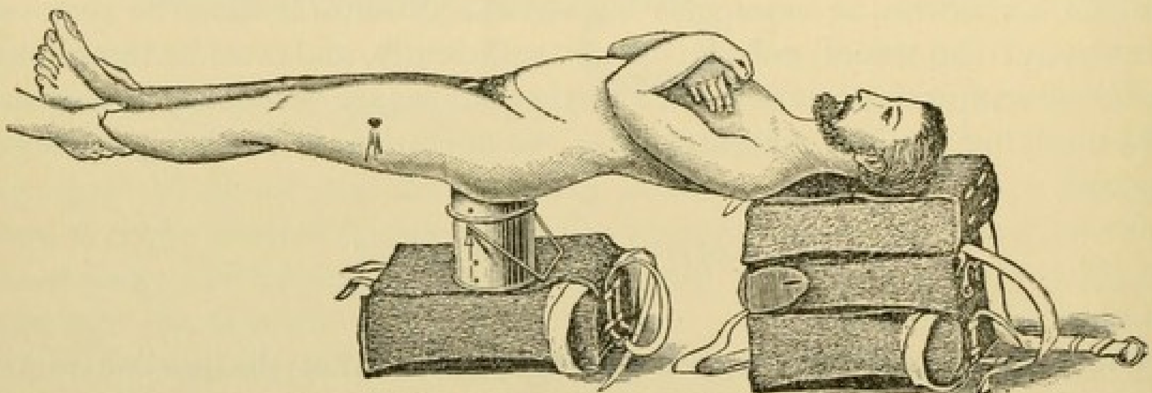


Fig. 44. Improvised Position Apparatus

be dressed, the assistant, with one hand, firmly holds the toes anteriorly, while with the points of three fingers of the other hand he supports the heel.

Figure 44 shows how, in war, for want of pelvic supports, the surgeon must help himself with objects always at hand; for instance, during the application of a pelvic dressing, on account of an injury to the femur, knapsacks, cooking utensils, and tin boxes are employed for this purpose. In case of necessity, even the edge of a ditch or of a rampart may be used. In time of peace, the surgeon will be less embarrassed to improvise and quickly procure such supports.

THE POSITION OF THE PATIENT IN BED

This requires a great deal of attention and practical experience.

First, the bed should be so placed that it is, as far as possible, accessible from all sides; hence, it should not touch the wall anywhere. Since, however, this would limit the space very greatly, generally only three sides are left accessible, the head of the bed being placed against the wall, preferably against that which contains a window, because the patient is not then inconvenienced by the light. If the bed is so placed that the light falls upon it laterally, then that wall must be selected from which the diseased portion of the body receives the full light; else, in dressing the wound, the surgeon has to work in the shadow.

For a comfortable position of very feeble, decrepit patients, **air cushions** and **water cushions** often cannot be dispensed with. If the patient, for instance, during his meals, desires to assume a sitting or half-sitting position, the placing of many pillows behind his back is rather uncomfortable. More practical is the adjustable **back rest** (Fig. 45), which can be *changed* to any desired position and which, after being folded, can remain under the pillow. For it may be substituted a light chair reversed, having its back and the anterior edge of the seat placed in a downward direction behind the pillow. If it is difficult for the patient to raise himself in bed, he may be easily assisted by a "**releveur**," a loop carried from the end of the bed and placed within reach of his hand.

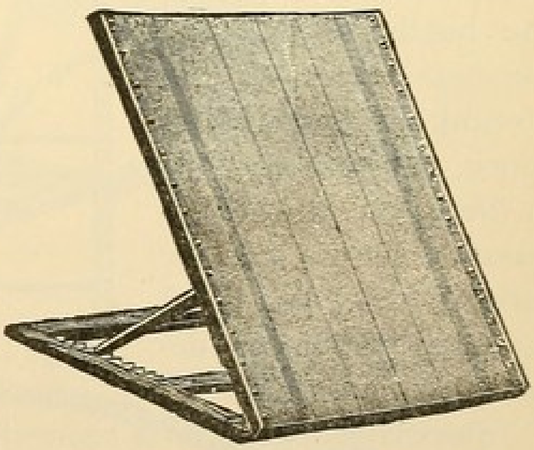


Fig. 45. Adjustable Back Rest

Bandaged limbs are *always* elevated upon "*chaff*" *pillows* or upon an apparatus described below. They are protected from the pressure of the bed coverings, often causing inconvenience, and from other casual contacts by a **protecting basket** consisting of three loops of strong wire connected by three bars of the same material (Figs. 46–47).

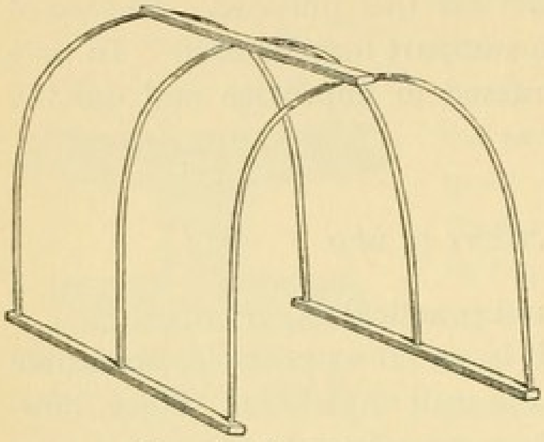


FIG. 46. PROTECTOR

Finally, if patients are the subjects of such serious wounds that it is advisable for them to lie as nearly immovable as possible to prevent the pain caused by each movement, or if they are unconscious, an **apparatus for lifting** them is very beneficial. By means of it, the patient can be easily and comfortably raised in his bed, whenever it becomes necessary to renew the dressings or the bed linen, to cleanse and wash the posterior portion of his body, and to prevent it from becoming sore by lying in one position, or to facilitate the alvine evacuation.

The Invalid Lift, an apparatus for lifting patients (Fig. 48, *a* and *b*) is especially to be recommended, and is in general use both on account of its *safety* and on account of the ease with which it can be managed. It consists of five pairs of arms, the lower ends of which (spatula shaped) are padded and support the patient safely (like the hands of so many nurses). By means of a crank with an endless screw, the patient, lying in the arms of this apparatus, as if held by forceps, can be lifted uniformly into any desired position.

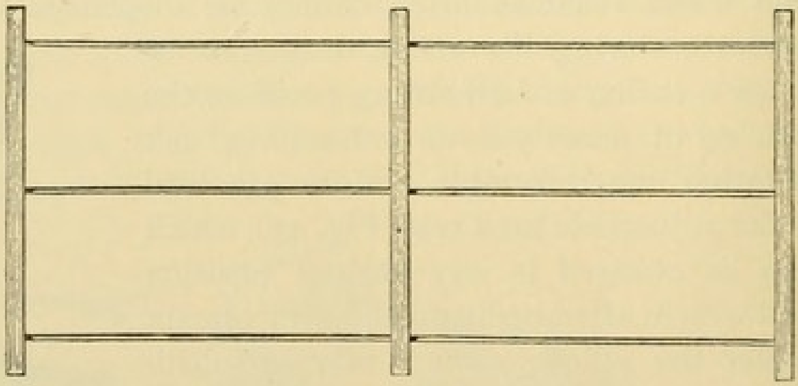


FIG. 47. THE SAME IN STRAIGHT FORM FOR TRANSPORTATION

Since this apparatus is somewhat expensive, it will probably be used only in hospitals. Hence it is desirable to improvise such an apparatus rapidly and with less expense for more modest demands.

The **suspension stretcher** (Fig. 49), on account of its simplicity and practical arrangement, is to be recommended.

Four broad strips of canvas are provided on one side with loops and on the other with straps; two of these are placed under the thorax of the patient, and two under his legs; one pole of the stretcher is placed on one side through the loops, and on the other side the straps are buckled to a second pole. Both poles are lifted at the same time at the head and at the

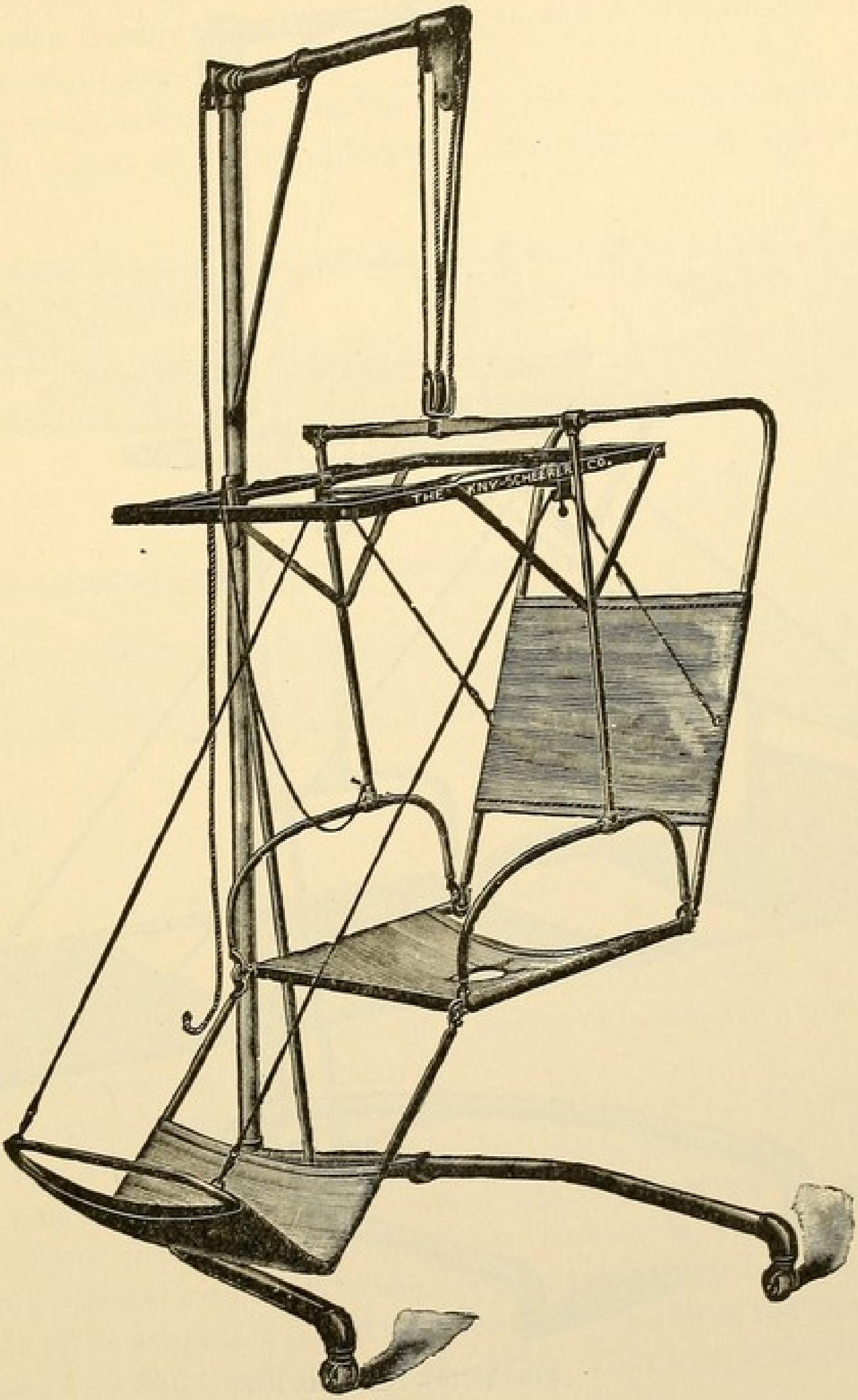


Fig. 48 (*a*). Invalid Lift

end of the bed, and are there kept apart by two transverse bars provided with holes.

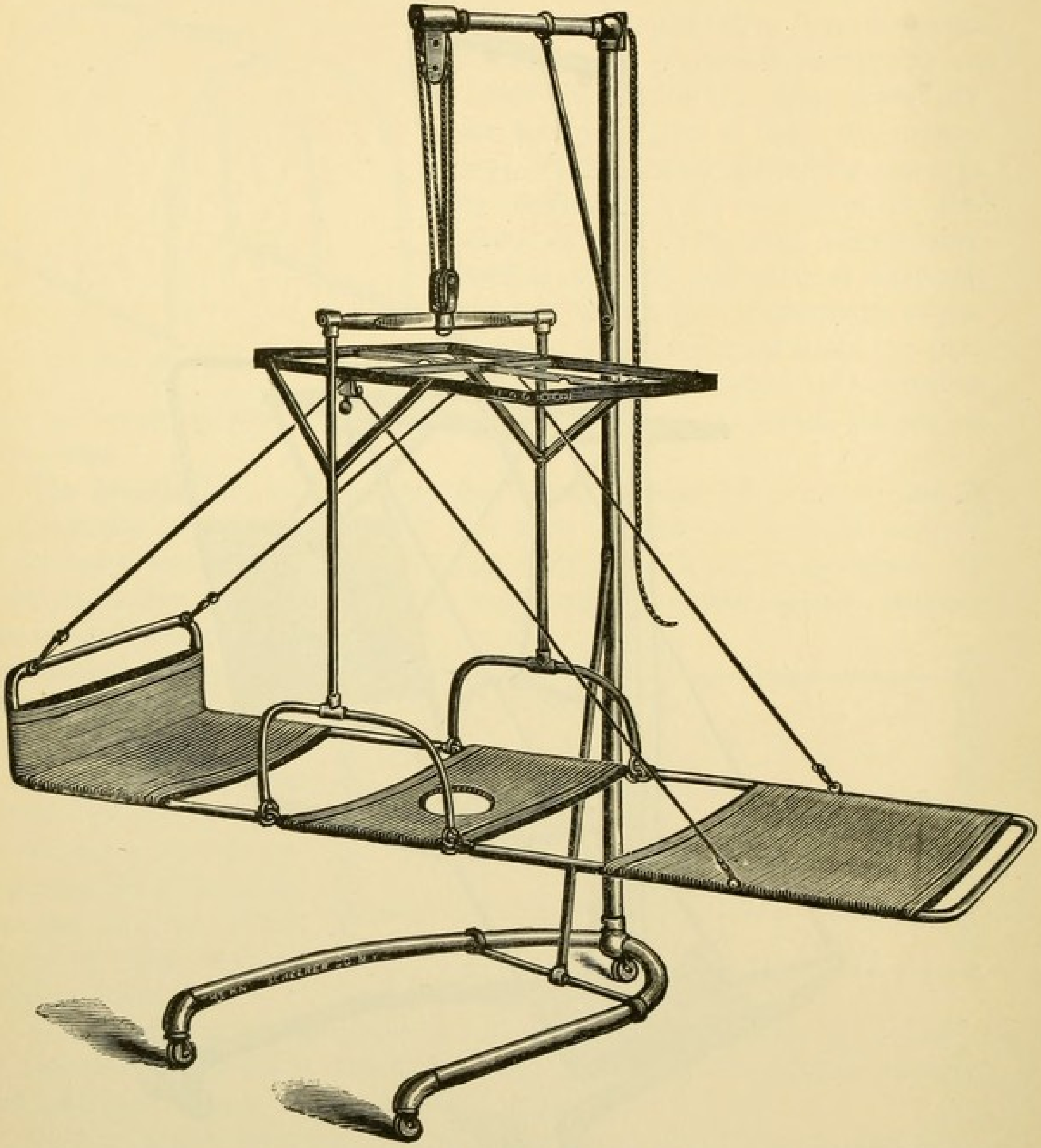


FIG. 48 (*b*). INVALID LIFT

The wounded portion (here, the region of the hips) remains free, so that the dressings can be changed conveniently.

A similar apparatus has been mentioned by *Laub.*

The **suspension frame** (Fig. 50), according to *von Volkmann*, is also very suitable for these purposes.

The canvas stretched on the wooden frame has a hole in the middle for defecation. By means of the two lifters of girth fastened to the ends, the

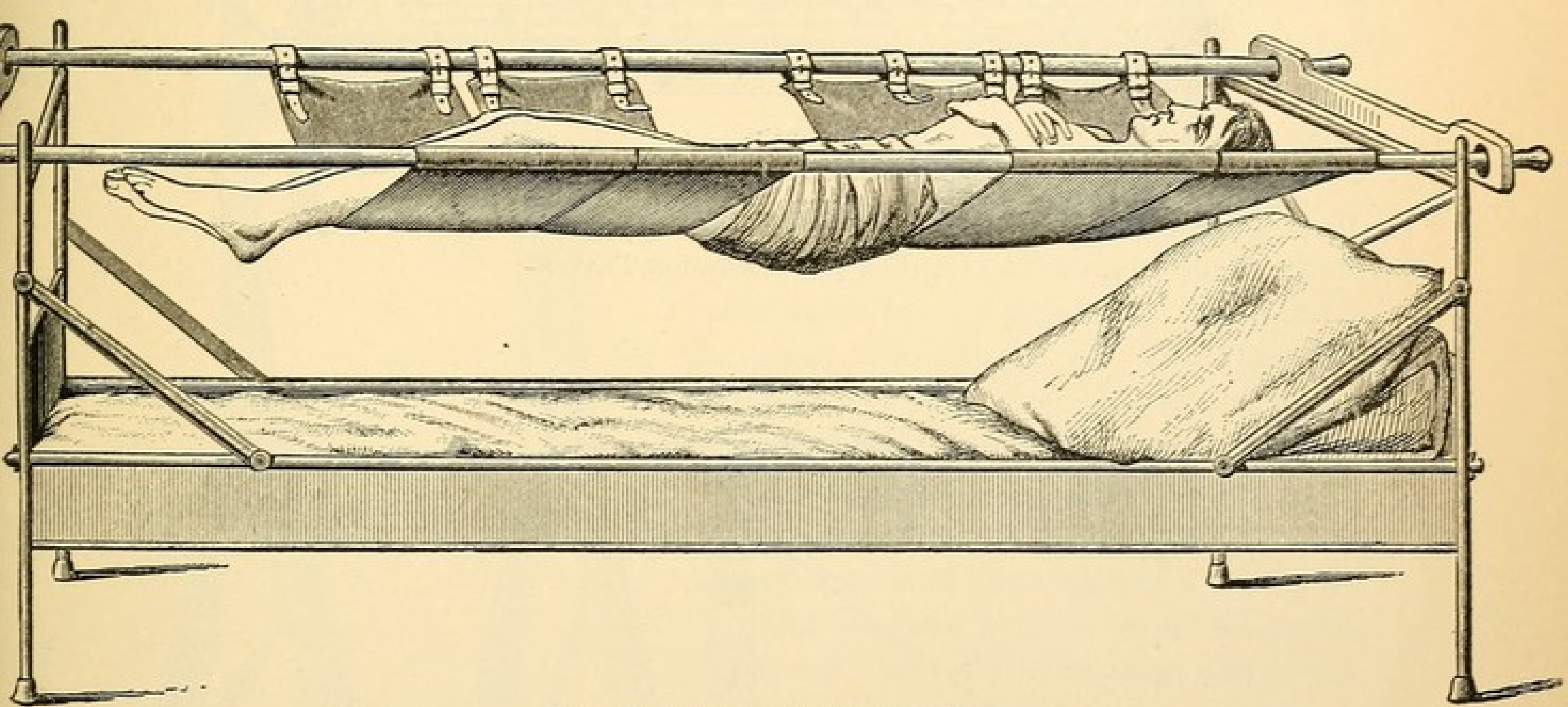


FIG. 49. SUSPENSION STRETCHER

frame, with the patient, is lifted, and kept in this position by means of wooden supports that can be turned up. Roller supports for extension treatments are fastened to the frame itself.

Moreover, the **suspensory apparatus** for patients (Fig. 51), invented by *Siebold*, is to be recommended on account of its simplicity. The strong supporting pole is easily raised by means of a pulley fastened to the ceiling of the room. Since the straps, provided with buckles, in which the patient is placed, apply themselves firmly to the body when the pole is raised, in places where this is to be avoided a board must be inserted above the portion of the body, as shown in the illustration to the left. This keeps the straps apart.

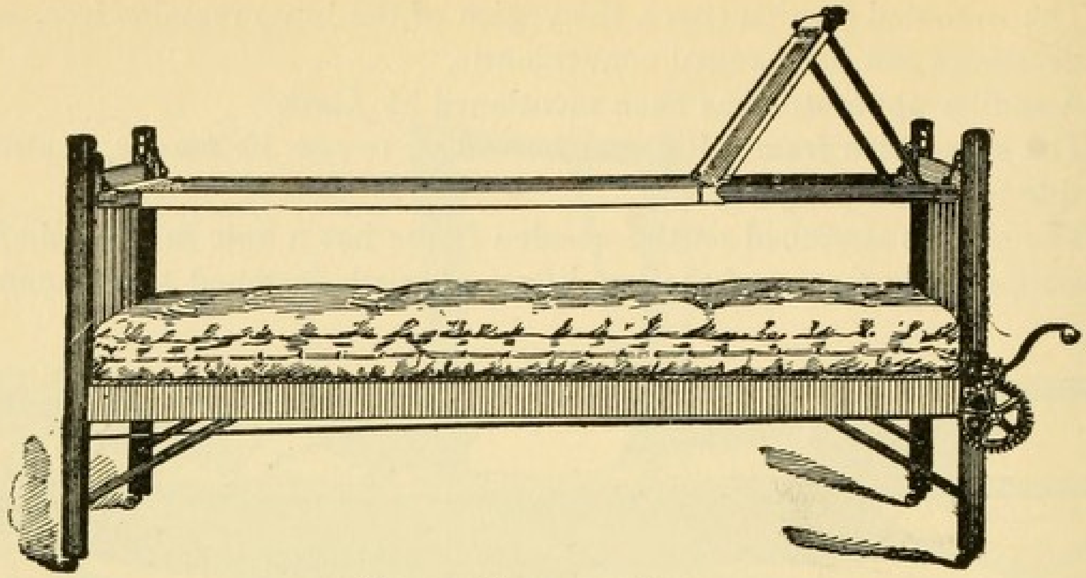


Fig. 50. Suspension Frame

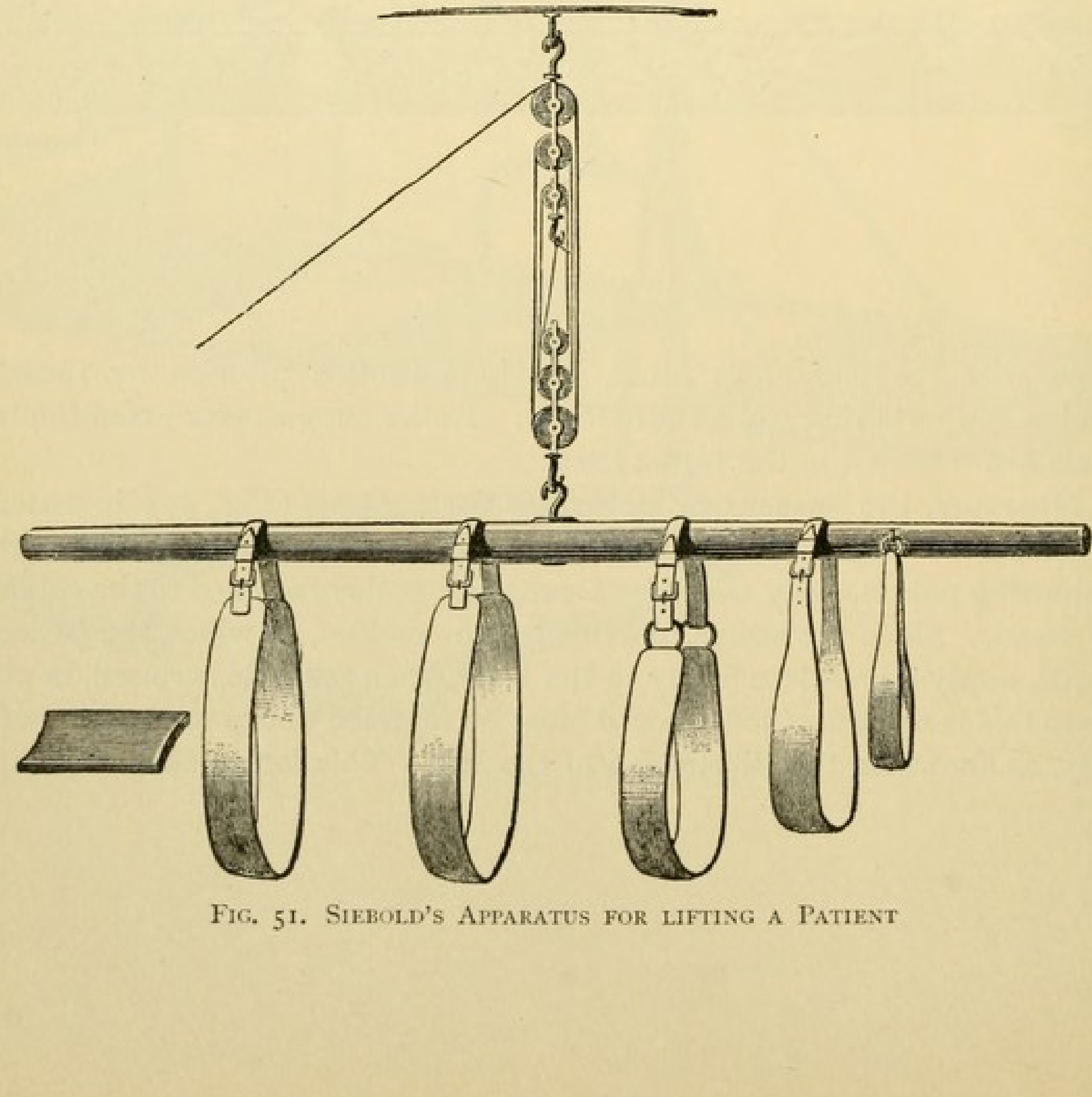


Fig. 51. Siebold's Apparatus for lifting a Patient

SECONDARY ANTISEPSIS

All fresh wounds that have evidently become infected and all wounds considered at first aseptic, in which symptoms of *sepsis* (profuse secretion of the wound, pain and swelling in the region of the wound, inflammation, suppuration, and wound fever) have set in, must be immediately subjected to *thorough disinfection;* and this must be the more energetic, the more threatening the septic symptoms are.

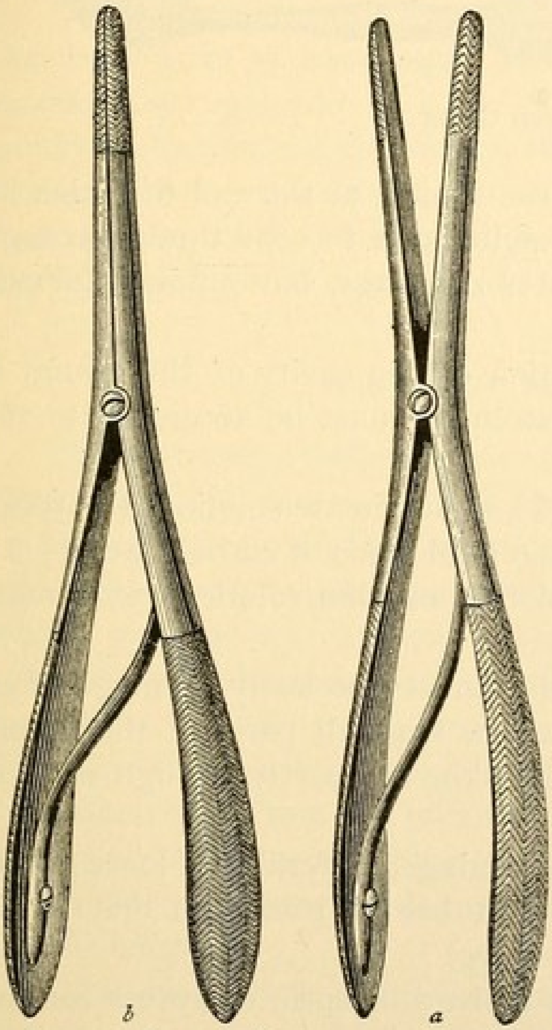
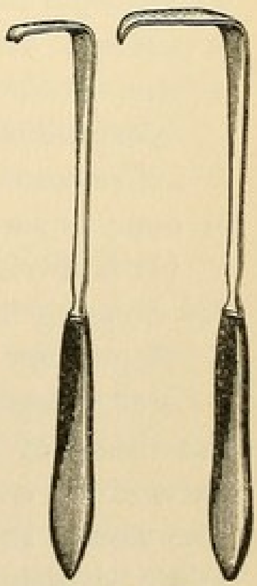


FIG. 52. ROSER'S DILATOR. *a*, open; *b*, closed

Here are to be observed the same principles that hold good for primary antiseptic treatment of wounds; and, since the surgical treatment required in most cases is very painful, it is advisable to place the patient on the operating table and to narcotize him, in order that the surgeon may not be hindered by his restlessness and his lamentations from performing the disinfection with the necessary degree of thoroughness.

The surgeon begins, as in all operations, by carefully cleansing and disinfecting the whole neighborhood of the wound. Next, if it concerns wounds on the limbs, after raising the same vertically, he interrupts the circulation by resorting to elastic constriction; he *enlarges* the wound to the requisite extent by cutting the skin, and by forcing apart the soft parts with the finger, dressing forceps, or the *dilator* (Fig. 52); and by means of blunt retractors (Figs. 53–54), he draws the wound margins so far apart that the entire internal surface becomes accessible for inspection.



FIGS. 53–54 VON LANGENBECK'S BLUNT RETRACTORS

Then, first, all *coagula* and granulations are scraped off with the finger, with sponges, and the sharp spoon (Fig. 55). All bloody or pus-infiltrated fragments of tissue, membranes, layers of cellular tissue, and portions of the muscles are removed with forceps, scissors, and knife; all foreign bodies (portions of the clothing, loose fragments of bone, bullets, earth, dirt) are removed; the operator penetrates with his finger into all

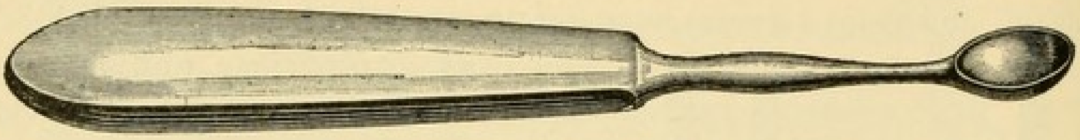


FIG. 55. SHARP SPOON, CURETTE

the pockets and *sinuses* of the cavity of the wound, at the end of which he makes incisions through the fascia and skin upon forceps thrust through the remaining tissues from within (counter openings, buttonholes) for the insertion of drainage tubes.

Next, a thorough *washing* and irrigation of the cavity of the wound is made with antiseptic solutions, which in strength must be according to the degree of septic infection.

In milder cases, the weak carbolic (3%), or sublimate solutions (1 : 5000) are sufficient; in more serious cases, stronger solutions of carbolic acid (5%), sublimate (1 ‰), lysol (2%), or the chloride of zinc solution (8%) must be used.

Then, everywhere, and especially in the sinuses, so many drainage tubes are inserted that the drainage of the secretions from all parts of the wound is perfect; after this, the incisions of the skin are partly, though not too tightly, sutured.

Next follows an antiseptic compressive bandage, preferably of loose gauze, which remains in position until the drainage tubes are removed; this should be done as soon as possible (in five or six days).

(It is advisable to substitute the best moist antiseptic compress for the dry dressing in the treatment of *all infected wounds.*)

A primary healing is often successfully obtained in this manner.

But if sepsis has progressed far, if the secretion has an offensive odor, if the tissue of the wound is coated or decomposed, or if the contused soft parts are in a state of gangrene, then primary healing cannot be expected. The wound should be sufficiently enlarged, left open, and covered with antiseptic dressings or packed (**tamponing**). *Iodoform gauze* is especially suitable for this purpose. It safely prevents further decomposition without producing local cauterization, as do the strong antiseptics.

In large open septic wounds (crushings by machinery, contusions, etc.) are employed **antiseptic compresses** (gauze compresses dipped in acetate of aluminium, sublimate, or carbolic solution). These are changed frequently (every hour); and with each change of dressings, either the wound is irrigated with the same fluid or the **antiseptic immersion** is employed — that is, in an antiseptic solution, the injured portion of the body is immersed day and night, or at least for many hours during the day.

Permanent antiseptic irrigation sometimes renders excellent service in the *worst cases of acute septic phlegmonous inflammation* (which, in severe lacerated wounds and in large diffuse extravasations of blood, sometimes occurs on the first day) in which the rapidly advancing sanious infiltration of the cellular tissue is recognized by the hard, dark red, and painful œdematous swelling of the skin, rapidly spreading over the whole limb, and accompanied with high fever and rapid loss of strength.

PERMANENT ANTISEPTIC IRRIGATION

This purposes to allow fresh antiseptic fluid to enter the wound continually, and by this means to wash away the putrid secretions.

In order to obtain this, apart from the surgical treatment described before, the operator makes numerous small incisions from 2 to 3 centimeters long — multiple scarifications — through the skin and the fascias, especially in all places where the layers of epidermis are detached from their basement membrane, in order to create free drainage for the secretions of the wound, and allow the antiseptic fluids everywhere to penetrate into its depths. If the hemorrhage from the inflamed tissues is very great, which is usually the case, it is best arrested by a firm packing (tamponing), and by bandaging with antiseptic gauze bandages, which are allowed to remain in position for several hours.

Then, into all the openings, drainage tubes are introduced deep into the wound; into some of them the nozzles of irrigators are inserted. The latter have been placed on a shelf above the bed, and contain non-poisonous antiseptic fluids — for instance, solutions of acetate of aluminium (0.5%–1%), of potassium permanganate (3%), or better of hydrogen dioxide (3%), of boric acid (4%), creolin (0.5%), thymol (0.1%). The two first-mentioned solutions produce oily precipitates, which clog the tubes and necessitate more frequent irrigation of the same. Poisonous antiseptics cannot, without danger, be used for this purpose.

Next, a stream of these fluids, the rapidity of which must be regulated by stop-cocks, is allowed to enter the wound. The fluid issuing from the drainage tubes that remained free flows upon a waterproof sheet placed under the limb and is drained into a pail. The position of *Bardeleben* and the wire slings of *von Volkmann* (see below) are very suitable for this purpose.

Very practical for **permanent irrigation** is **the apparatus of** *Starke* (Fig. 56). It consists of a glass tube, 50 centimeters long and 5 centimeters wide, on which are made drainage openings for five rubber tubes; the latter are provided with glass points introduced into the drainage tubes. By means of stop-cocks the force of the stream can be regulated in each tube, and by means of inserted wires, the desired position can be secured for the tubes. A very practical apparatus, used in *Czerny's* clinic, was described by *von Meyer*.

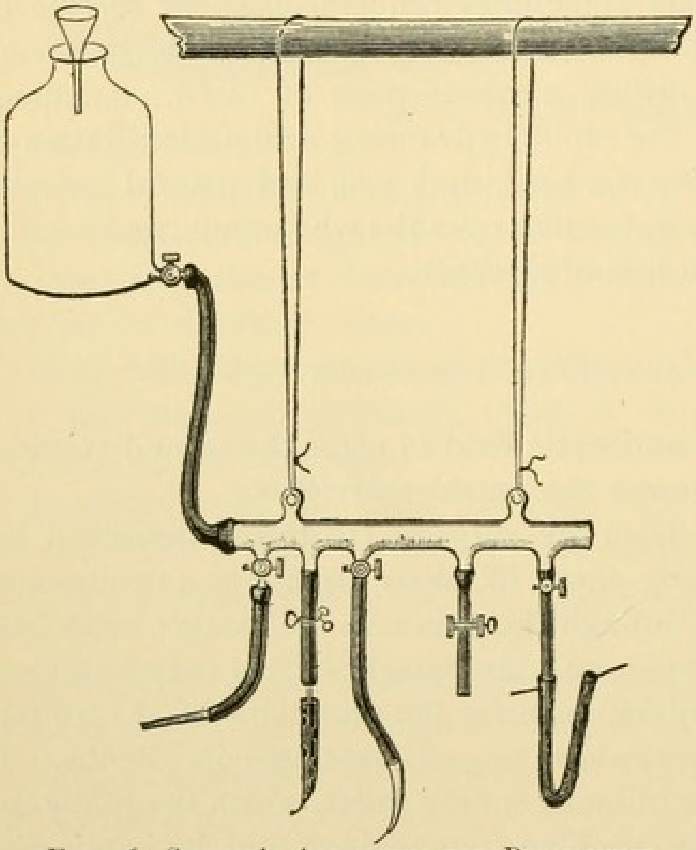


Fig. 56. Starke's Apparatus for Permanent Irrigation

It is necessary always to watch the effect of the irrigation apparatus. The antiseptic fluid must not run through in a continuous stream, but only in a rapid fall of drops. In order to effect this properly, it is sometimes practical to introduce a medicine dropper (Fig. 57) into the **irrigator tube,** as mentioned by *von Volkmann*.

Fig. 57. Von Volkmann's Drop Canula

Generally, after the irrigation, a fall of the temperature and an improvement of the general condition soon set in. At any rate, the application is rather complicated, and requires preparation and constant superintendence. Its efficiency seems especially to lie in the rapid drainage of the secretions of the wound, less in the disinfection of the secreting surface of granulations, which in most cases is strongly irritated, cauterized, and excited to profuse secretion. At any rate, the *careful packing* (*tamponing*) with *iodoform* *gauze* or lysol gauze, which is to be renewed as often as necessary, seems to work just as well, and has the advantage of being simpler and more easily managed.

While antisepsis in the widest sense of the word removes the inflammation, or, at any rate, the infection of *wounds* of all kinds, nevertheless, for combating the inflammation of such tissues as lie deep under the *uninjured* skin and beyond the reach of the air, we use

THE ANTIPHLOGISTIC TREATMENT:

REST, ELEVATED POSITION, AND REDUCTION OF TEMPERATURE

are the chief antiphlogistic remedies.

A large portion of the following chapters treats of securing rest for the injured and inflamed portions of the body (dressings, position).

Elevated position promotes the return of venous blood and of lymph and diminishes the arterial pressure — thereby antagonizing hyperæmia — and promoting the absorption of extravasations and exudates.

For *elevation of the limbs*, longitudinal pillows filled with chaff, chopped straw, sand, etc., are used. Several of these, as the case may require, are placed one upon another, and their easily displaceable contents are forced to each side, so that a longitudinal groove is formed for the reception of the arm or leg. A number of less simple appliances are used to secure a higher degree of elevation.

Thus, for a high elevation of the hand, are used : —

(*a*) The **adjustable oblique board** (*von Esmarch* — Fig. 65), which rests on a table standing near the bed, or on a board fastened to the bed, and which, at the same time, is so constructed that it conducts into a pail the solution when permanent irrigation is practised.

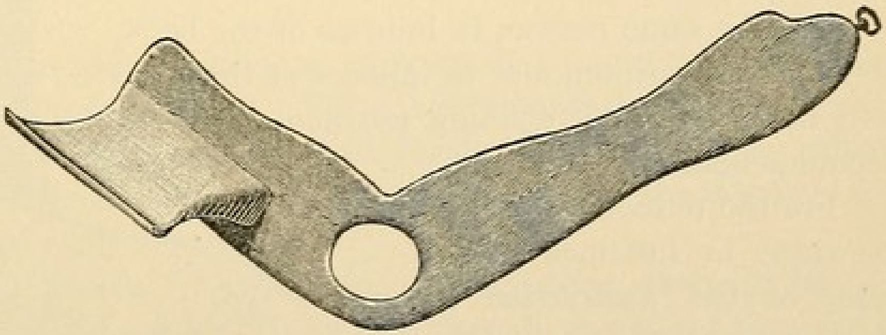


Fig. 58. Von Volkmann's Suspension Splint

(*b*) The **suspension splint** (*von Volkmann* — Fig. 58). On this the whole arm is fastened with serpentine turns of a bandage, and, by means of a cord tied to the lower end of the splint, it is raised and suspended (to a post). (Fig. 59).

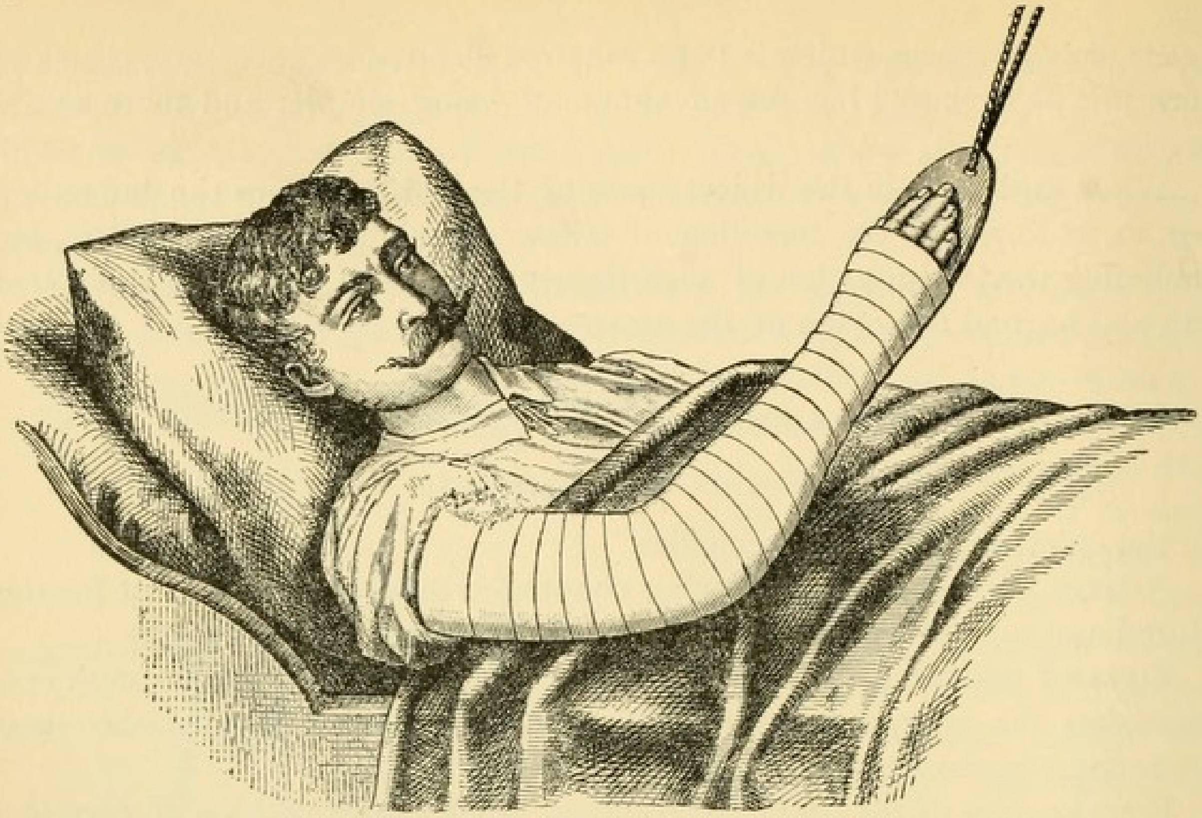


FIG. 59. SUSPENSION OF THE HAND ACCORDING TO VON VOLKMANN

For a high elevation of the leg, either the various fixation splints (*Petit's* fracture box, double inclined plane, etc.), may be used, or, after fixation of the limb by means of a few cords and wooden boards, the limbs may be suspended in such a way that the foot is suspended higher than the rest of the body (Fig. 60).

For the same reason, in injuries of the back, the ventral position, and in injuries of the head and neck, the half reclining position, are to be recommended.

For the reduction of temperature in inflamed parts, **cold,** or the **abstraction of heat,** is employed in various ways : —

1. In the form of **cold compresses.** These, if they are really to abstract heat

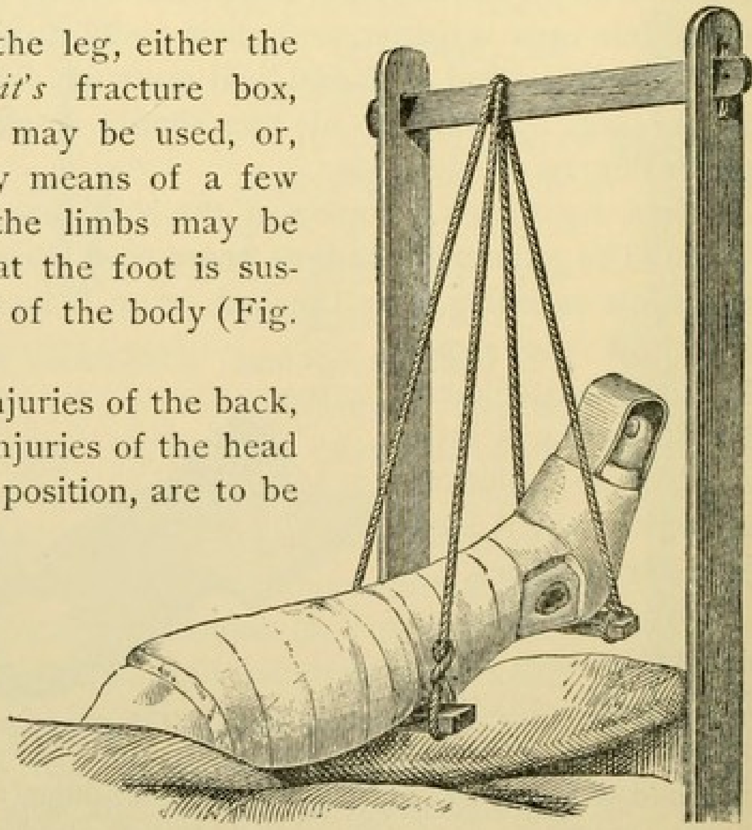


FIG. 60. SUSPENSION OF FENESTRATED PLASTER OF PARIS DRESSING

constantly, must be changed very frequently; if they remain in position long enough to become warm, they disturb the injured part, and produce an *irritating effect* (*Priessnitz's* compresses). It is best to use two compresses, one, *well wrung out*, being used while the other lies in a basin of cold water near the bed. It is well to place a few pieces of ice in the water. If a sufficient quantity of cold water cannot be had, it is advisable to use a refrigerating mixture (1 part of ammonia and 3 parts of saltpetre, coarsely powdered with a mixture of 6 parts of vinegar and 12–24 parts of water) (*Schmucker*).

2. As **dry cold**, preferably by means of **ice** in rubber bags (ice bags).

These ice bags must be securely closed by wooden tampons or large corks (champagne corks), around which the *closed* orifice of the bag is securely fastened by means of a narrow band (Fig. 61). Ice bags provided with a screw cap do not keep waterproof very long, and are more expensive.

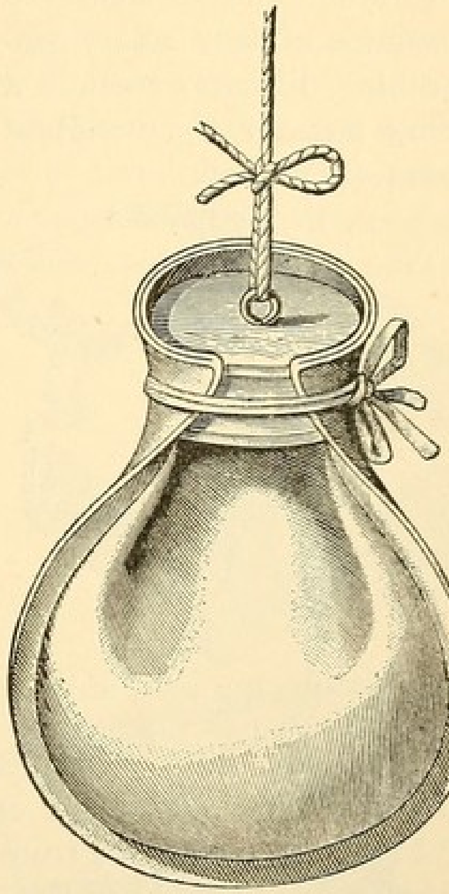


Fig. 61. Ice Bag

If the *cooling* becomes *excessive*, a *few layers of linen or gauze* are placed between the ice bag and the body; otherwise, either congelation or gangrene might set in. The cold should at all times *produce a pleasant sensation*, for it is then that it relieves pain most effectually.

It is not advisable to use *bladders*, as they are not perfectly waterproof, and, moreover, they soon decompose. To be made water-tight, before being used, they are either painted outside and inside with varnish or rubbed thoroughly with fat. Decomposition is prevented by washing them in antiseptic solutions before each new filling.

Glass bottles and *tin boxes*, filled with ice or cold water, abstract the heat even more energetically than rubber bags, but they do not adapt themselves so well to the part to which they are applied. In practice among the poor, however, or as a makeshift, the cold bottles can be very well employed — for instance, on the perineum, in the axilla, and the inguinal region.

In the treatment of inflammatory diseases of the vertebræ (spondylitis), *tin boxes* moulded to the shape of the body and filled with cold water render excellent service (*von Esmarch*), both because the patients can lie upon them comfortably and because the abstraction of heat is very considerable. Figure 62 shows a cooling box for the vertebral column of the neck.

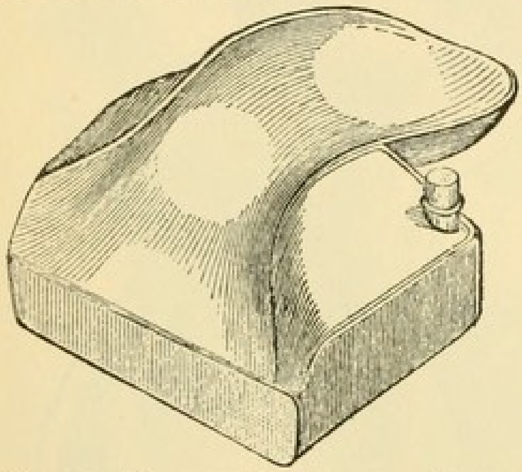


FIG. 62. COOLING BOX FOR THE VERTEBRAL COLUMN OF THE NECK

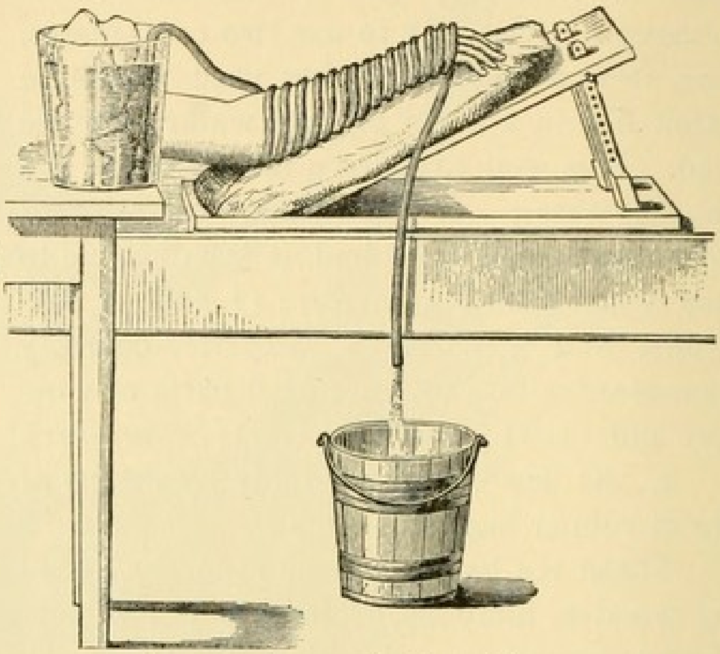


FIG. 63. ESMARCH'S COLD COIL

In inflammations of the extremities, a very decided effect can be expected from the **cold coil** (*von Esmarch* — Fig. 63), a long rubber tube wrapped in coils about the inflamed part. One end of this coil, provided with a stone or a perforated tin block, is placed in a pail filled with ice water, whilst the other end is conducted into an empty pail. Through suction at the lower end, circulation of the ice water is produced, and this circulation can be regulated by tying a string around the lower portion of the tube. If the upper pail has become empty, it is filled again by pouring into it the water that has flowed off.

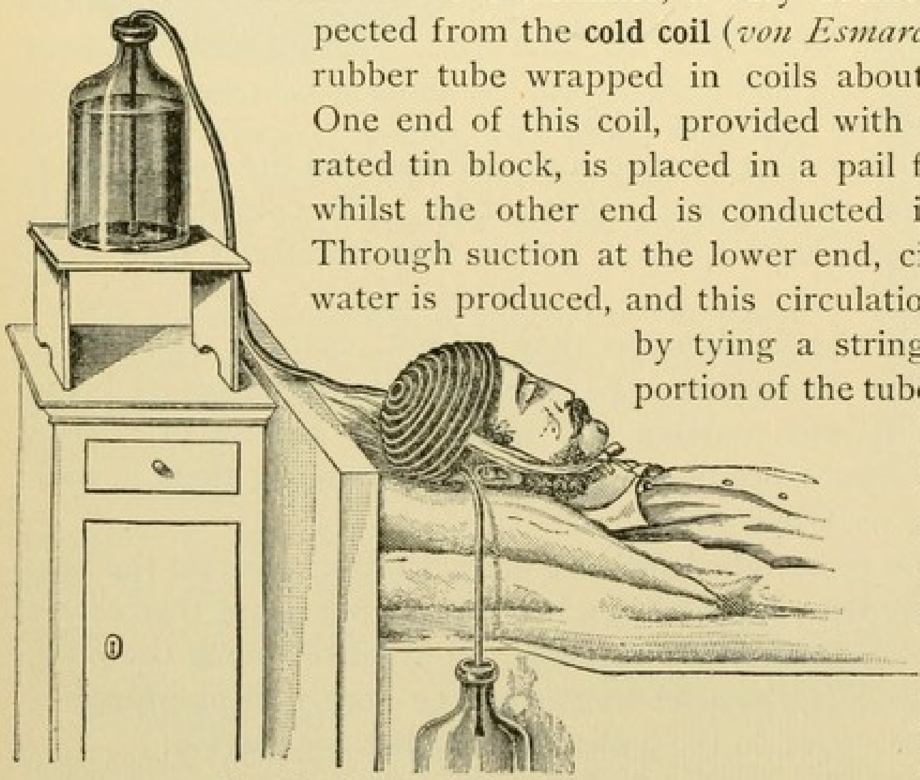


FIG. 64. LEITER'S COLD HEAD COIL

For the same purpose, *Leiter* used thin flexible lead tubes, which refrigerate still more rapidly and efficiently, because metal, as we know, conducts heat better than rubber (Fig. 64).

In order to abstract heat from the *whole* body in febrile diseases, it may be covered with a *cooling cover*, consisting of a linen cover, one side of which is sewed with closely running coils of a rubber tube (*von Esmarch*). It is simpler to fill a large water bag with water of the desired temperature and to place the patient upon the same. This constant effect of the cold, of course, is then felt to be more unpleasant than a cold pack in wet sheets or the short stay in a full cool bath, wherewith similar results may be produced.

3. By **irrigation** with cold water (Fig. 65).

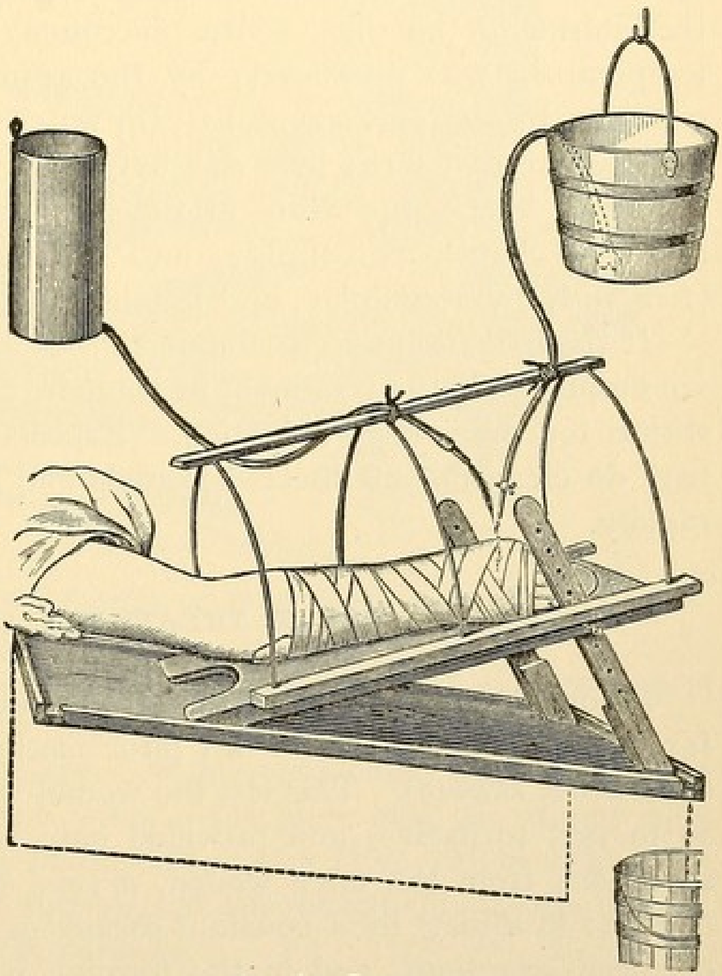


FIG. 65. IRRIGATION

From an irrigator hung up over the bed, cold water is allowed to trickle in drops upon the injured part, covered with a bandage in which the water is diffused. The rapidity of the falling of the drops is regulated by a straw placed in the point of the irrigator. Instead of an irrigator, a rubber tube may be used, one end of which is provided with a stopcock, while the other, provided with a perforated tin plug, is lowered into the pail filled with water. The tube works like a siphon, and must be set to work by suction. Smaller siphons of glass or tin tubes may also be used for this purpose. The heat-abstracting effect of the irrigation is very great, in consequence of the evaporation of the water. Hence, water of very low temperature need not be used. The water that flows off must be caught on an inclined plane or on a waterproof sheet (oil cloth), placed beneath it, and be conducted into a pail placed under it.

4. By cold local **permanent baths (immersion)**.

For this purpose, tubs are used for the arms and the legs (Figs. 19, 20).

The injured limb is placed in the tub on strips of bandages fastened to the tub by buttons on each side. A very low degree of temperature is not required, since the effect of the permanent bath is very powerful. Water from 69° to 72° Fhr. cools very perceptibly in a bath continued for a long time. Generally the regulation of the temperature by the addition of cold water may be left to the patient himself.

Note. — Through the experiments of *Völcker* and *Zerssen*, it has been proved that it is possible to cool a part of the body to *a greater depth* by the local withdrawal of heat. A thermometer introduced 3–5 centimeters into the interior of the tibia — after necrotomy — showed that in this place the temperature was decreased: by the application of ice bags 50° Fhr. in 9 hours; by the permanent bath in water gradually becoming cooler (86°–54°) 54° in 14 hours; by irrigation with cold well water (46°–50°) 52° in 9 hours. The temperature of the body taken in the rectum sank during this time hardly perceptibly, and did not reach the normal minimum (*Esmarch*, "Verbandplatz und Feldlazareth," 2d edition, 1871, pp. 140–143).

If the irrigation and the immersion in antiseptic solutions just described are employed in the treatment of wounds, they can very well serve as a substitute for permanent irrigation. Especially by means of the permanent bath do cleansing of infected wounds and inclination toward healing set in rapidly.

OPEN TREATMENT OF WOUNDS

Before the antiseptic treatment of wounds became generally known, by far the most successful of all prior methods was the "*Open Treatment*" (*Bartscher, Burow*). This left the wound without any medical assistance, — so to say, to itself — and provided only for a constant discharge of the secretions from the open wound, *devoid of all dressings*. Its *advantages* consist: in *drying* by a constant escape of the secretions, in the drying up of these secretions, and in the forming of scabs, which do not furnish a favorable nutritive soil for the germs of infection; in securing rest for the wound, which is mostly disturbed by the frequent changes of dressings — often with unclean material, lint, old linen, adhesive plaster, etc.

This method has, however, great *disadvantages*. The surgeon from the beginning does *not expect any primary healing* of the wound and allows the air free access to its surface. In consequence of this, in badly ventilated, dirty rooms, infection and decomposition of the secretions may easily ensue. For this reason, the method is employed only when for some reason the antiseptic treatment of the wounds cannot be carried out. For war it is not at all suitable.

After the wound has been cleansed from gross impurities and after all hemorrhage has been arrested, the limb is elevated, and under it is placed a

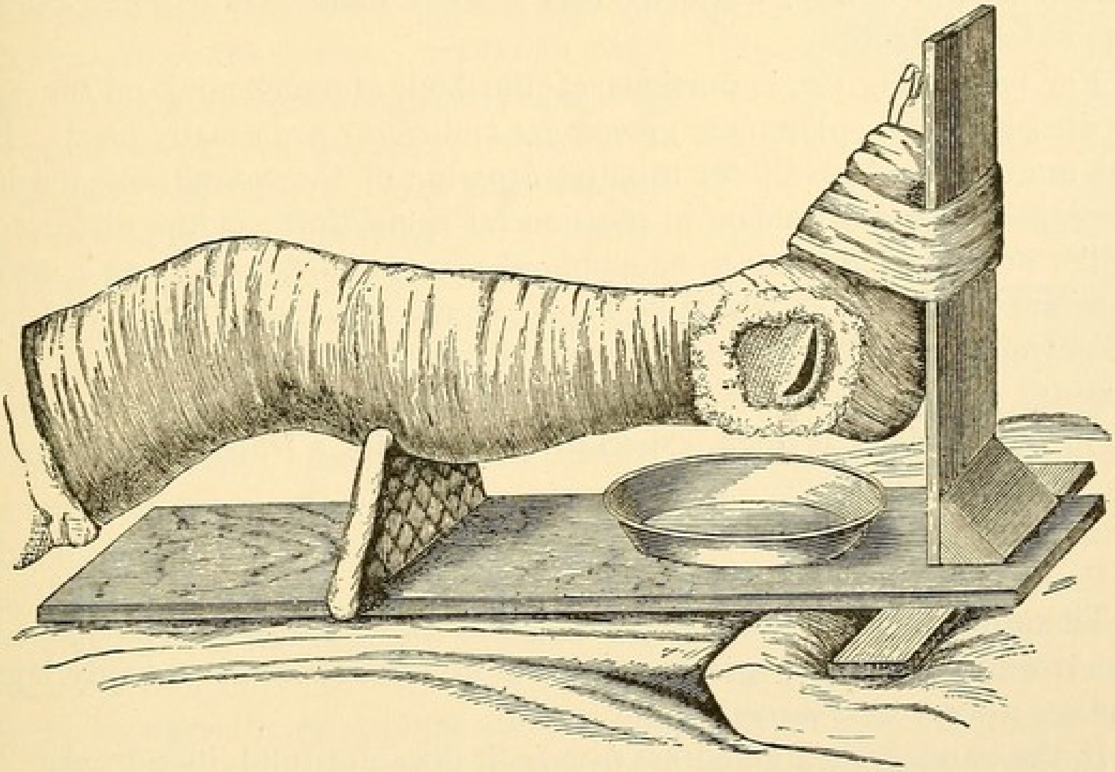


FIG. 66. FENESTRATED PLASTER OF PARIS DRESSING

small basin to receive the secretions. To protect the wound against insects and dust, linen in a single layer or gauze may be placed over it.

If fixation dressings are necessary — as in complicated fractures, severe contusions, and after resections of joints — the place over the wound must be left open in the dressings by cutting a fenestra (Fig. 72), or the object is attained by the application of interrupted suspended splints (see below), which are especially useful for this purpose.

BANDAGING

A bandage must not only be practical and good, but must also be *well* applied; for it is the only part of the operation that the layman sees, and from it he may often form an opinion of the surgeon's skill. In pre-antiseptic times, especial value was attributed to bandages applied according *to the rules of technique* and according to exact regulations. Now, we must pay especial attention to the *condition* of the materials for dressing, and since most modern materials are very soft and pliable, only little skill is necessary to apply them well. Nevertheless, without spending too much time in applying the dressings, the surgeon should always aim, not only to make them practical, but also to make them appear well. Even without special natural ability, dexterity and a light hand may to some extent be acquired by practice.

For bandaging single portions of the body, for fastening on the wound the dressings, the splints, etc., *bandages* and *cloths* are usually used. Bandages are used exclusively for the first dressing of the wound and for larger dressings that are to remain in position for some time; cloths are used for smaller dressings that are to be changed often, and especially as a *valuable substitute* for dressings where no bandages are at hand or where their application would require too much time and expense. Moreover, since the cloth dressings can be applied more easily and simply than the bandages, they are, in the hands of laymen, especially suitable for a *temporary bandage*.

BANDAGES

The application of the bandages — that is, *the bandaging itself* — must be performed with very great care and exactness, since a badly applied bandage *always does harm*.

If the bandage is applied *too loosely*, it does not fulfil its purpose. The several turns become displaced, come to lie one upon the other, and thus produce pressure.

If the bandage is applied *too tightly*, then from the constriction under violent pains venous stasis immediately occurs in the parts below the constriction; and if this is not soon relieved gangrene (Fig. 67), or an incurable degeneration of the fibres of the muscle, cut off for some time from the circulation of the blood, will occur (ischemic paralysis of the muscles and contracture — *von Volkmann*).

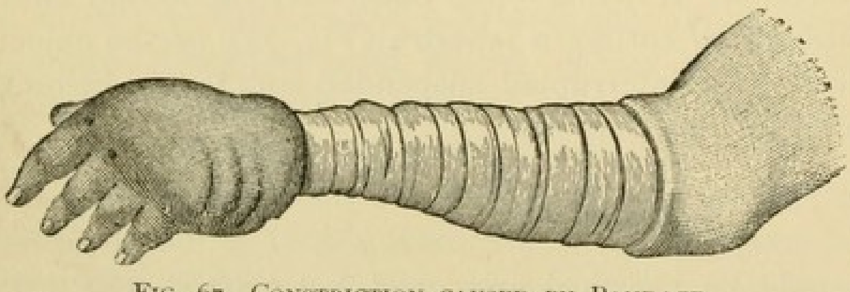


FIG. 67. CONSTRICTION CAUSED BY BANDAGE

Poorly fitting also is the bandage if it *gapes* largely — that is, if one margin is drawn tight and presses into the skin, while the other stands off from the surface of the body (Fig. 68). This occurs most frequently when the bandage is "tortured" — that is, when, neglecting the prescribed rules, the operator forces it to take a course that it does not take of itself. A bandage should be applied with *moderate tightness*, so that it does not get out of place, nor yet cause pressure; the right measure for this can be learned only by practice.

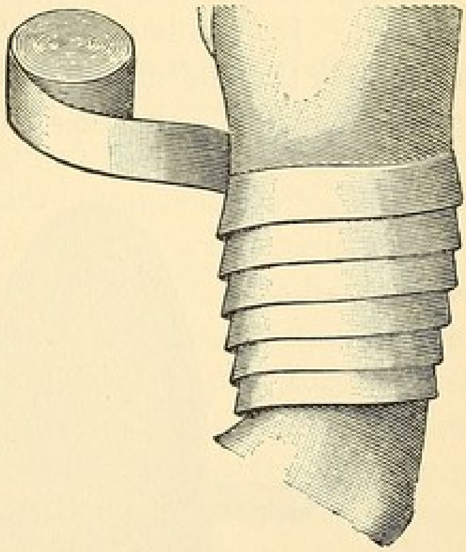


FIG. 68. GAPING BANDAGE

Bandages that have been applied *dry*, but that have afterward become wet (from compresses, irrigation), contract greatly and may then cause stasis; on the other hand, bandages applied *wet* (starch bandages) become loose from subsequent drying. The latter, therefore, may be drawn more tightly from the beginning; while the former are best applied wet.

Rubber bandages must not be drawn at all, since even slight elastic pressure in time becomes unbearable.

Before a bandage is applied, it must be rolled firmly and smoothly: First, make a small stiff roll by simply **winding** and turning between the fingers one end of the bandage; next, place this upon the inner surface of one hand so that the part to be rolled passes between the thumb and the fore finger or between the fore finger and the middle finger; then, with the other hand, by means of supination movements in the hollow of the hand, gradually roll up the free end of the bandage until it can be forced through the fingers only with difficulty (Fig. 69). The more firmly a bandage is rolled, the more easily can it be applied. If a larger number of bandages are to be rolled up quickly, it is better to use a *bandage roller* (Fig. 70). Bandages rolled up from beginning to end are called "*one-headed*," those rolled from each end to the middle are called "*two-headed*."

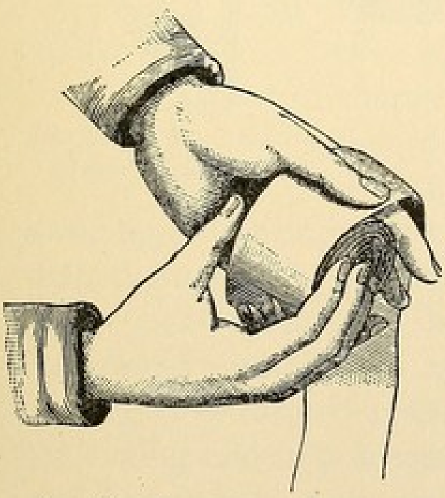


FIG. 69. ROLLING A BANDAGE

To **apply** the bandage, hold one end firmly with the left thumb to the portion of the body to be bandaged; roll the bandage around this from left to right until its beginning is covered, and thereby held in position; next, carry it as closely as possible along the body, preferably allowing it always to unroll of its own accord upon the body itself slowly in the tours described below, but always *centripetally* and corresponding to the lymph current.

For *fastening* the end of the bandage, a pin, or, better, a safety pin, may be used. If such is not to be had, or if the surgeon wishes to do without it, he divides the end of the bandage by tearing it lengthwise — especially the gauze bandage — and ties it together in front with the other end.

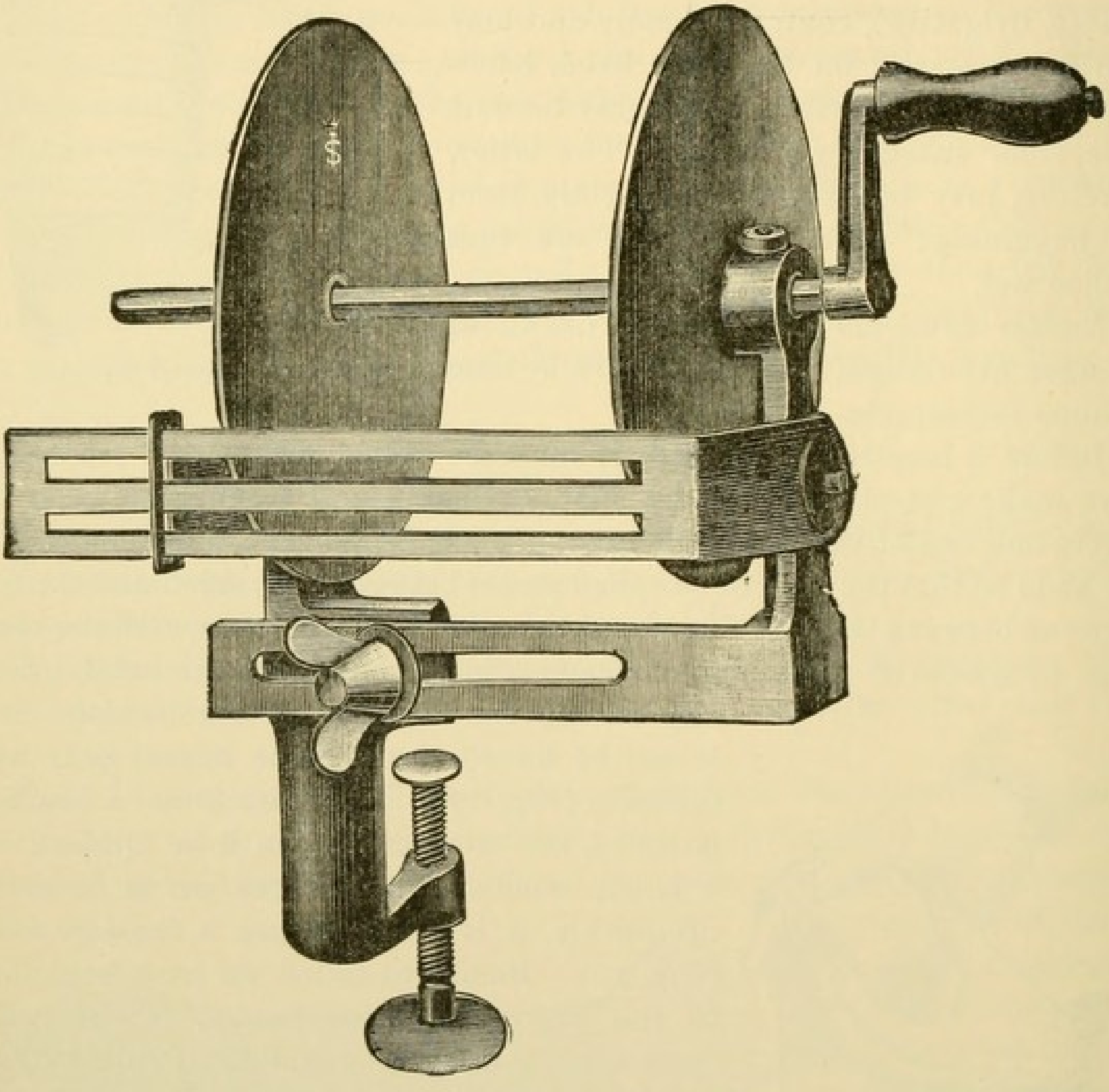


FIG. 70. BANDAGE ROLLER

To **unwrap** the bandage, catch it loosely at one end, like a skein, and pass the rolled-off part carefully from one hand to the other. In this way, the bandage is made to pass in the air around the limb without touching it, or without drawing it to and fro. Inexpensive gauze bandages are divided with scissors.

We distinguish the following turns: —

1. The **circular turn** (*circular bandage*, fascia circularis) surrounds the portion of the body in the form of a ring in tours covering one another completely (Fig. 71 below).

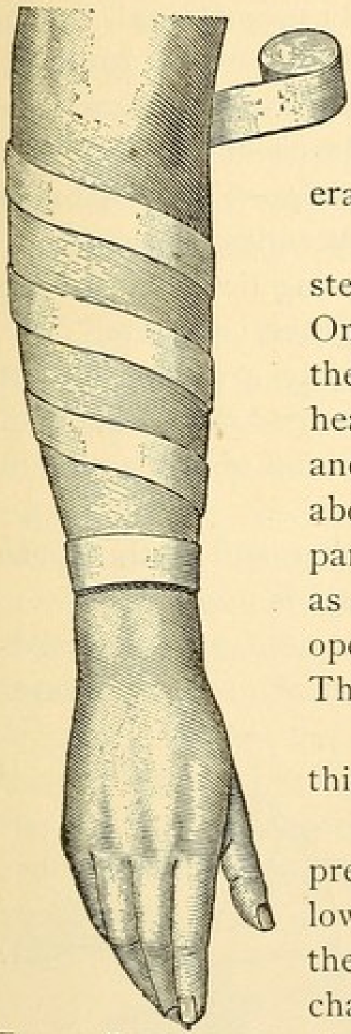


FIG. 71. CIRCULAR AND SERPENTINE TURNS

2. The **screw or spiral course** (*screw or spiral bandage*, dolabra ascendens) encircles the limb in the form of a screw, *gradually* ascending; the several tours cover one another about one-half (Fig. 72).

3. The **serpentine turn** (dolabra repens) ascends in steeper spiral turns, covering the limb only *incompletely*. On limbs with an increasing circumference (cone-shaped), these tours form themselves of their own accord if the head of the bandage is allowed to run along the skin and, as it were, to roll off of its own accord (Fig. 71 above). In order to secure an *even* envelopment on parts of increasing thickness (lower arm, thigh, and leg), as soon as the bandage begins to ascend too steeply, the operator must turn it down again on the other side. This is the —

4. **Reversion** (dolabra reversa, renversé). To make this tour: —

At the place where the bandage no longer covers the preceding turn, place the tip of the left thumb upon its lower margin. Next, with the right hand guiding, change the bandage from the pronation to the supination position, and, at the same time, so bring it in contact with the limb that, though previously drawn tight, it now becomes *perfectly loose*. Turn the head of the bandage once in a downward direction so that the hand is again prone. Having thus formed a smooth fold in the bandage, guide the rolling end in a descending direction around the limb, and turn it over again in line with the former fold. If, in making these turns, many inversions of the bandage follow each other, their angles — for the sake of good appearance — should form a regular zigzag line in the axis of the limb. The several turns cover each other about one-half. To

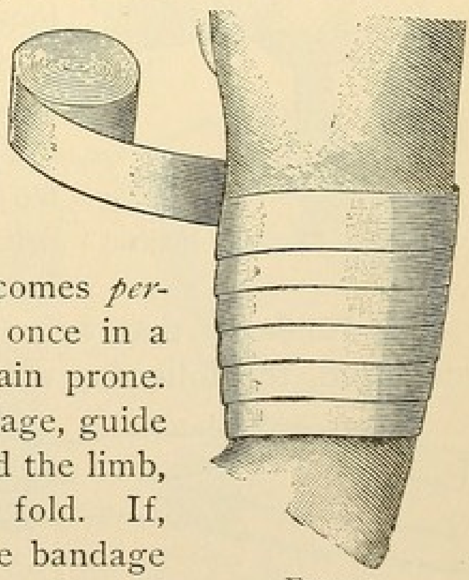


FIG. 72
SPIRAL BANDAGE

make these reversed turns well and rapidly requires practice and skill. The bandage applies itself almost of its own accord, if it is held loosely and drawn tight again immediately after the reversion has been made. Strong tension in making the reversed turns produces unsightly projections.

5. The **cross turn**, figure-of-8 (*spica tour*), is used where the bandage passes over a joint toward another portion of the body where, owing to a great difference in circumference, simple ascending turns of the bandage cannot be made. In this case, the bandage is carried *obliquely* over one side of the joint, transversely to the other side; and then, ascending obliquely, is carried across the first oblique turn. The point of crossing lies about in the median line. The several turns do not cover one another completely, but only about two-thirds (Fig. 89). In accordance as they are repeated in ascending or in descending lines, *spica ascendens or descendens* is obtained. The crossings form a figure faintly resembling the position of the grains in an ear of corn.

If the places of crossing, however, cover one another and if the turns of the several tours extend on both sides like a fan, there is produced —

6. The **fan turn** (*ray, turtle turn*, testudo). This is used only for bandaging the bent knee and the elbow joint. In accordance as the operator commences with the turns from the sides, advances toward the middle, and ends here with a circular tour, or commencing with a circular tour gradually covers both sides (the opening or the closing of a fan), we distinguish the *testudo inversa* and the *testudo reversa* (Figs. 73, 74).

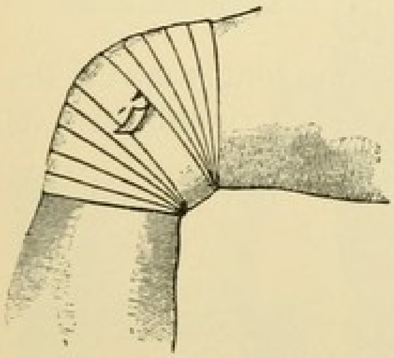


FIG. 73. TESTUDO INVERSA

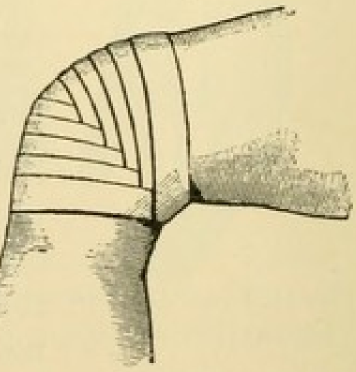


FIG. 74. TESTUDO REVERSA

Of bandages that were formerly much used, though now but seldom employed, the following are to be mentioned for special purposes: —

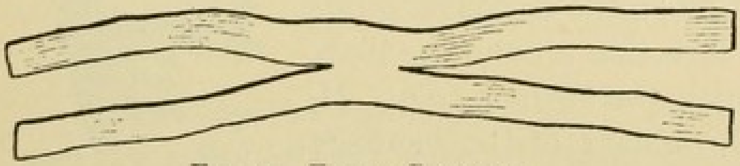


FIG. 75. FUNDA BANDAGE

The **double-headed** bandage, rolled up from each end, was especially used on the head and on amputation stumps. It can be employed also for the approximation of the margins of the wound and in ulcers of the leg (see Fig. 78).

The **many-headed** bandage (*Scultet's* bandage), which consisted of many short strips covering each other one-half, was sometimes used for bandaging complicated fractures and for plaster of paris dressings (Fig. 76).

The **funda bandage,** about 1 meter long and divided from each end to the middle with the exception of a small joint-piece, makes a very practical dressing for smaller projections (nose, chin); the middle portion is applied to the part to be protected, the two lower ends are carried upward and the two upper ends downward (Fig. 75).

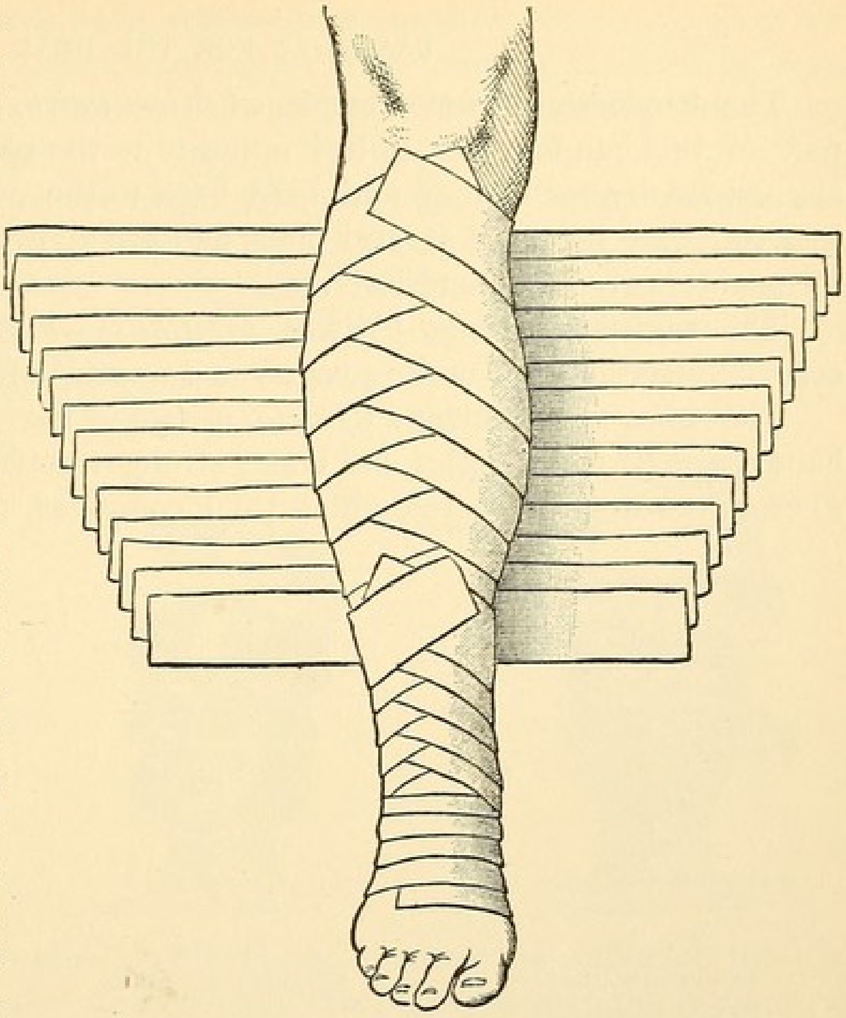


FIG. 76. SCULTET'S MANY-TAILED BANDAGE

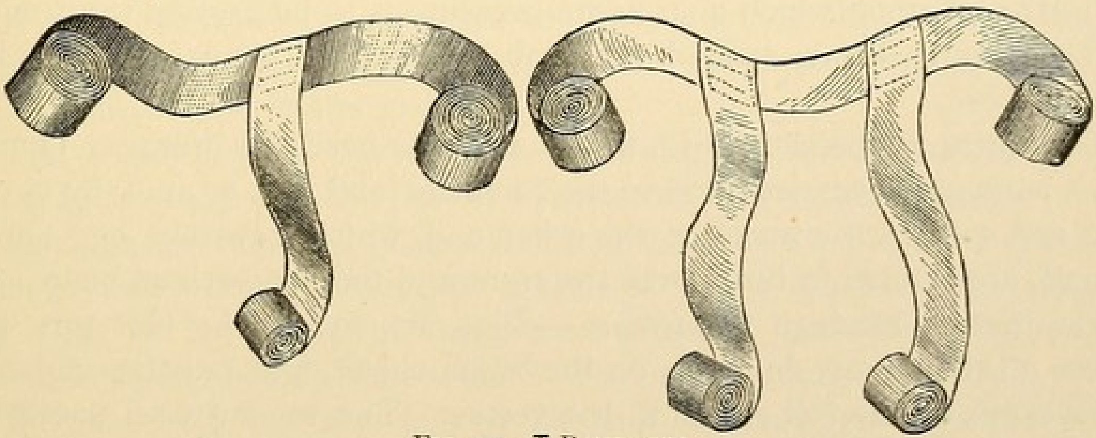


FIG. 77. T BANDAGES

The ***T* bandage,** a strip of muslin to the middle of which another strip has been fastened at a right angle, is used for some dressings on the pelvis and on the head (Fig. 77).

BANDAGES FOR THE HEAD

The **double-headed union bandage** (*fascia uniens* — Fig. 78). The middle part of this bandage is applied opposite to the place of injury; the heads are passed by each other and then back to the point of starting; in this way turns are repeated several times and are allowed to cover each other in turns anteriorly and posteriorly.

The **sagittal bandage** (*fascia sagittalis* — Fig. 79), a T bandage, is especially suitable for uniting transverse wounds of the skull.

The **cross-knot bandage** (*fascia nodosa* — Fig. 80) is a double-headed bandage. At right angles and under strong traction, its turns are allowed to cross the wound covered with a thick compress, as in tying up a package.

Fig. 78
Double-headed
Union Bandage

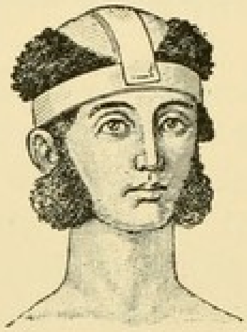


Fig. 79
Sagittal Bandage

Fig. 80
Cross-knot Bandage
(*Fascia nodosa*)

It is especially suitable as a temporary bandage for wounds which bleed profusely and upon which a stronger pressure is to be exerted (tourniquet). A cravat firmly drawn around the limb or a rubber bandage answers the same purpose.

The **mitra Hippocratis** (Fig. 81) is a double-headed bandage. One end of this bandage is carried around the forehead and the occiput by circular turns and so fixes the turns of the other end, which, covering one another one-half, are carried in turns over the right and the left parietal bone.

The **halter bandage** (*capistrum* — Figs. 82, 83). The first turn commences on the vertex, descends on the right cheek, and passing under the chin ascends on the left cheek to the vertex. The second turn passes in a posterior direction behind the right ear to the neck, on its left side anteriorly under the chin, and over the right cheek up to the vertex; thence closely again behind the left ear to the nape of the neck, past the right side of the neck, under the chin and over the left cheek back to the vertex.

After these turns have been repeated two or three times, covering one another like the tiles of a roof, about two-thirds, they are fastened by a circular turn around the forehead and the occiput, which turn can if necessary be repeated several times.

In antiseptic surgery, this *bandage* is well adapted to the treatment of injuries of the jaw, and is preferable to all others after *operations on the head;* since, in using broader bandages, the whole head and neck, with the exception of the face, may be enveloped with its turns (Fig. 83). If it is applied with moist starch bandages, the *essential* course of the turns must be observed in order that the bandage may fit well.

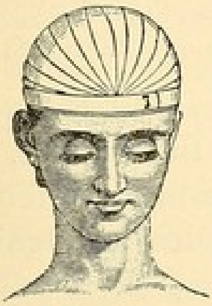


FIG. 81
MITRA HIPPOCRATIS

FIG. 82
HALTER BANDAGE

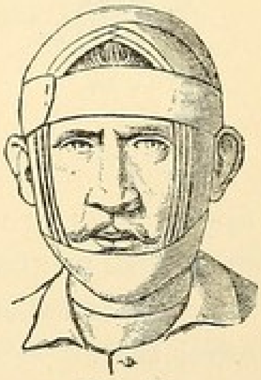


FIG. 83
HALTER BANDAGE

The **eye bandage** (*monoculus* — Fig. 84), to cover the region of the eye, commences with a circular turn around the forehead and the occiput; to this is added an oblique turn over the parietal bone to the other side below the ear. These two turns of the bandage are repeated several times so that the circular turns always cover one another; but the oblique turns are spread fanlike on the parietal region and below the ear, and across each other in front of the nose over the glabella.

To cover *both* eyes, the turns are applied on both sides, so that a star of six rays is formed, with the root of the nose as centre (binoculus).

Bandage for the nose (Fig. 85) is made in the simplest manner with a roller 60–70 centimeters long, the middle of which is placed upon the nose. The ends on both sides of the nose are turned once around their axis, carried obliquely across the cheek and the occiput, and tied there.

This dressing can also be applied with a funda bandage, the ends of which, crossing each other at the side of the alæ of the nose, extend above and below the auricle to the occiput.

The **funda maxillæ** (Fig. 86), for fixing the broken lower jaw and for smaller wounds of the region of the chin, is applied with a roller about 1 meter long and 6 centimeters wide. By tearing from each end to the middle portion about 5 centimeters wide, it is turned into a funda bandage. The middle portion, provided with a slit, is placed on the middle of the chin;

FIG. 84
EYE BANDAGE
(Monoculus)

FIG. 85
BANDAGE FOR THE
NOSE

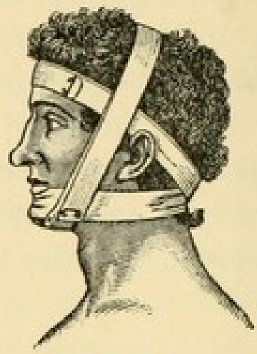


FIG. 86
FUNDA MAXILLÆ

the upper ends are conducted horizontally backward to the occiput, and crossing here are carried obliquely in an anterior direction to the forehead; the lower ends ascend across the cheek to the vertex, and descend again on the other side.

BANDAGES FOR THE ARM

For bandaging the *several fingers* (**chirotheka**), it is best to use a small flannel or cambric bandage (finger bandage). From a circular tour around the wrist, the turns pass obliquely across the back of the hand to the base of the fingers. The finger is bandaged by serpentine tours to its point; thence the bandage ascends in spiral tours to the base of the finger, and, crossing the first turn on the back of the hand, it returns to the wrist.

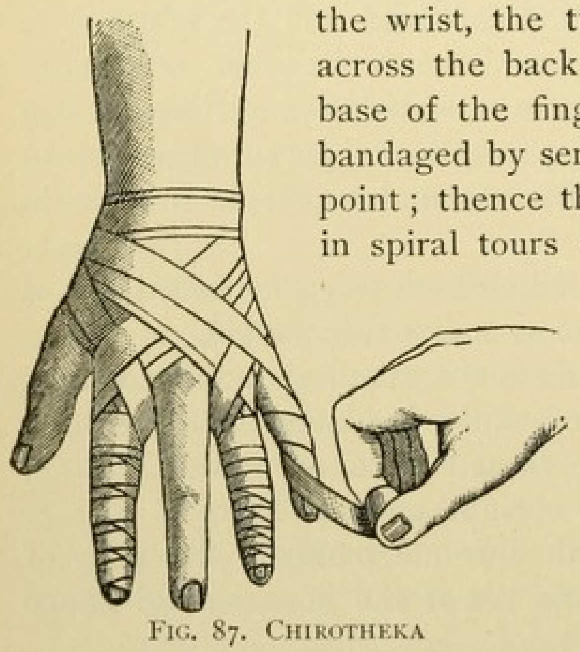


FIG. 87. CHIROTHEKA

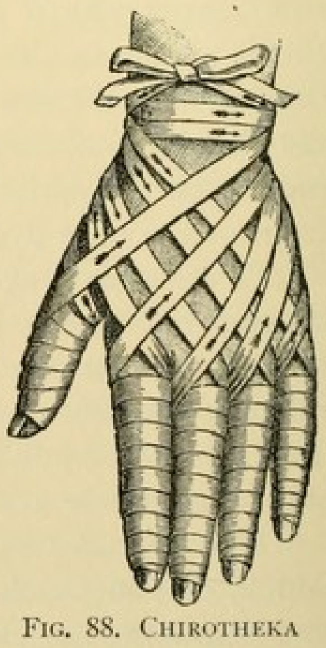


FIG. 88. CHIROTHEKA

The manner of bandaging *all* the fingers may be inferred from what has just been said: Starting from the wrist, the surgeon may begin bandaging the forefinger or the little finger; after bandaging each finger, he carries the bandage in an upward direction to the wrist so that finally it forms a spica on the back of the hand over each metacarpal bone (Figs. 87, 88).

The **cross bandage of the hand** (*spica manus* — Fig. 89), for covering the back and the palm of the hand, commences with a circular turn over the wrist or around the base of the fingers, and passes thence in several ascending and descending spica turns around the middle of the hand. In a similar manner is applied the *spica pollicis*, which envelops the base of the thumb.

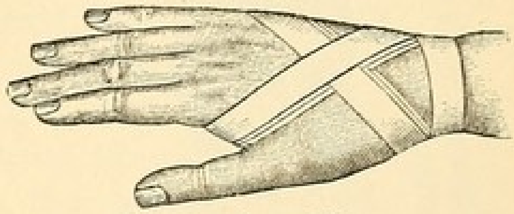


FIG. 89. SPICA MANUS

Similarly, with a circular turn commencing around the four points of the fingers, continuing in spica turns, and advancing to the wrist, the whole *hand together with the thumb* may be bandaged.

The **testudo cubiti** is applied on the flexed elbow, as described above, so that the several turns cross one another on the flexure of the joint.

The **spica humeri** (Fig. 90) commences with a circular turn in the upper third of the humerus, passes from the left, across the eminence of the shoulder and the back, to the axilla of the other side, and crossing, on the diseased shoulder, the first turn, returns to the beginning end of the bandage; thence it takes its course again parallel to the first turn, and covering it one-half, continues to the axilla of the other side; here the turns should cover each other completely, and so forth until the whole region of the shoulder is bandaged. Finally, a few turns are carried around the first circular turn on the humerus or around the chest.

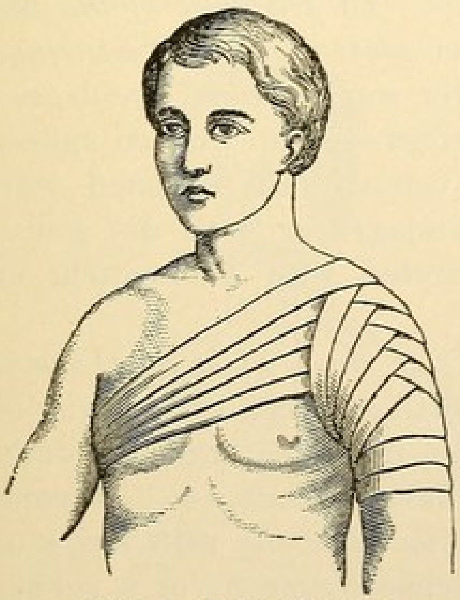


FIG. 90. SPICA HUMERI

The **bandaging of the whole arm** (*involutio brachii* — Fig. 91) commences with bandaging the several fingers and the thumb with a long narrow roller. With a broader bandage, the spica manus is next applied across the many small turns of the bandage on the back of the hand, and ends with a circular turn around the wrist. In one or two spiral turns, it ascends along the forearm — to which a series of reversed turns is added — as far as the elbow, which is bandaged by figure-of-8 turns; ascending thence to the arm, it runs in continuous spiral turns to the axilla; the shoulder is bandaged with a spica turn.

General rules for bandaging in **injuries** of the *hand* and of the *fingers:* No strangulation! untie the buttons of the shirt! cut open the sleeves of the shirt and of the undershirt to the axilla! do not commence the bandaging of the hand with a tight circular turn around the wrist! avoid the hanging position of the hand!

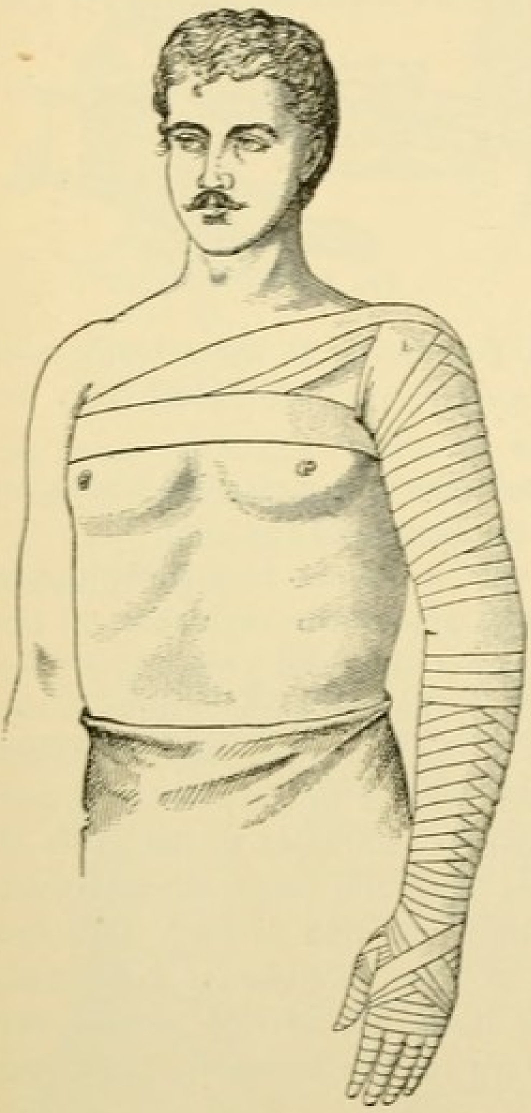


Fig. 91. Bandaging of the Hand and the Arm

In *fresh simple wounds*, secure union by means of English court plaster, wet or dry gauze bandages saturated with traumaticin or collodion, or fine sutures (epidermis suture — *Donders*). Hemorrhage must be arrested mostly by pressure (bandaging).

In *contused wounds* of the fingers, bandage with small gauze bandages that have been dipped into a weak antiseptic solution and moisten them from time to time. It is better, however, to use reliable antiseptic dressings. In *fractures of the fingers*, use either *plaster of paris dressings* — bandage over small flannel bandages; or *splint dressings* — small wooden splints padded with cotton and fastened with wet starch bandages or with dry gauze bandages saturated with traumaticin or collodion.

In *fractures of single metacarpal bones*, a large cotton ball is placed in the palm of the hand. On this, the hand is firmly wrapped with flannel bandages (ball bandages). In case of strong retraction, an *extension dressing* with strips of adhesive plaster is practical; these are made tense by means of a rubber ring on a hand board (see Fig. 266).

After *exarticulation of a finger*, the narrow spica bandage may be used (Fig. 92).

In **fracture of the clavicle**, the displacement of the fragments may be corrected, even if not permanently, by the **bandage of Desault**. It is true that this is no longer in fashion, but it is an excellent object lesson; its several turns are used in nearly all the bandages of the shoulder.

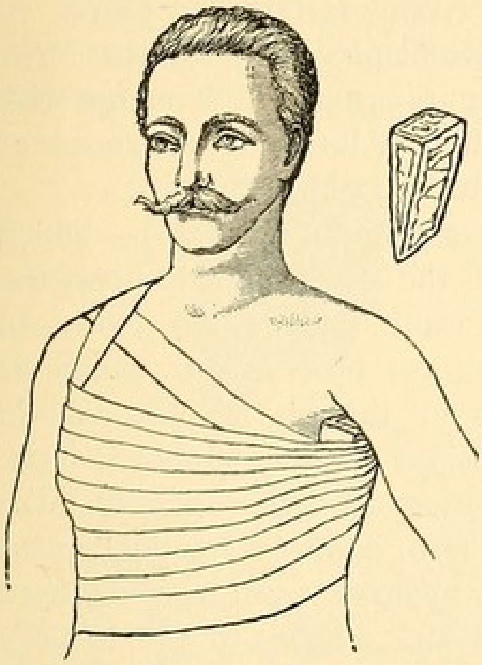


Fig. 93. Desault's Bandage for Fracture of the Clavicle. (*a*) First bandage

The *first* bandage (Fig. 93), by means of turns encircling the chest, fastens a *wedge-shaped pad* in the axilla of the abducted arm.

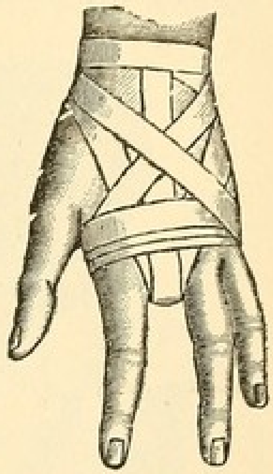


Fig. 92. Narrow Spica Bandage

After the arm has been brought to the side against the pad, it is fixed against the thorax by the *second bandage* (Fig. 94) and is, at the same time, forced backward, while the shoulder is drawn away from the trunk over the pad.

The *third bandage* supports the arm in the form of a mitella (Fig. 95). It takes its course from the axilla of the healthy side to the shoulder of the diseased side; and, passing around the elbow of the same, it returns to the axilla. These three

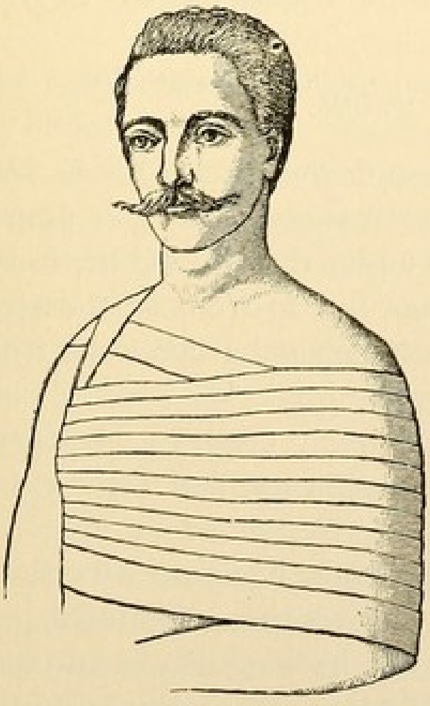


Fig. 94. Desault's Bandage for Fracture of the Clavicle. (*b*) Second bandage

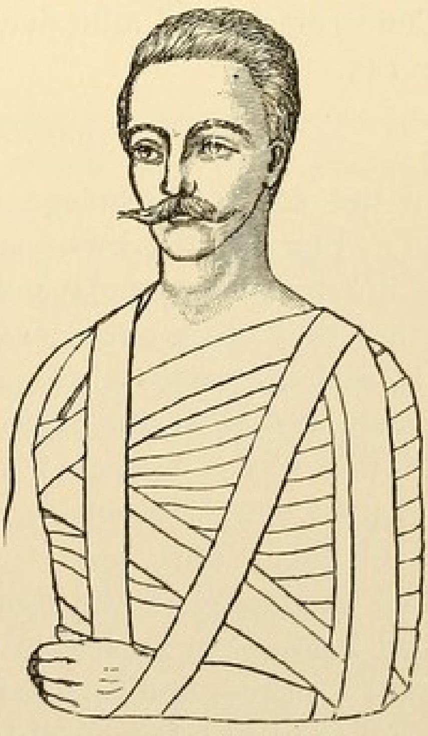


Fig. 95. Desault's Bandage for Fracture of the Clavicle. (*c*) Third bandage

points are always touched in the same order — axilla, shoulder, elbow. The last end of the bandage is carried from the healthy shoulder downward around the wrist and to the diseased shoulder, and is fastened there.

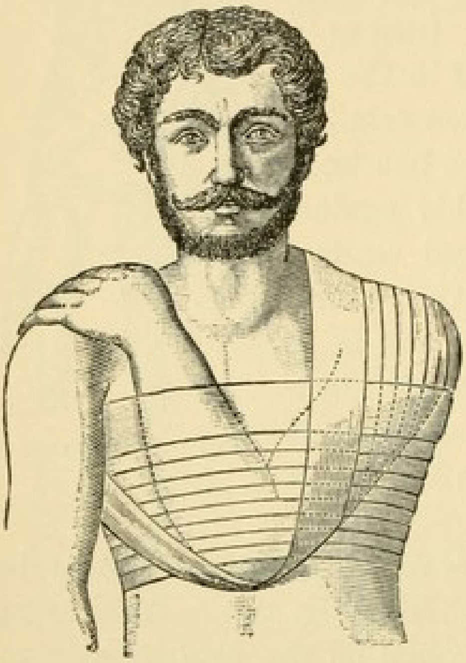


Fig. 96. Velpeau's Bandage for Fracture of the Clavicle

To prevent the displacement of the turns of the bandage, impregnate the bandage with starch paste, or for the last turn use starch or plaster of paris bandages.

The **bandage of Velpeau** (Fig. 96) — which fixes the hand of the diseased side upon the healthy shoulder and fastens the elbow in front of the ensiform process — is useful as well in fractures of the clavicle, as also in chronic inflammations of the shoulder joint. It consists of horizontal turns encircling the thorax and the arm, and of vertical turns which take their course from the diseased shoulder, around the elbow, to the healthy axilla. The elbow rests as if in a sling, and is drawn upward. The turns, applied alternately, cross each other in front of the diseased arm in the form of a spica.

Concerning the adhesive plaster bandage according to *Sayre*, see page 155.

BANDAGES OF THE TRUNK

In the **stellated bandage** for the chest and the back (*fascia stellata, Stella* — Fig. 97), the turns are carried on both sides in spica or figure-of-8 turns around the supraclavicular region and under the two axillæ, in such a way that they cross one another in the median line in front of the sternum and behind the vertebral column. A few turns placed around the trunk or both shoulders serve for fixation.

In this way a similar bandage, formerly much used, can be made — namely, the *quadriga*, which, according to rules, is applied with a double-headed bandage (Fig. 98).

The **bandaging of the thorax** and the **abdomen** becomes very simple if a broad bandage is applied in spiral turns. In order that the bandage may be applied firmly, and especially that it may not become displaced laterally, it is well to place a few spica turns (figure-of-8 turns) around the shoulder or the hip. Bandages in the *region of the pelvis* are mostly applied in spica coxæ turns (anterior — for instance, after operations for hernia, on the bladder, penis, scrotum, etc.). For operations on the anus, the **T** bandage is best. It is, moreover, just as practical to use so-called *bathing drawers*, which apply themselves well everywhere and which are not expensive.

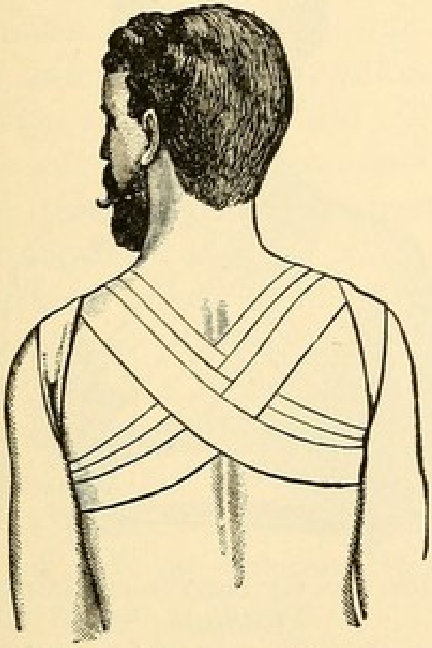


FIG. 97. STELLATED BANDAGE (Stella Dorsi)

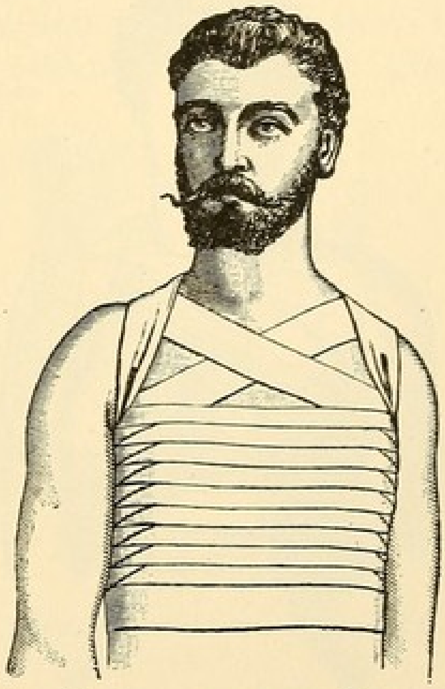


FIG. 98. BANDAGE OF THE THORAX (Quadriga)

The **compressive bandage for the female breast** can be applied in various ways: either in several single oblique turns, which pass from the healthy shoulder below the diseased mamma, and, covering each other in the form of overlapping turns or in the manner of a testudo, extend to the axilla of the diseased side; or else in turns which are applied around the healthy axilla and allowed to cross each other over the shoulder (Fig. 99). In arranging the turns of the breast ascending from below upward, the mamma is not only compressed but also supported (*compressorium et suspensorium mammæ*).

A *suspensorium mammæ duplex* (Fig. 100) is best applied with the turns of the above described *stellated bandage* (Fig. 97), to which a few circular turns around the lower mammary region are added.

The **bilateral compressive bandage for the breast** (*compressorium mammæ duplex*) is made in spica or figure-of-8 turns, which cross each other in front of the sternum. The bandage is carried from the superior side of one mamma to the inferior side of the other; across the back to the inferior side of the first and to the superior side of the other; thence across the back again to the superior side of the first. This process is continued in such a way that the turns, like a testudo, always approach more and

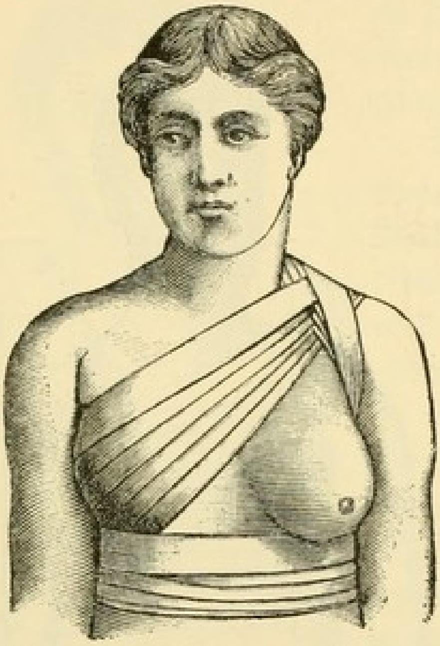


Fig. 99. Suspensorium Mammæ

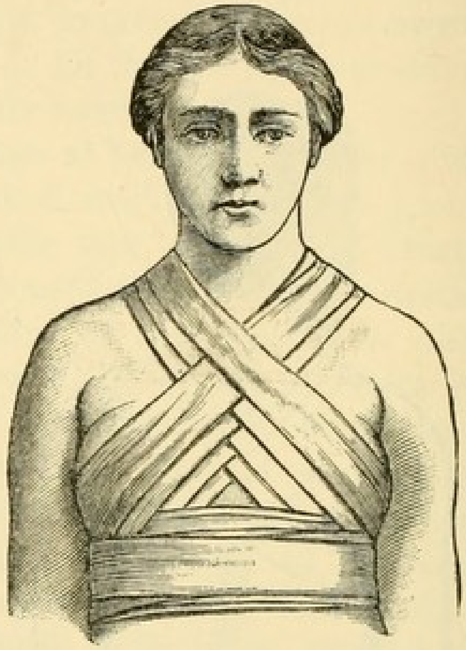


Fig. 100. Double Suspensory Mammary Bandage

more a central point — namely, the nipple. For a firmer fixation of the bandage, either the final tours are carried around the shoulders or a few circular turns are added around the thorax.

BANDAGES OF THE LEG

The toes are covered together with a circular bandage, and bandaging each toe separately is dispensed with.

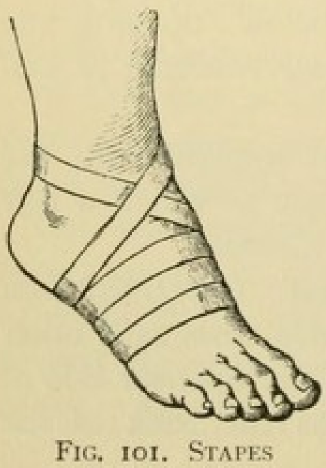


Fig. 101. Stapes

The **stapes** (Fig. 101), for bandaging the dorsum of the foot, consists of two or three spiral turns, fastened by a spica turn carried across the ankle joint. The **spica pedis** is applied in the same manner as the spica manus: to the circular turn over the malleoli are added three or four circular turns across the dorsum of the foot. The *whole* foot can be bandaged very well by increasing the number of these turns with a broad bandage — only the heel is left imperfectly covered. If the heel is also to be well protected, then **the foot is bandaged** in the following manner (*involutio pedis*): —

The bandage begins immediately above the toes with a circular turn; then follow two or three reversed turns on the dorsum of the foot, next three spica turns around the dorsum of the foot and the malleoli. Having arrived closely in front of the ankle joint, the bandage now takes its course from the plantar surface to the right (of the patient), around the calcaneus over the Achilles tendon, anteriorly from the left to the right again over the Achilles tendon, on the left around the calcaneus toward the plantar surface, anteriorly over the ankle joint, posteriorly around the heel; it then ascends across the malleolus to the leg.

The **testudo genu** has been described above on page 72.

The **spica coxæ for the hip** (Fig. 102) resembles essentially the spica humeri. After a circular turn around the upper third of the thigh, there follow three or four spica turns, encircling the pelvis. The crossings may be placed upon the anterior, lateral, or posterior region of the hip.

Applied on both sides, this *spica coxæ duplex* is the best bandage for the pelvis. Fig. 102 shows a bilateral spica coxæ anterior ascendens, on the right leg — descendens on the left leg.

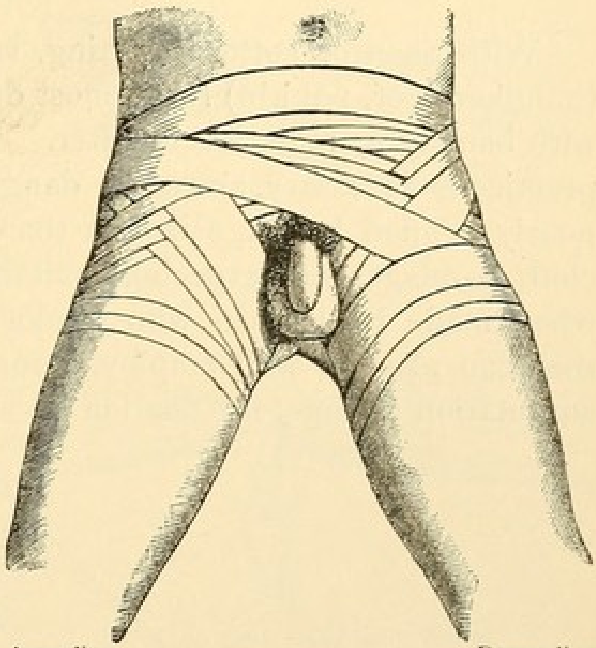


FIG. 102. DOUBLE ANTERIOR SPICA FOR THE HIPS

Bandaging of the whole leg (*involutio Thedenii* — Fig. 103) commences with the bandaging of the foot described above. Thereupon follows the bandaging of the leg, by a broader ascending spiral bandage with reversed

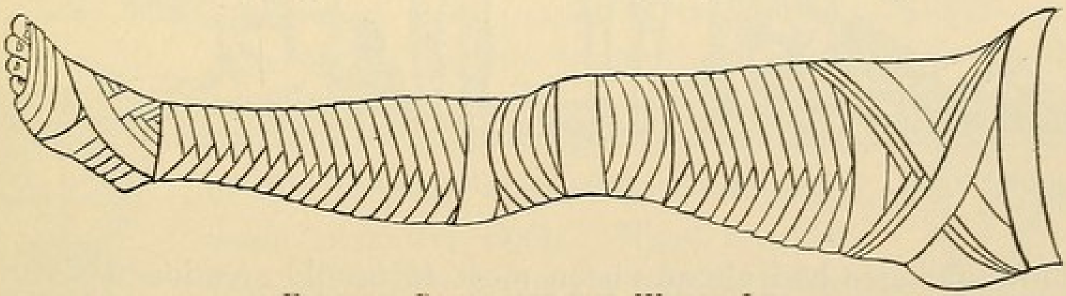


FIG. 103. BANDAGING THE WHOLE LEG

turns; of the knee, by a testudo; of the thigh, by an ascending spiral bandage with reversed turns; of the region of the hip joint, by a spica coxæ completed with a few circular turns around the hypogastric region.

Many of the bandages here described are obsolete, and are used in practice little or not at all. They can all be very well made use of, however, in **practice work**; and although the application of a moist gauze bandage is easier than that of a stiff linen one, nevertheless, for exact antiseptic bandaging, a thorough knowledge of the technique of bandaging is indispensable.

CLOTH BANDAGES

With linen or cotton (shirting, stouts) of triangular (kerchief) or square (handkerchief, napkin) form, most dressings may be applied just as well as with bandages, many even better. For the application of cloths, only little practice is necessary, since the danger of strangulation and stasis even in a poorly applied bandage is less than when gauze bandages are used; the cloth bandages are especially suitable for *temporary dressings*, particularly when made by laymen who render the first assistance (Samaritan). But they can also be well employed for bandaging wounds—for instance, for amputation stumps, for fixation of small dressings, compresses, splints, etc.

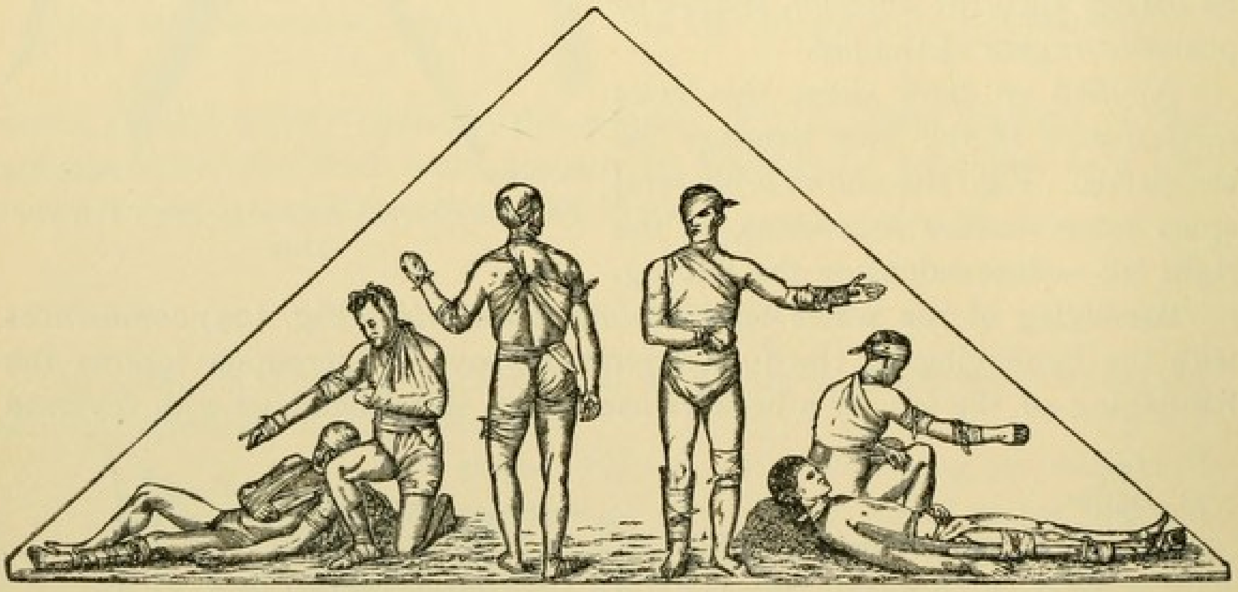


FIG. 104. VON ESMARCH'S TRIANGULAR CLOTH

Cloth bandages had already been most favorably mentioned sixty years ago by *Gerdy* and *Mayor;* but they were forgotten, and were brought into common use only by the introduction of my **triangular cloth** (Fig. 104). This is printed with figures on which the various bandages are illustrated. By these, the expert obtains a quick survey of what he has learned, while an inexperienced person obtains a good object lesson for his action, a lesson of great advantage, especially to soldiers on the battle-field.

We make a distinction between *square* cloths and large and small *triangular* cloths.

The former must consist of square pieces, the sides of which are from 90 to 130 centimeters long. The latter (large triangles) are obtained by an oblique cut; by cutting from the point to the middle of the base, they may be divided again into two halves (small triangles). A triangular cloth has a *point*, two *extremities*, two *small sides*, and one *long side*.

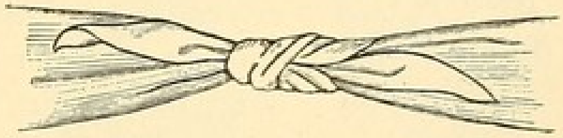


FIG. 105. SAILOR KNOT

For fastening the extremities together, it is best either to use the *sailor knot* (Fig. 105), which holds more securely than the *granny's knot* (Fig. 106), or by the use of safety pins.

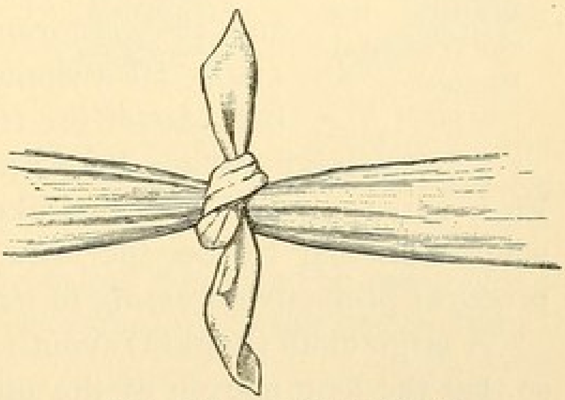


FIG. 106. GRANNY'S KNOT

As can be seen from the pictures printed upon the cloths, they can be used for various purposes in different forms and sizes; now, as a **cloth bandage** folded together from the point to the base into a long and small cravat; now, as an open **triangle** with a manifold application of the extremities, by doubling them, inverting them, tying them together, or fastening them with safety pins.

On the several parts of the body, the cloths are used in the following manner:—

For *bandages of the head*, the following are serviceable:—

1. The **triangular head cloth** (capitium triangulare—Figs. 107, 108).

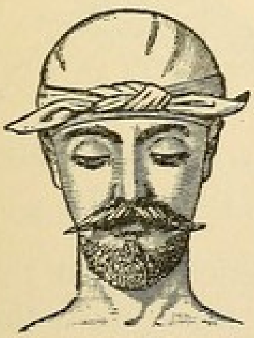


FIG. 107. TRIANGULAR HEAD CLOTH (Anterior view)

The middle of this triangular cloth is applied over the vertex so that the long side hangs down transversely in front of the forehead, while the point hangs down over the neck. Next, the two extremities are carried across both ears in a posterior direction and allowed to cross each other over the occiput and over the point which hangs down; thence they are carried again anteriorly

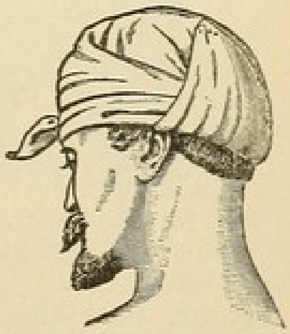


FIG. 108. TRIANGULAR HEAD CLOTH (Posterior view)

and are knotted together over the forehead. Finally, the point hanging down posteriorly is drawn forcibly downward, turned up over the occiput, and fastened over the vertex with a safety pin.

2. The **funda capitis** (Figs. 109, 110). This is a square cloth, 60 centimeters long and 20 centimeters wide, split on the two small sides like a divided funda bandage. If the operator desires to use it in fastening a dressing over the parietal region, he knots the two posterior extremities below the chin and ties the two anterior together over the nape of the neck (Fig. 109). But if the dressing is to be fastened over the occiput, the anterior extremities are tied together under the chin and the posterior over the forehead (Fig. 110). In a similar manner, a funda capitis is made for the frontal region.

FIG. 109. FUNDA BANDAGE FOR THE TEMPORAL REGION

FIG. 110. FUNDA BANDAGE FOR THE OCCIPUT

3. The **large square head cloth** (capitium magnum quadrangulare — Figs. 111–112). This covers, like a hood, not only the skull but also the whole auricular region, the neck, and the throat. It is, therefore, a very practical protective dressing in bad and in cold weather.

A large cloth (napkin) about 1 meter square is folded together diagonally, so that the long margin of the upper half recedes behind the long margin of the lower part as much as the width of the hand. In this way, a rectangle is formed. This is applied to the head of the patient as follows: The middle line of the cloth covers the sagittal suture; the free margin of the lower surface hangs down to the tip of the nose; the margin of the upper surface extends to the superciliary region; the narrow margins fold themselves upon the two shoulders. Of the four extremities hanging down anteriorly upon the breast, first the two exterior are tied together under the chin; next, the margin of the lower surface hanging down in front of the eyes is turned up toward the forehead, and the two inner extremities of the same are

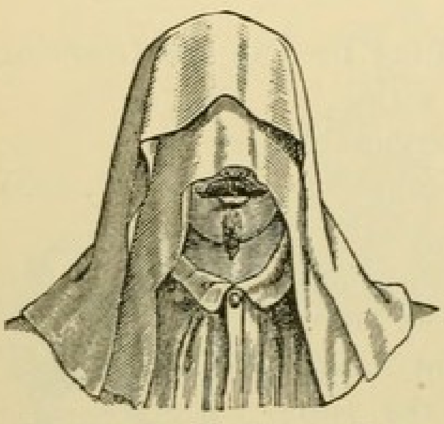


FIG. 111. LARGE SQUARE HEAD CLOTH

FIG. 112. LARGE SQUARE HEAD CLOTH

drawn backward over the ears and tied together over the nape of the neck.

With the triangular cloth folded in the shape of a cravat there can be very easily formed a **frontal bandage,** a **buccal bandage,** and an **eye bandage** (Fig. 113).

With two such cloths, also a four-tailed **bandage for the chin** may be extemporized (Fig. 114). This is done by placing the middle of one cloth upon

Fig. 113
Eye Bandage

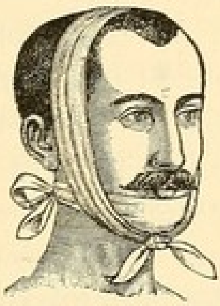


Fig. 114
Funda Bandage for the Chin

Fig. 115
Cravat or Kerchief

Fig. 116
Cravat with inserted Pasteboard

the anterior surface of the chin and by tying together the ends over the nape of the neck, while the other cloth is carried up to the vertex from the lower surface of the chin.

For fastening the bandage *over the neck,* the **kerchief** is of service (Fig. 115). This is a triangular cloth folded together in the form of a cravat. If a *piece of stiff pasteboard* or leather, etc., is incorporated, the bandage becomes still more secure, and the head can then be bent toward the injured side (transverse wounds), provided the maxillary margin of the healthy side has been raised by a sufficiently high insertion (Fig. 116).

For *bandages of the arm,* we use: —

1. The *vinculum carpi,* **cross bandage for the hand** (Fig. 117). This is a folded cloth, which is placed around the metacarpus in spica or figure-of-8 turns. The crossing is made over the place of the injury.

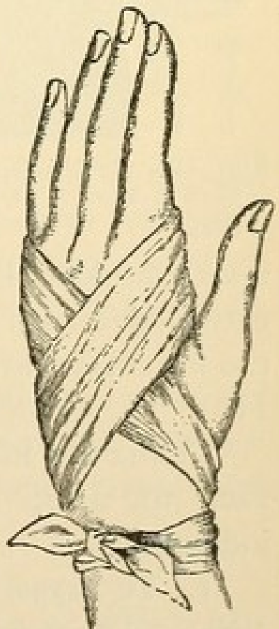


Fig. 117. Cross Bandage for the Hand

2. The *hand cloth,* **gauntlet** (Fig. 118). This is used for bandaging the whole hand. Upon the middle of the long side of the unfolded cloth, the flat hand is so applied that the wrist lies upon the margin, while the fingers correspond with the apex. This apex

is turned over the dorsal portion of the hand, the lateral extremities are tied over the wrist, and the apex is used for covering the knot. Amputation stumps may be bandaged in the same way (Fig. 119).

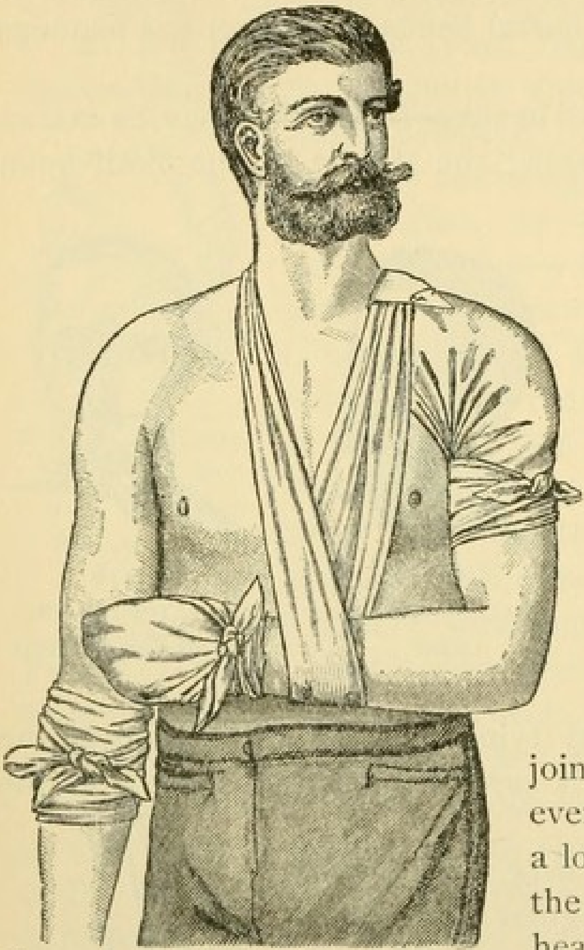


FIG. 118. SHOULDER CLOTH, HAND CLOTH, ELBOW CLOTH, AND SMALL SLING

3. The **elbow cloth**. This is applied folded, and bandages the region of the elbow joint in circular and spica or figure-of-8 turns.

4. The **shoulder cloth**. This is applied: either *folded together* in a spica tour around the shoulder, the ends being tied in the healthy axilla; or *unfolded*, the apex upon the shoulder and the extremities tied together in the other axilla. In this way, the brachium (arm) is also covered, and a restful position is thereby secured. It is very well to employ this method after exarticulation of the shoulder joint (Fig. 120). It is more practical, however, to use *two cloths*, placing one, folded as a loose sling, around the neck — or around the neck and the healthy axilla — and under this the other with its apex unfolded is carried and fastened, while the extremities are tied around the brachium (arm) (Figs. 118, 119).

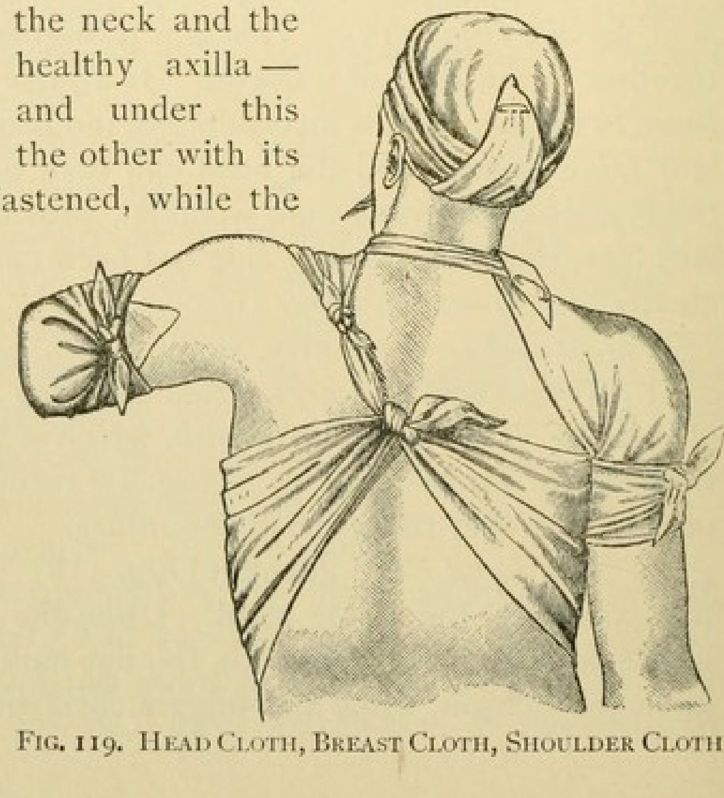


FIG. 119. HEAD CLOTH, BREAST CLOTH, SHOULDER CLOTH

Cloths are most frequently used to meet the following indications: —

1. To **support the arm** (*mitella*). The *mitella parva* is a sling made of the folded cloth (Fig. 118). Generally, however, the cloth is unfolded (*mitella triangularis*). It is

grasped at the apex and at one extremity. This extremity is carried over the healthy shoulder, while the apex is carried behind the elbow of the diseased arm; the arm itself is placed horizontally upon the cloth; the extremity hanging down is turned upward to the diseased shoulder and tied together with the other extremity over the neck; finally, the apex is drawn from behind the elbow and fastened in front of the arm with a safety pin (Fig. 121). When the shoulder of the diseased side cannot tolerate any pressure, the two extremities may also be carried over the healthy shoulder (Fig. 122). If, however, the healthy arm is to remain entirely free, then the two ends are tied together over the diseased shoulder (Fig. 123). For a safer and firmer position of the arm — for instance, after reducing a dislocation of the shoulder, or in case of fracture of the clavicle — a broad cravat, applied across the mitella, is added; this presses the arm against the breast (Fig. 124).

The **large square cloth for carrying the arm** (*mitella quadrangularis* — Fig. 125) is applied with a napkin, etc. The ends are fastened with safety pins, since the knots easily cause pressure, especially over the nape of the neck.

2. To **bandage a fractured clavicle.** According to *Szymanowsky* this bandage is made with three cloths; it draws the injured shoulder backward and upward (Fig. 126).

3. To *bandage the* **trunk.** In various ways, bandages for this purpose can easily be made with several cloths; *e.g.* the **cingulum pectoris** (Fig. 129), *Roser's* **apron bandage** (Fig. 127).

4. To *bandage the* **whole chest.** For this purpose, the cloth is so applied that the apex can be carried over the shoulder; the extremities on both sides are carried around the thorax to the back, where the three corners are knotted together (Figs. 119, 130). The **back bandage** is made by applying the cloth inverted.

Bandaging the region of the **pelvis** (Fig. 131). For this purpose, the apex of the cloth is carried from in front across the perineum, the extremities are tied around the hips, and the apex is fastened to them (improvised bathing drawers).

The **cloth for the buttocks** is inverted (Fig. 132).

Unna's **gauze sash** (Fig. 134) consists of two strips, one of which surrounds the hips, while the other, fastened to it, supports the penis and the scrotum, as if in a bag (suspensorium).

6. To bandage the **leg.** For this purpose, the following are serviceable: —

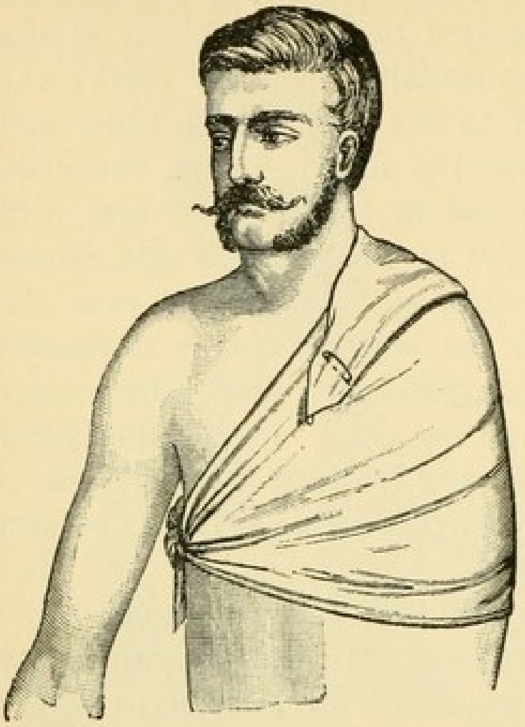


FIG. 120. BREAST CLOTH, SHOULDER CLOTH

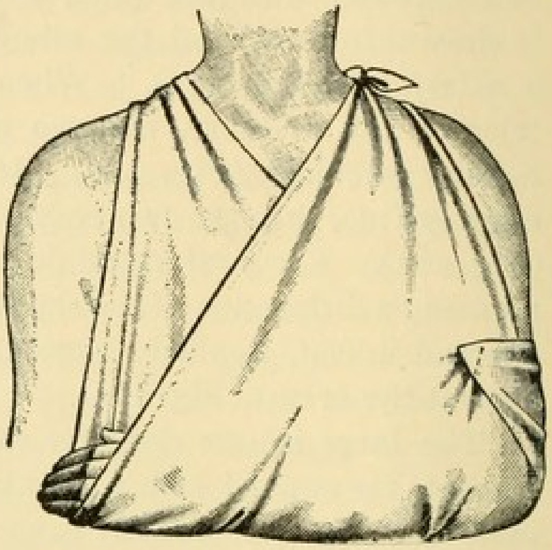


FIG. 121. MITELLA TRIANGULARIS

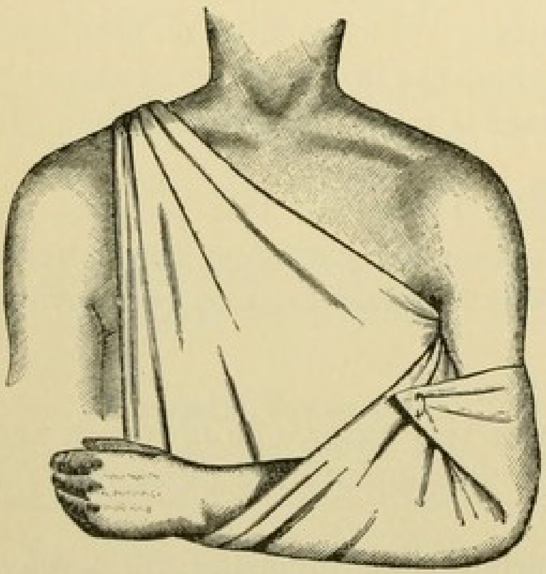


FIG. 122. OTHER FORM OF MITELLA

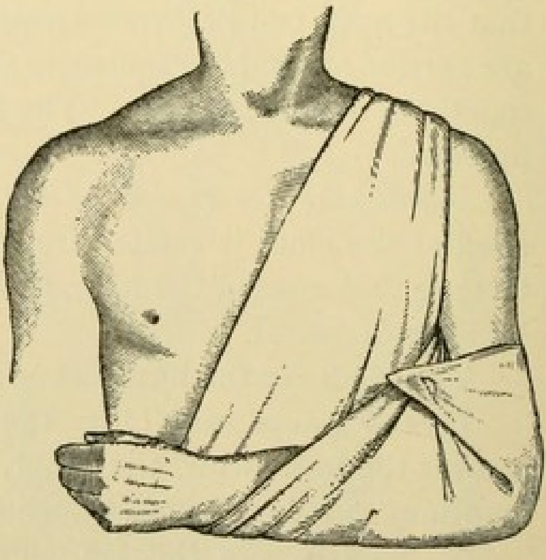


FIG. 123. CLOTH FOR CARRYING THE ARM

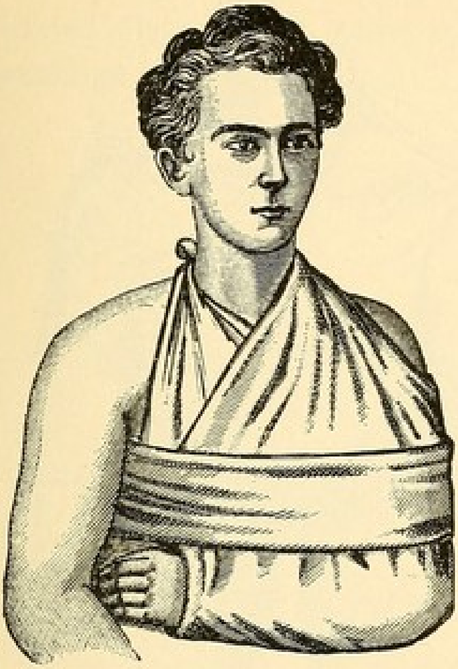


FIG. 124. MITELLA BANDAGE

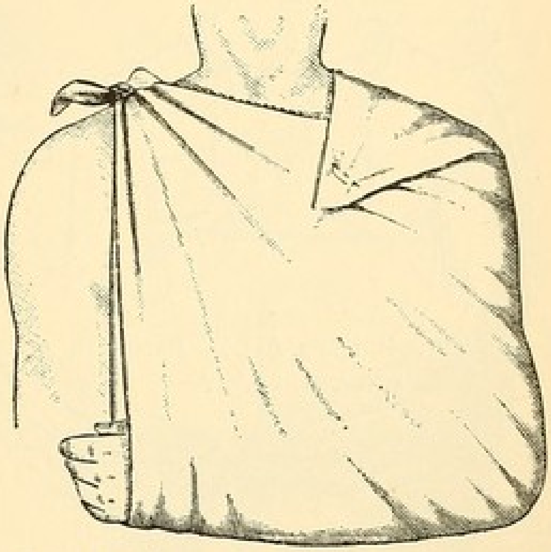
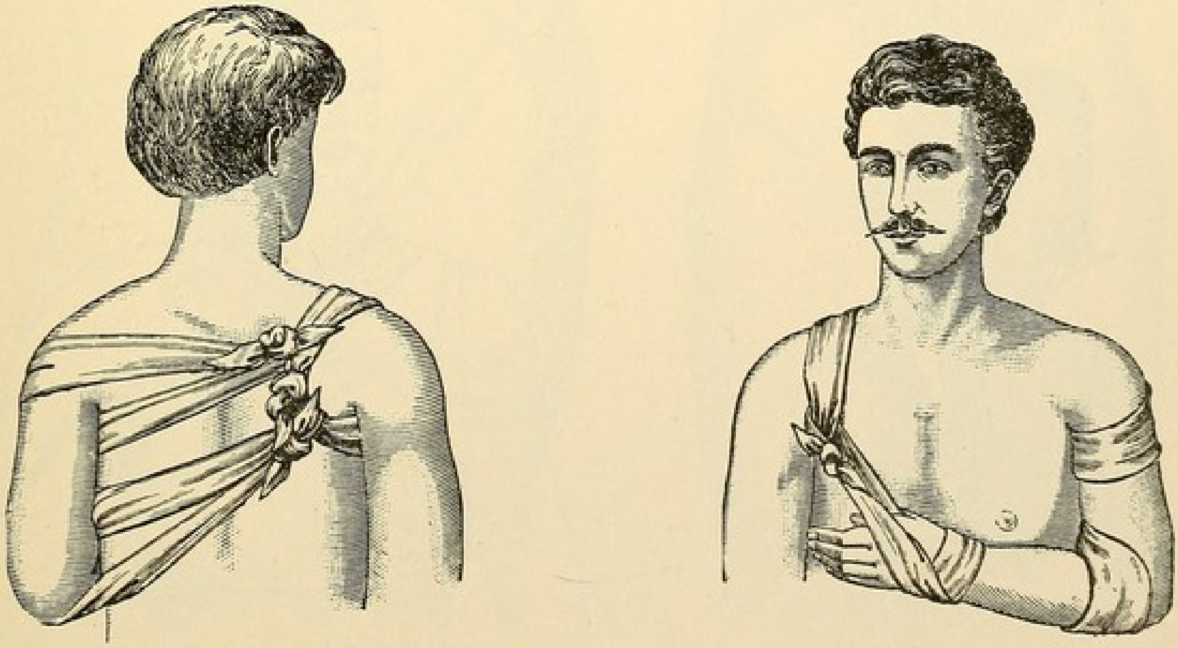


FIG. 125. SQUARE CLOTH FOR CARRYING THE ARM



a, Posterior view

b, Anterior view

FIG. 126. SZYMANOWSKY'S BANDAGE FOR FRACTURE OF THE CLAVICLE

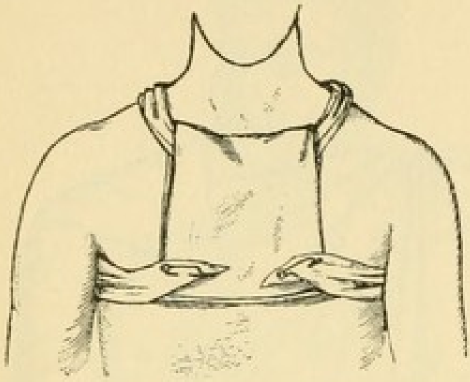


Fig. 127. Roser's Apron Bandage for the Chest

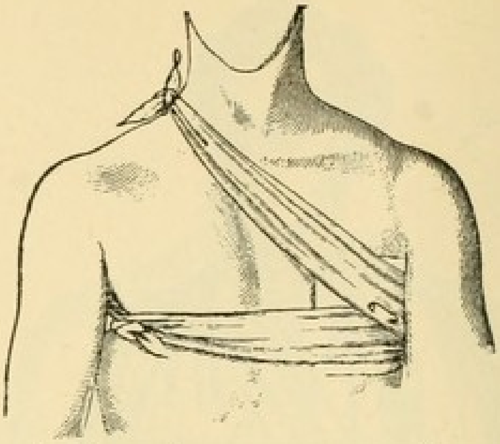


Fig. 128. Cloth Bandage for the Lateral Region of the Chest

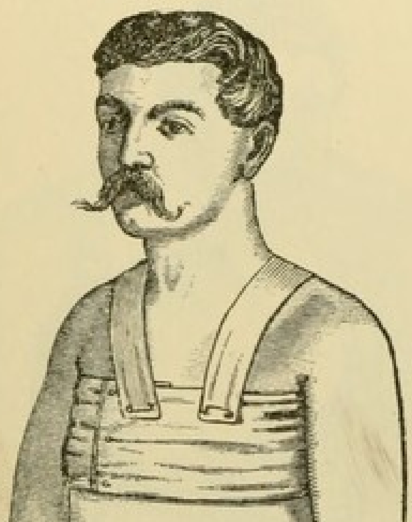


Fig. 129. Cingulum Pectoris

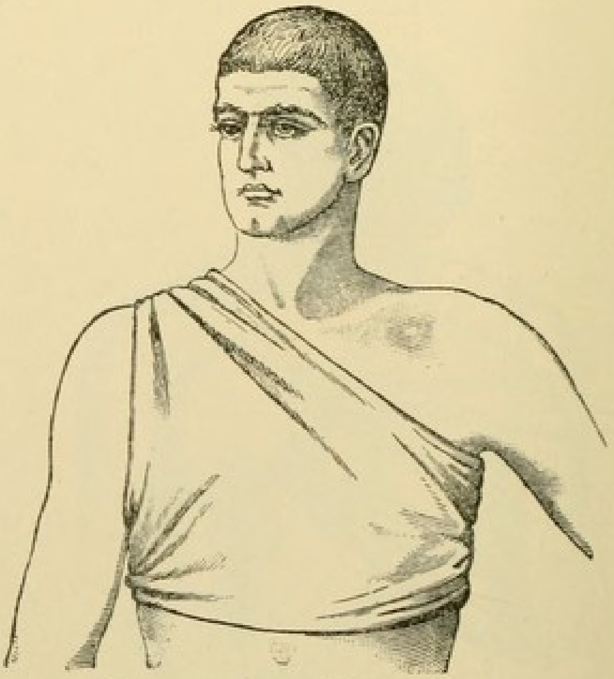


Fig. 130. Large Breast Cloth
Anterior view
The same, posterior view, see Fig. 119

(*a*) The **hip cloth** (Fig. 133). This is applied with an unfolded and a folded cloth, in the same manner as the shoulder cloth and *Roser's* **apron bandage** (Fig. 135).

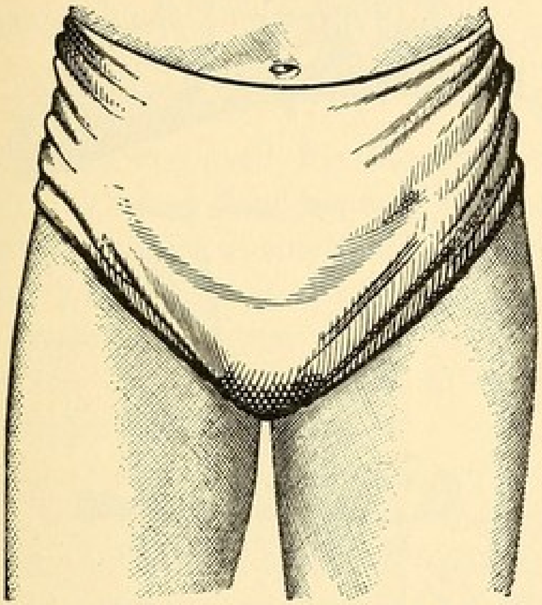


FIG. 131. BANDAGE FOR THE PELVIS

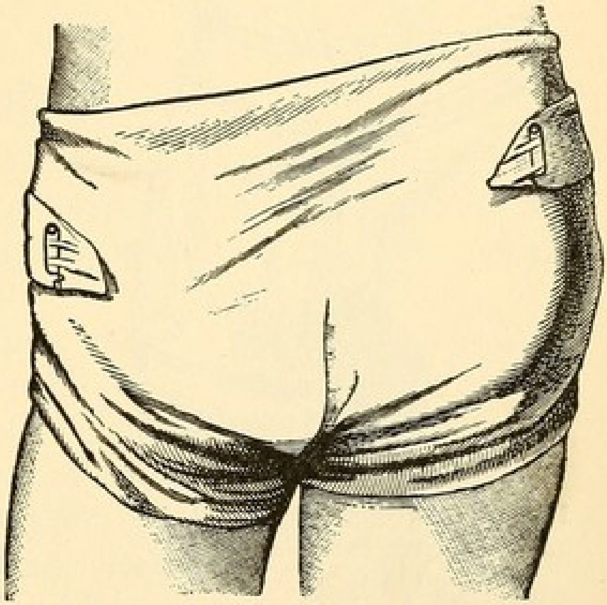


FIG. 132. CLOTH FOR THE BUTTOCKS

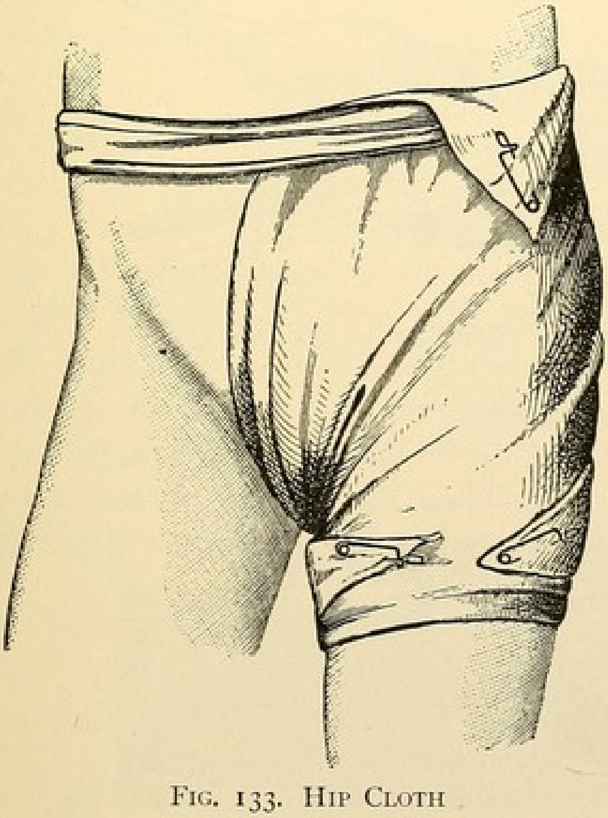


FIG. 133. HIP CLOTH

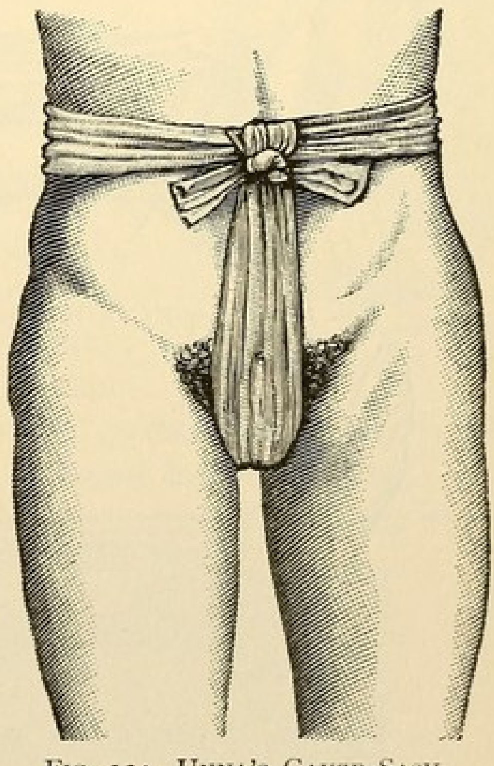


FIG. 134. UNNA'S GAUZE SASH

(*b*) The **knee cloth** (Fig. 136). This, folded together, is carried around the region of the joint in a spica or figure-of-8 turn.

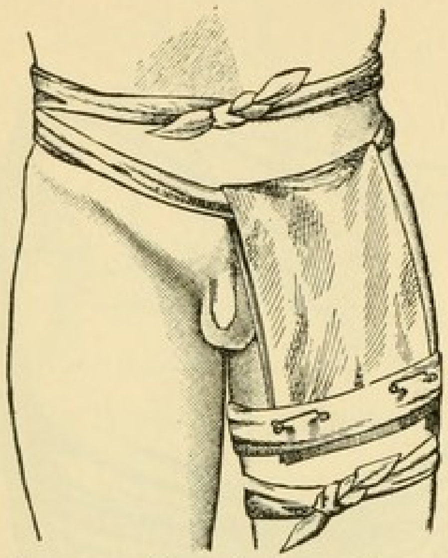


FIG. 135. ROSER'S APRON BANDAGE FOR THE INGUINAL REGION

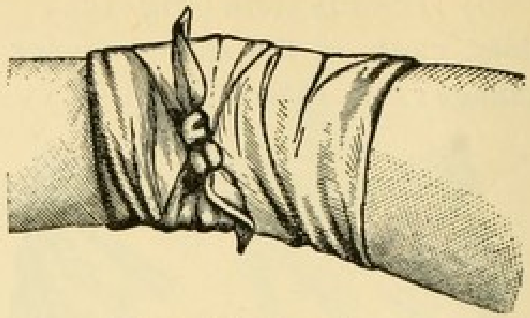


FIG. 136. KNEE CLOTH

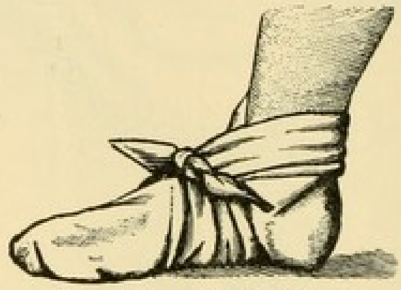


FIG. 137. FOOT CLOTH

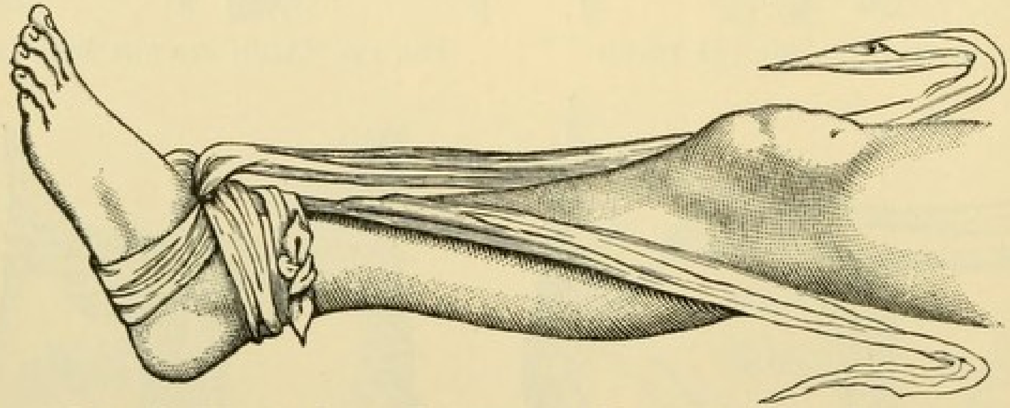


FIG. 138. MAYOR'S CLOTH BANDAGE FOR FRACTURE OF THE PATELLA

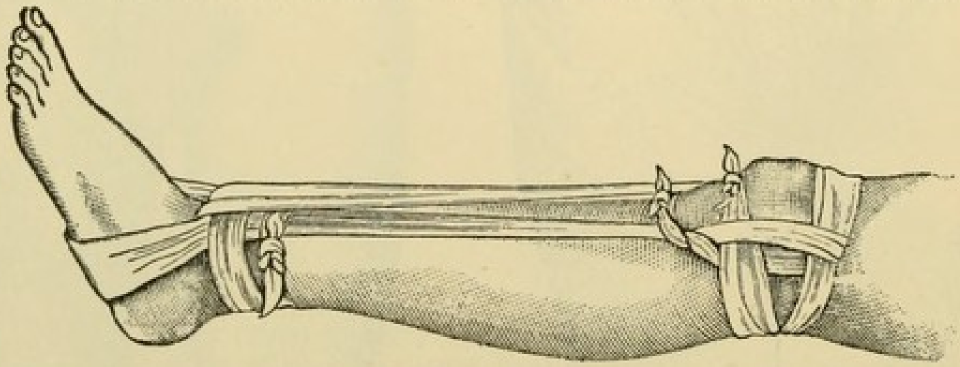


FIG. 139. MAYOR'S CLOTH BANDAGE FOR FRACTURE OF THE PATELLA

(*c*) The **patella bandage.** This is used *for fracture of the patella.* It is made with three cloths according to *Mayor;* but it is not especially effective, though very good for instruction on bandaging (Figs. 138–139).

(*d*) The **foot cloth** (Fig. 137). This is applied in the same manner as the hand cloth described above, by turning the apex over the dorsum of the foot, while the extremities, crossing each other, are carried over the dorsum and over the ankle joint.

SPLINTS

Splints are used for the purpose of securing rest for injured limbs, especially when their bones and joints are diseased or injured. The missing internal support of the limb is supplied by the splint until the disease or the injury has been repaired.

These supporting bandages, therefore, must embrace not only the diseased bone, but also the two neighboring joints and a portion of the following section of the limb, in order to secure complete rest and immobility for the injured part.

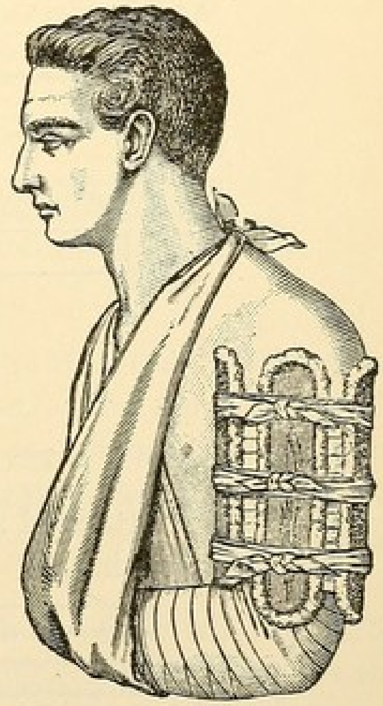


Fig. 140. Fixation Dressing for the Broken Arm

Of the large number of splints formerly used for the most various purposes, now comparatively few are in use. The most common are the following: —

1. WOODEN SPLINTS

Simple boards, well padded, are fastened by means of cloths or bandages to the limb, previously wrapped with bandages. Figure 140 shows such a fixation dressing for the broken brachium (arm). If such splints at their ends are provided with *tin sockets and joints* (*von Esmarch*), any desired size can be made by joining these together (for instance, for the whole leg). This *wooden splint, which can be taken apart*, can be very easily packed up, and occupies but little space. It is especially suitable for an extension splint during transportation (see below).

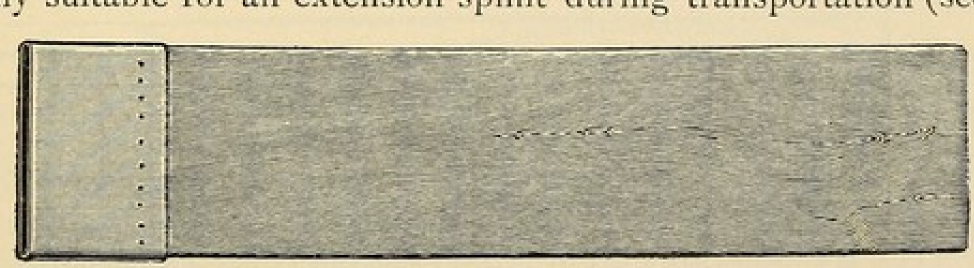


Fig. 141

Gooch's **flexible wooden splints** consist of thin strips of fir (6 millimeters), cut into parallel strips 1 centimeter wide by means of light, not perfectly penetrating, parallel cuts, and glued upon leather or canvas. They are perfectly flexible transversely, and perfectly firm longitudinally (Fig. 142).

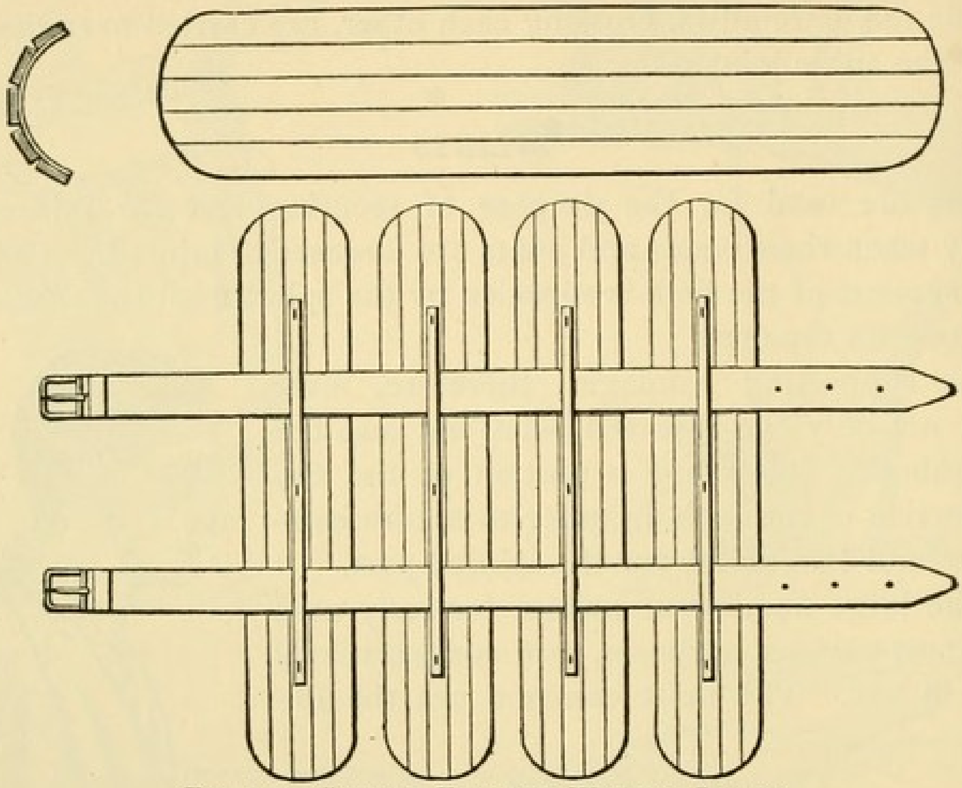


FIG. 142. GOOCH'S FLEXIBLE WOODEN SPLINTS

Through the attached strips of leather, straps with buckles are passed; these serve for fastening.

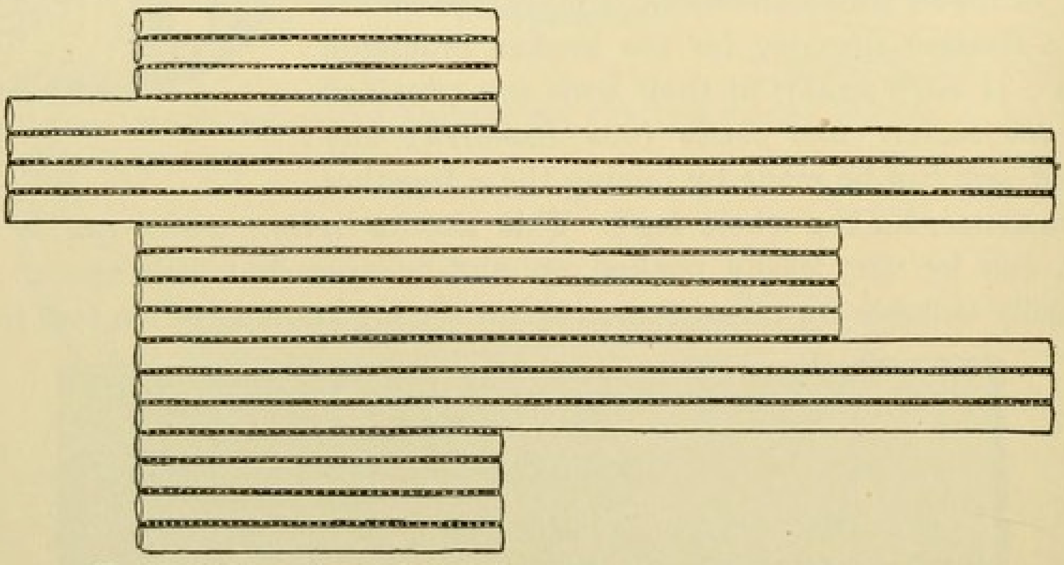


FIG. 143. SCHNYDER'S CLOTH SPLINTS FOR THE LOWER EXTREMITY

Schnyder's **cloth splints** consist of thin tablets of flexible walnut (veneer) from 2 to 2.5 centimeters wide and 3 millimeters thick, sewed closely side by side between two pieces of canvas or cotton cloth (Fig. 143).

Similar is *von Esmarch's* **splint material, which can be cut** (Fig. 144). It consists of two layers of material (stouts, shirting, canvas), between which

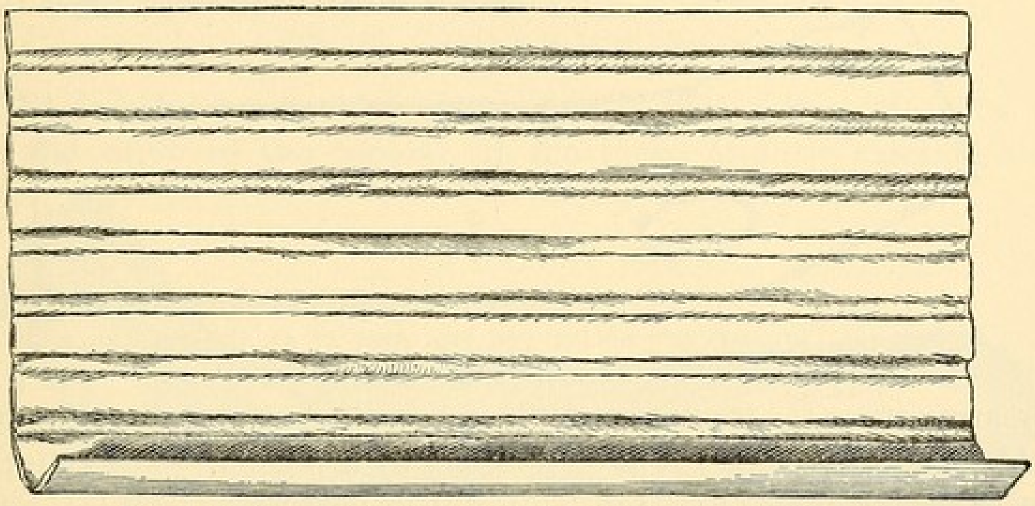


FIG. 144. VON ESMARCH'S SPLINT MATERIAL. (Can be cut)

thick paper strips are placed side by side at intervals of 5 millimeters and firmly agglutinated with silicious varnish, paste, or glue. This splint material is very light, can be made rapidly and inexpensively, can be cut with the scissors, and, rolled up, can be packed away in large quantities, since it requires but little space. As a temporary splint for transportation, it is very serviceable.

Stromeyer's **padded strips of wood** are very much used for injuries and diseases of the arm. They consist of light wood padded with cotton and covered with canvas or some waterproof material. The simple **board for**

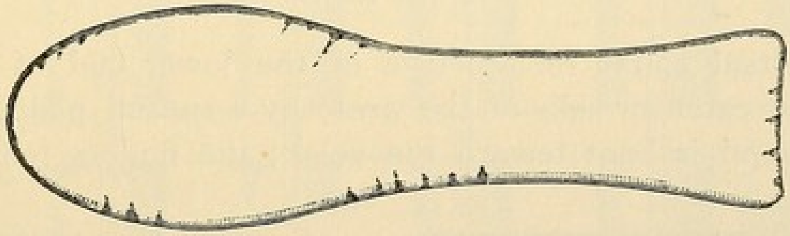


FIG. 145. STROMEYER'S HAND SPLINT

the hand (Fig. 145), to secure perfect rest for the hand and the fingers, is used everywhere, not only in fractures, but also especially in serious felon, phlegmonous inflammation, etc.

Nélaton's **abduction splint** (pistol splint) serves for fractures at the lower end of the radius.

First, the hand is fastened securely upon the anterior part of the splint; next, the splint is turned so that it comes in close contact with the forearm, to which it is fastened. The abducted position of the hand draws apart the two ends of the fracture, which lie one upon the other. The **splint for**

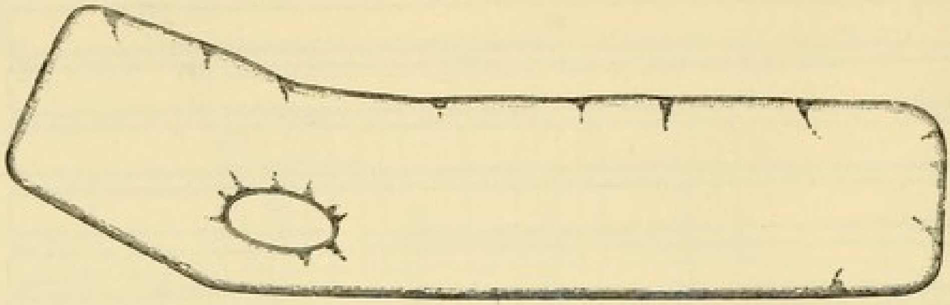


FIG. 146. STROMEYER'S SPLINT FOR THE ARM AT AN OBTUSE ANGLE

the forearm serves for fractures of the forearm when the elbow joint has to be held at a right angle; it is supported by a mitella. The **splint for the arm at an obtuse angle** (Fig. 146) is useful in contusions, sprains, inflammations of the elbow, where ice bags are to be employed, and where the patient is confined to his bed.

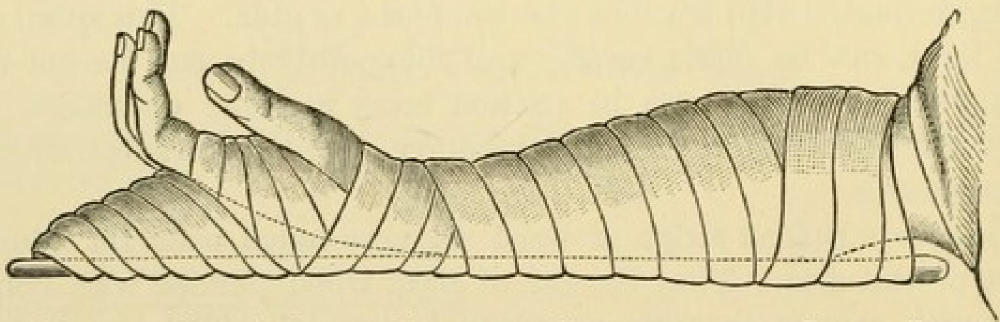


FIG. 147. ROSER'S DORSAL SPLINT FOR FRACTURE OF THE LOWER END OF THE RADIUS

Roser's **dorsal splint** for fracture of the lower end of the radius is applied on the extensor side of the arm; by a special padding, the dorsal part of the hand is bent toward the volar; the fingers remain free (Fig. 147).

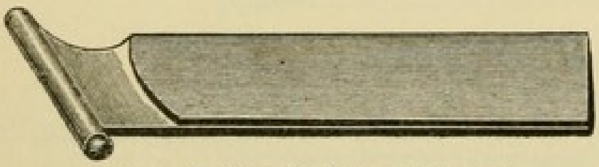


FIG. 148. CARR'S RADIUS SPLINT

Carr's **radius splint** has an excavation for the wrist, while the fingers, which remain free, grasp the transverse bar (Fig. 148).

Clover's **radius splints** (Fig. 149) are provided with an excavation for the wrist, and the part for the hand bent off at an angle.

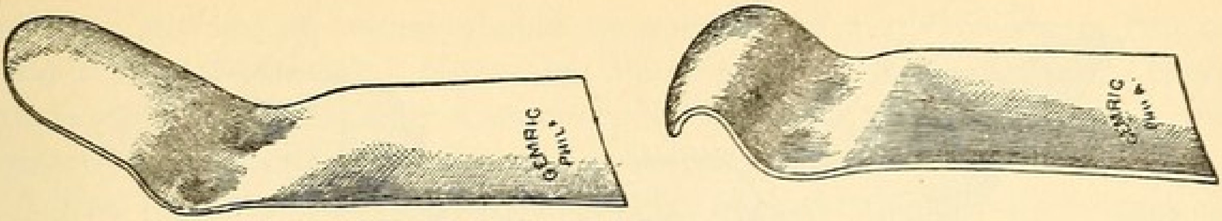


FIG. 149. CLOVER'S RADIUS SPLINTS

The **English hollow-moulded splints** (*Bell*, *Pott*, *Cline*) are very neatly carved and fitted to the contour of the limb; at their external surface,

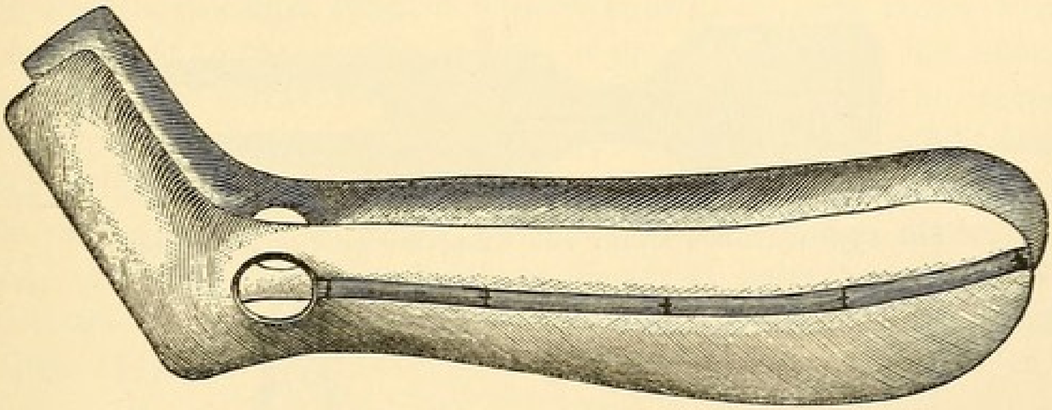


FIG. 150. BELL'S HOLLOW-MOULDED SPLINTS FOR THE LEG

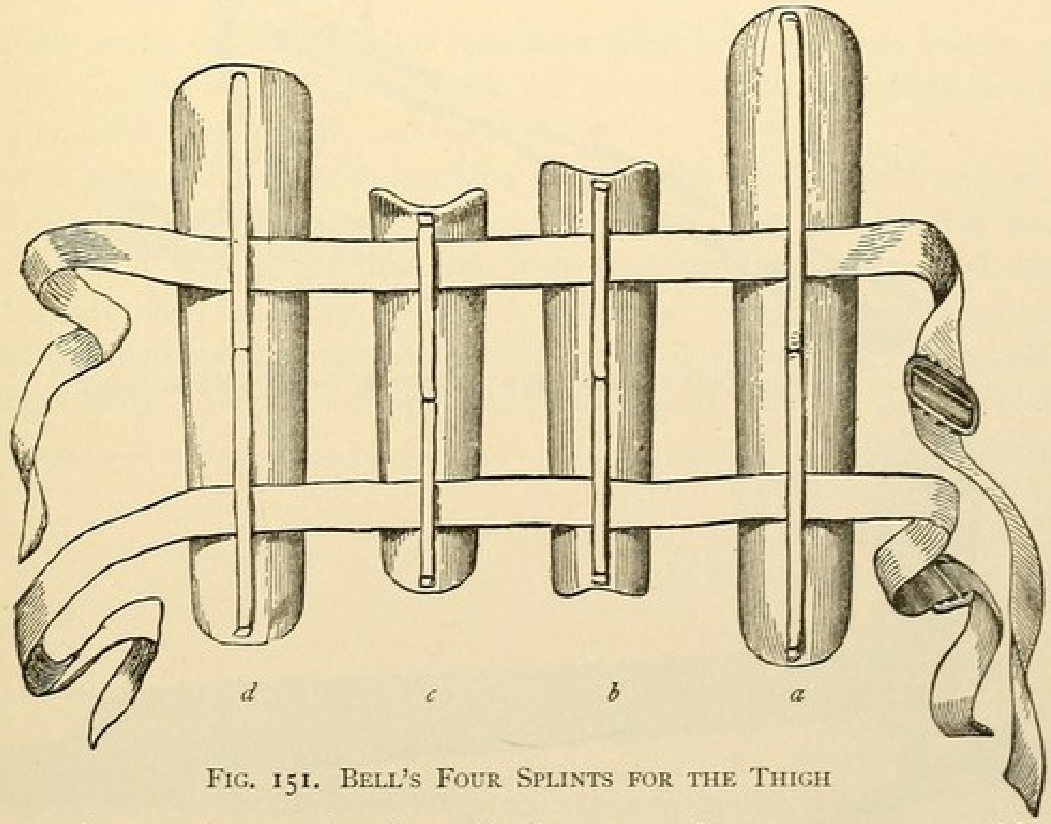


FIG. 151. BELL'S FOUR SPLINTS FOR THE THIGH

leather strips are fastened; through these are drawn straps provided with buckles, which serve for fastening the splints to the limb. The hollow

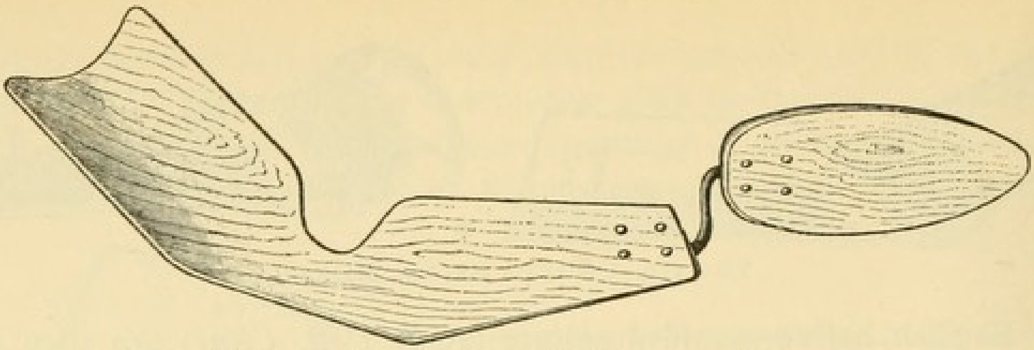


Fig. 152. Von Volkmann's Supination Splint

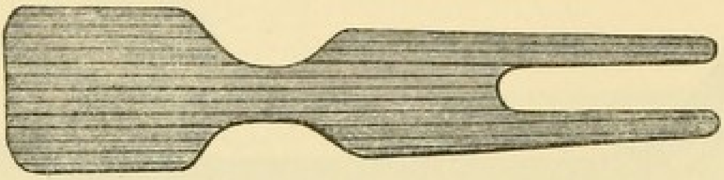


Fig. 153. Watson's Splint for Resection of the Knee Joint

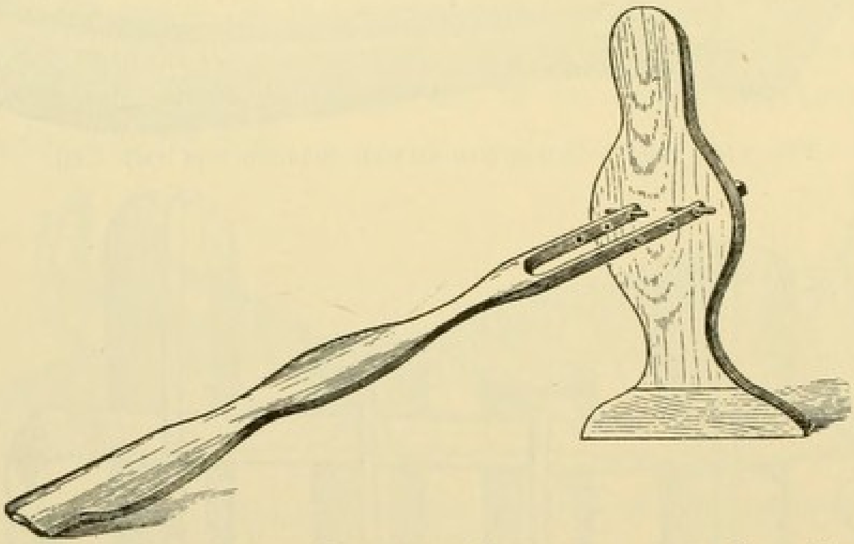


Fig. 154. Watson-Vogt's Splint for Resection of the Knee Joint

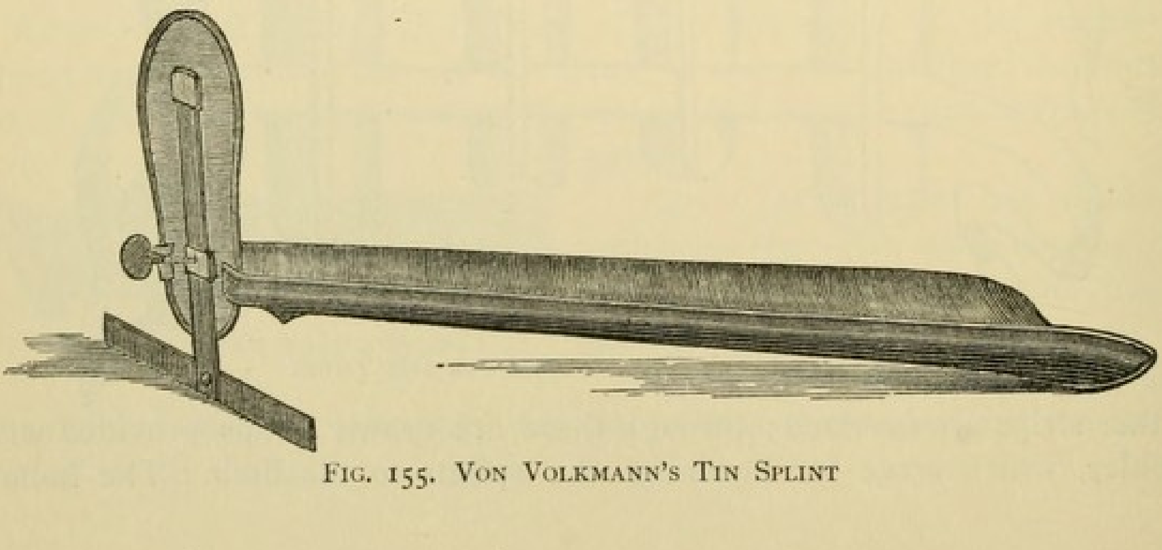


Fig. 155. Von Volkmann's Tin Splint

internal surface, of course, should be padded. Figure 150 shows two of *Bell's splints for the leg.* Figure 151 shows four *splints for the thigh;* these are so applied that *a, b, c, d,* come to lie on the anterior, the interior, the posterior, and the external side of the limb respectively.

Von Volkmann's **supination splint** (Fig. 152), suitable for all injuries of the forearm, is a wooden arm splint. The part for the hand is fastened at a right angle to its surface, so that the hand occupies a position halfway between pronation and supination.

Von Volkmann's **knee splint** is a short splint similar to Bell's (Fig. 151, *c*); it is fastened to the popliteal space in order to prevent the knee joint from moving after extravasations into the same, and in order to prevent the pressure of the applied bandages upon the vessels in the popliteal space.

Watson-Vogt's **splint for resection of the knee joint** (Figs. 153, 154) is suitable only for cases in which a more frequent change of dressings is required. It is applied with starch or plaster of paris bandages. In the normal course of wound-healing, *von Volkmann's* splint may be substituted for it (Fig. 155).

2. TIN SPLINTS

Splints made of **tinned sheet iron** have long been used as hollow splints, especially for the leg. For the arm, the lighter kinds of splints are better, especially when the patient can walk about.

Petit's **boot**, a flat, hollow-moulded splint, with a foot board and an opening for the heel, was improved by *von Volkmann;* he simplified it and provided it with a T-shaped adjustable iron foot support, to prevent the foot from turning over laterally. This **T splint** of *von Volkmann* is now used everywhere in the treatment of large wounds of the leg. It is a substitute for the numerous suspension and resection splints, since in cases which take an aseptic course, the bandages may remain in position for weeks until healing has been completed.

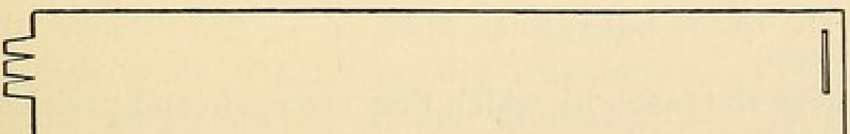


FIG. 156. SALOMON'S TIN SPLINT

In the Danish army, *Salomon* introduced flat splints of *thin* **tin plate,** 35 centimeters long and 10 centimeters wide. These have at one end two small projections, each divided in three parts; on the other end are two slits, into which these projections can be inserted and fastened by bending; in this way splints of any desired length can be easily and rapidly made (Fig. 156).

For immediate use, splints may be cut from **sheet zinc** by means of strong scissors. These may be bent with the hand and moulded to the

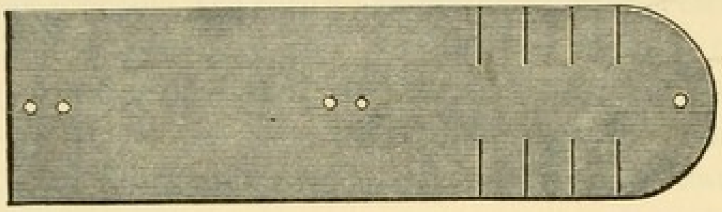


FIG. 157. SPLINTS OF SHEET ZINC

contour of the limb (Figs. 157, 158). Models for these splints were mentioned by *von Hoeter*, *Schoen*, *Port*, and others.

We must mention here also *Lee's* flexible, perforated, nickel-plated *metal splints*. They adapt themselves well to any flexion of the surface of the body, and are, moreover, light, durable, and inexpensive. Still lighter would be **splints of aluminium**, which, on account of the growing cheapness of the metal, will probably soon be in general use.

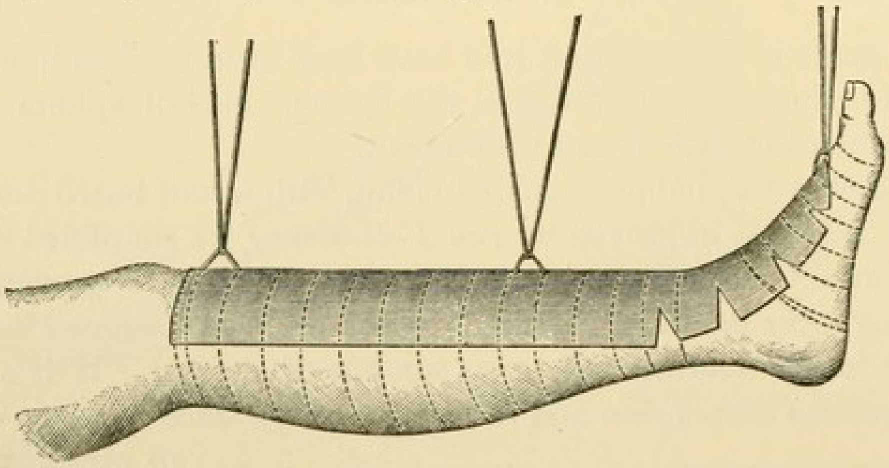


FIG. 158. SPLINTS OF SHEET ZINC

Tin splints, on account of the ease with which they are made and packed, aside from their great cleanliness, are especially suitable for military use; also, in time of peace, they are in great favor on account of their practical adaptation. They are surpassed, however, by

3. WIRE SPLINTS

These have the following merits: they are very light and clean; they allow every infection of the dressing to be noticed at once; they do not prevent the secretions from evaporating; and they hold the bandages in place better than smooth tin.

Roser has mentioned several splints of **iron wire**. Figure 159 shows one for the leg. More recently, other models of **tinned wire** have been used

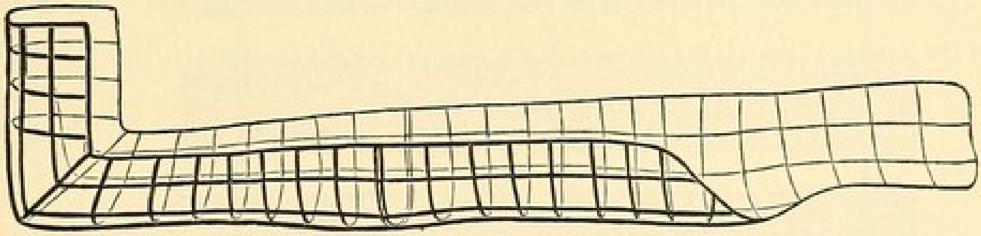


FIG. 159. ROSER'S WIRE SPLINT FOR THE LEG

more extensively (*e.g.* Fig. 160). *Cramer's* **flexible wire splint** (Fig. 161) is most excellent and is applicable for all purposes. It consists of strong

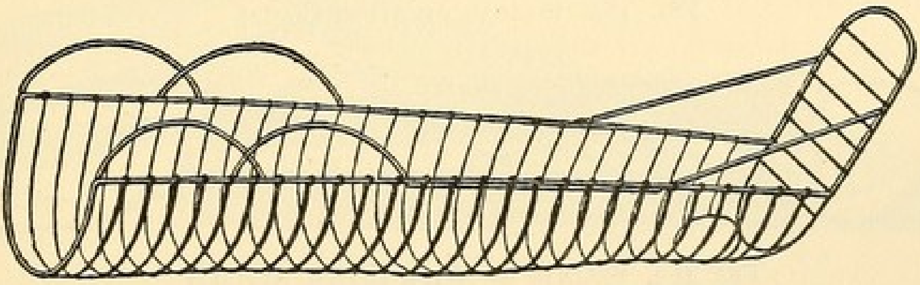


FIG. 160. WIRE SPLINT FOR THE LEG, WITH HANDLES FOR SUSPENSION

tinned wires, between which finer wires have been stretched, like the rounds of a ladder. The several pieces can be fastened in front one above another; they can be bent on the flat and on the edge; wherever desired, openings can be made by breaking out several of the thin wires; or thinner portions can be formed by bending the wires — in short, there is no form of a splint which could not be rapidly extemporized with *Cramer's* splint. Moreover, it is light, clean, and elegant.

Almost as useful are the splints of **wire cloth** (*von Esmarch*) (Figs. 162, 163), which are light, inexpensive, and flexible.

Splints of telegraph wire (*Porter*) probably will not be used so frequently

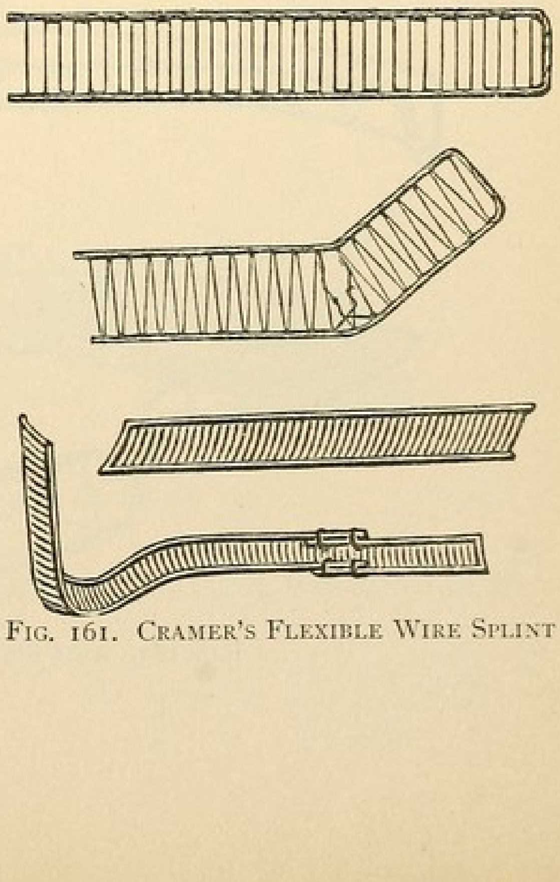


FIG. 161. CRAMER'S FLEXIBLE WIRE SPLINT

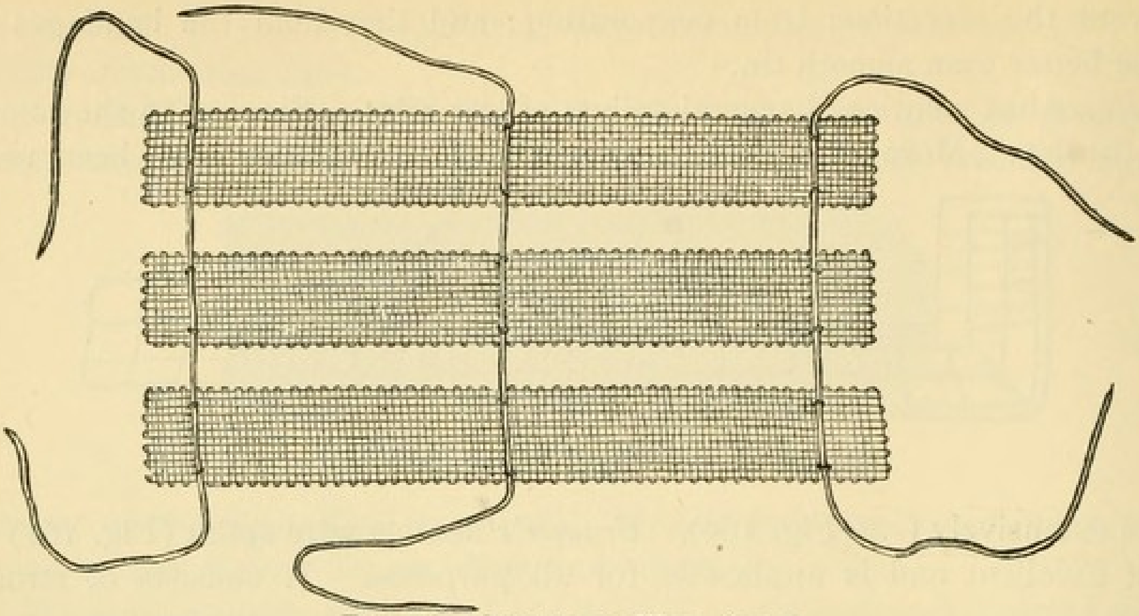


FIG. 162. SPLINTS OF WIRE CLOTH

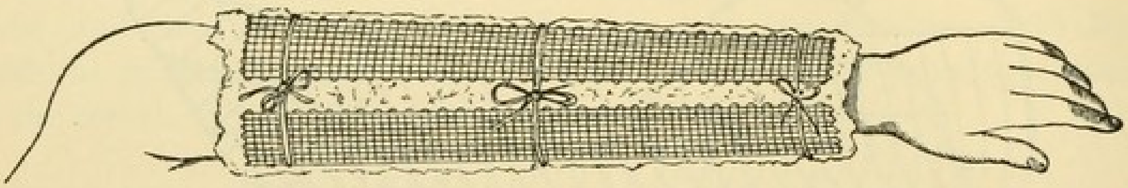


FIG. 163. SPLINTS OF WIRE CLOTH APPLIED

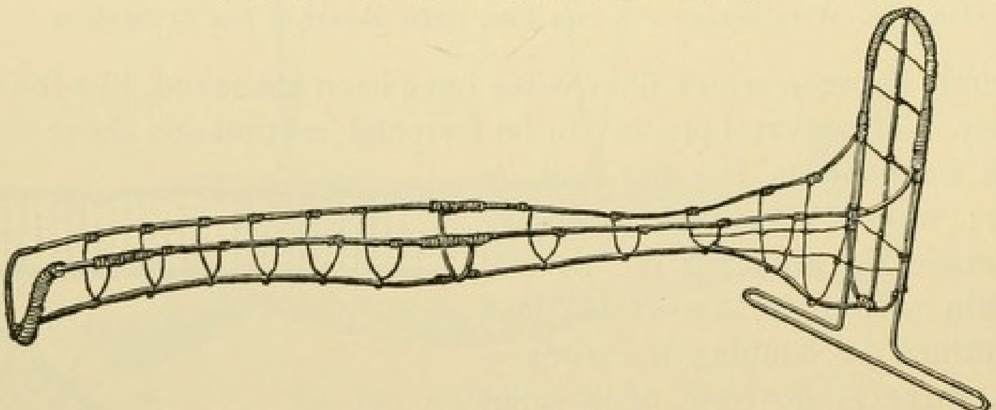


FIG. 164. LEG SPLINT OF TELEGRAPH WIRE WITH FOOT SUPPORT

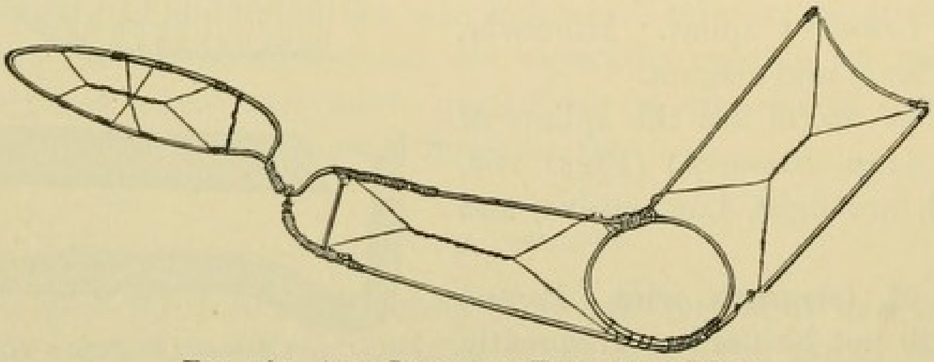


FIG. 165. ARM SPLINT OF TELEGRAPH WIRE

in the future, because the telegraphic circuits are now made with cast bronze wires, which cannot be so well bent. With telegraphic wire, the most common wood and tin splints can be very well substituted, but the making of such splints is always laborious and requires time and especially practice. Figures 164 and 165 show some splints which are frequently used, but for which the wire splints described above may be substituted more easily and inexpensively.

4. GLASS SPLINTS

The splints for the arm and the leg mentioned by *Neuber*, made of thick cast glass, are very clean and, to a certain degree, aseptic; they also allow

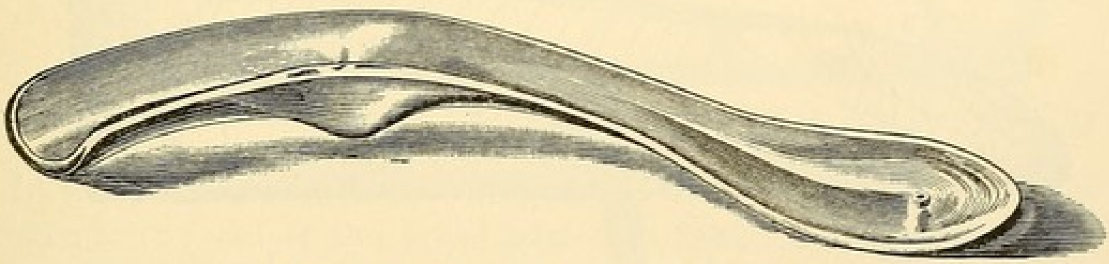


FIG. 166. NEUBER'S ARM SPLINT OF GLASS

the smallest infection or penetrating secretion to be recognized at once; but they have the disadvantage of being heavy, very expensive, and fragile.

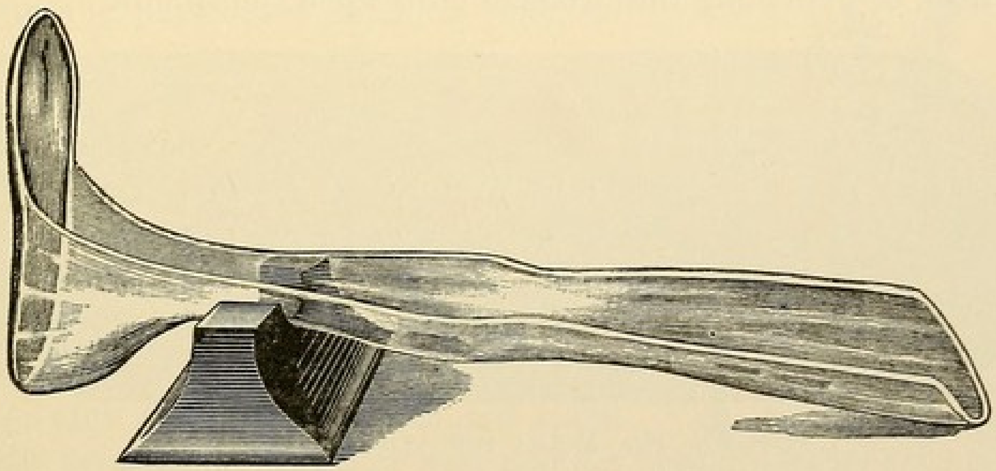


FIG. 167. NEUBER'S LEG SPLINT OF GLASS

In large and rich hospitals they may be of advantage. Figures 166 and 167 show glass splints for the arm and the leg.

5. SPLINTS OF PASTEBOARD

From **thick gray pasteboard**, splints of any desired form can easily be cut with a sharp knife; the straight edges in which the splint is to be bent to form a groove must be sufficiently incised from the outside with a knife,

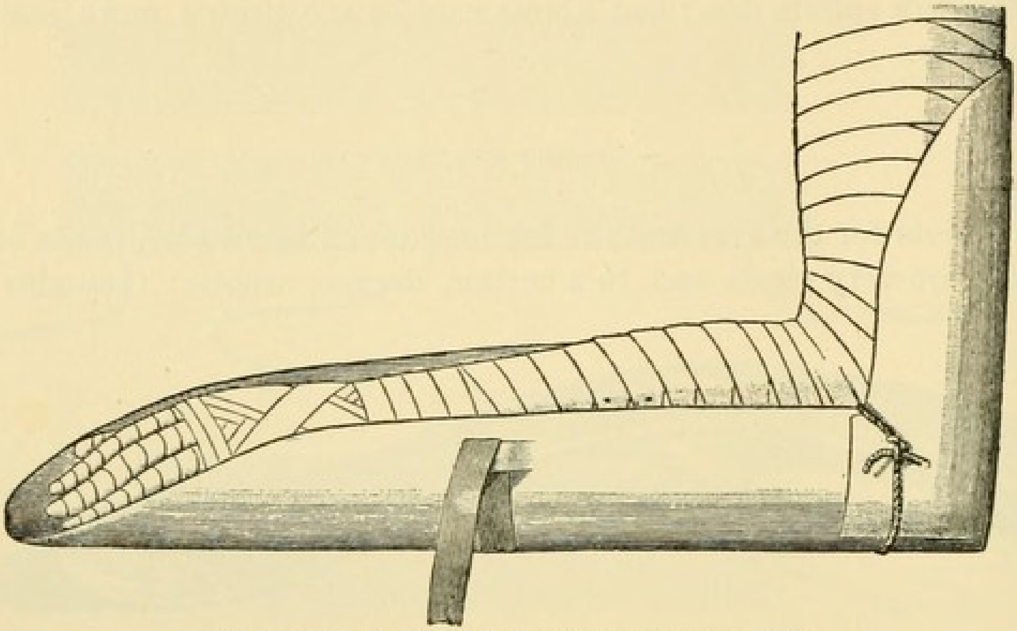


FIG. 168. PASTEBOARD SPLINT FOR THE ARM

so that the edge can be turned over evenly. If the pasteboard is strong enough, the splints have sufficient power of resistance; this, however, may be increased by painting the pasteboard with glue, silicious varnish, or linseed varnish, or by nailing thin wooden laths upon the splints.

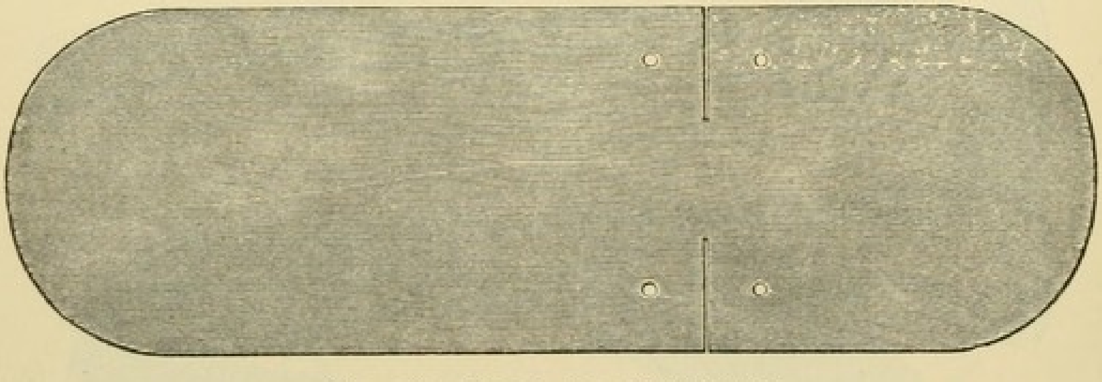


FIG. 169. MODEL FOR ARM SPLINT

Pasteboard is used especially for fixation of the arm.

Figure 168 shows a **pasteboard splint for the arm**, which is very practical for all injuries of the elbow joint, forearm, and wrist; it can be easily and quickly made from the model (Fig. 169), either as a semicircular or as an angular tube. In wounds on the palmar surface of the hand with injuries of the tendons and nerves (after the ends have been sewed), the end of the splint projecting beyond the hand is bent upward like a cap and holds the hand in supination bent toward the volar side (Fig. 170).

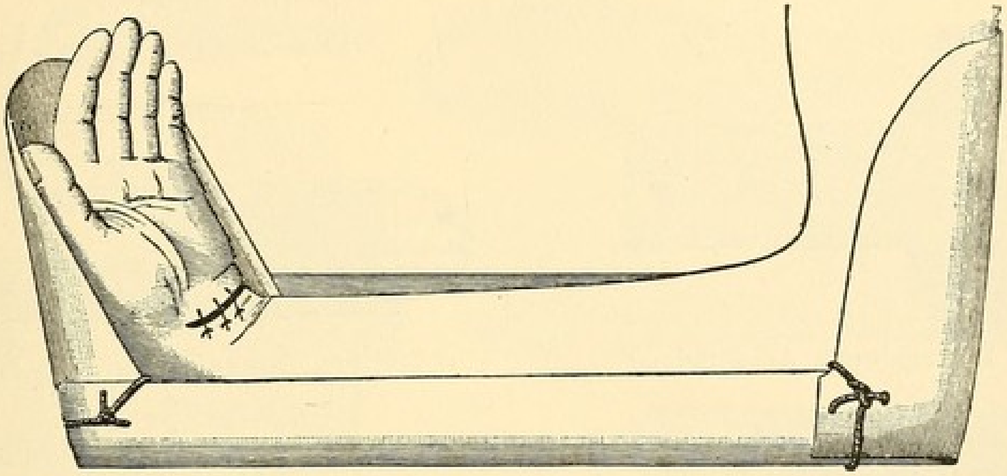


FIG. 170. PASTEBOARD SPLINT FOR INJURIES ON THE VOLAR SIDE OF THE WRIST

In fractures of the humerus, especially at its upper end, it is advisable to make at one end of the broad pasteboard splint four longitudinal cuts at equal intervals. The five small projections thereby formed are bent over the shoulder in the form of a **cap,** and the whole is fastened with a spica humeri (Fig. 171).

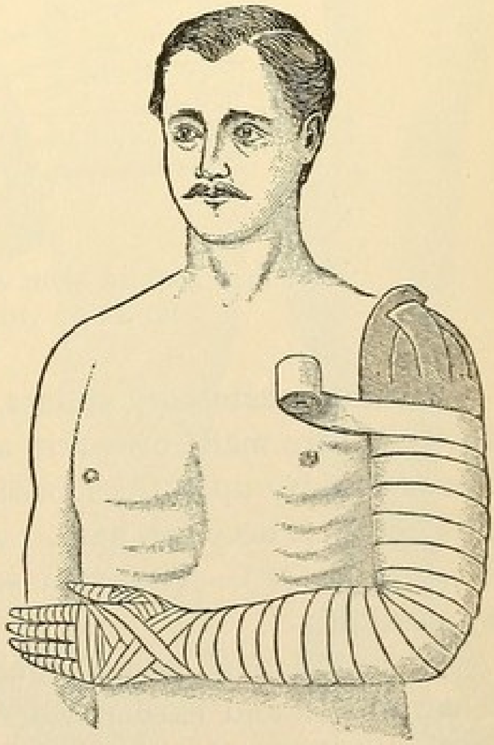


FIG. 171. PASTEBOARD SPLINT FOR FRACTURES OF THE HUMERUS

In fractures of the lower end of the humerus, the pasteboard splint is sufficient (Fig. 168).

The **alar splint**, according to *Dumreicher* (Figs. 172, 173), is an excellent method of fixation for fractures of both bones of the forearm, since by it the forearm is held in a half-pronated position with the elbow flexed, whereby as satisfactory a healing of the two injured bones as possible is obtained. One rectangular pasteboard splint is firmly pressed to the volar and another to the dorsal side of the half-supinated forearm; and for fastening them, a narrow splint provided with square alar processes is applied to the ulnar side. The whole dressing is fastened with bandages. By means of the pressure of the lateral splints upon the muscles, the bones which run parallel to each other are forced apart at the places of fracture. Without them (for instance, upon a common pasteboard splint, in full pronation) the ends of the bones would be

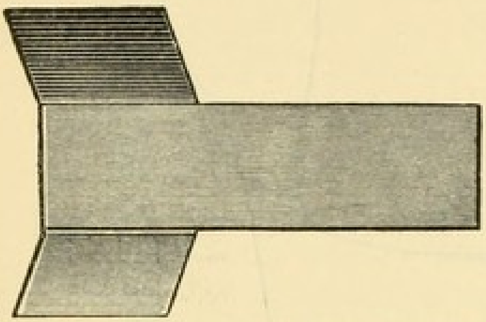


Fig. 172. Dumreicher's Alar Splint

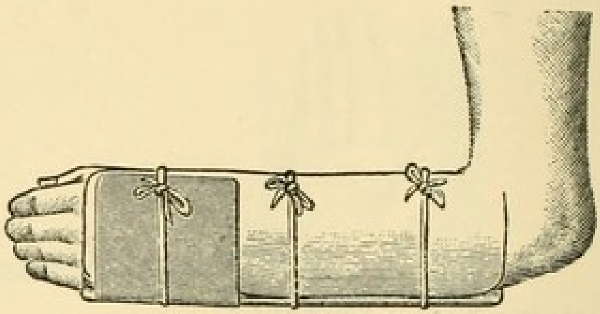


Fig. 173. Dumreicher's Alar Splint

forced by a circular bandage in the direction of the intra-osseous space, and would either heal together in the shape of an X, or perhaps cross each other completely (Fig. 174). The method described above should be followed in applying all the other splints for the forearm.

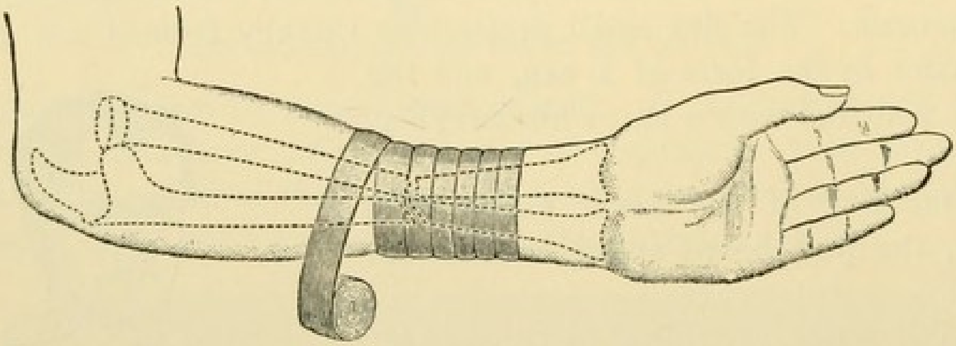
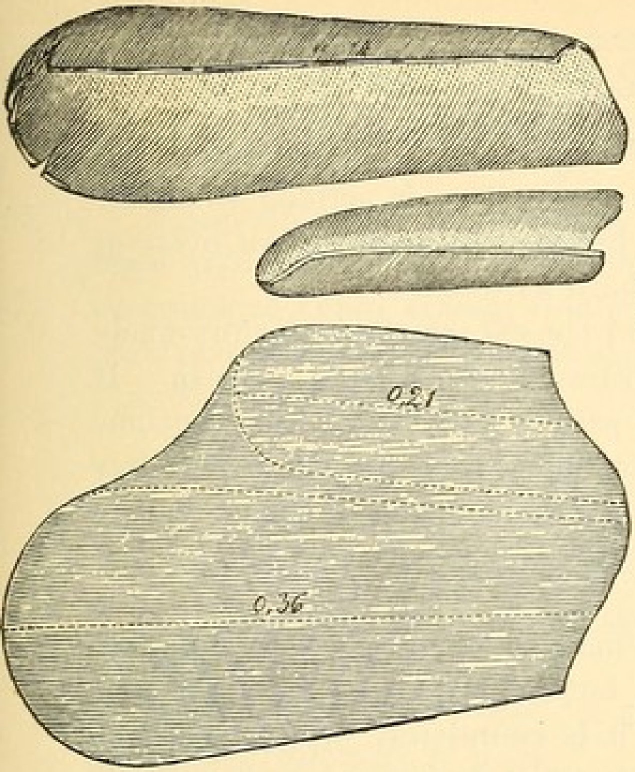


Fig. 174. Danger from a Circular Bandage in Fractures of both Bones of the Forearm (according to Albert)

Moulded pasteboard splints, which can be well applied to the contour of the body, are made over arm and leg models. The moistened pasteboard is allowed to dry upon the model, and is afterward painted with varnish; by this means it becomes hard. *Merchie* has recommended such bivalve splints (Figs. 175–178). They may serve as **models for all splints that can be made by moulding.**

More practical, however, are materials so prepared that they will soften when heated and harden when rapidly cooled. Packed in flat sheets, they occupy little space; and, cut to the required size, they make accurately fitting splints for the patient.



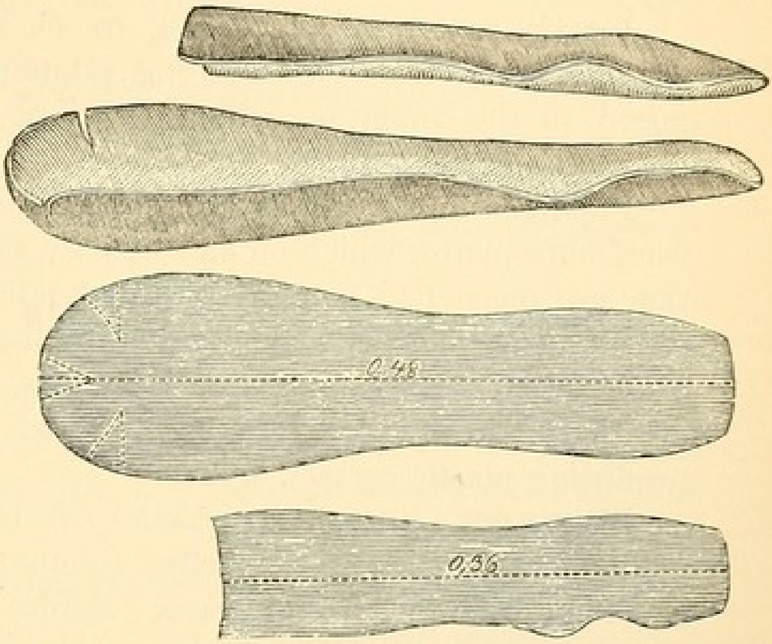
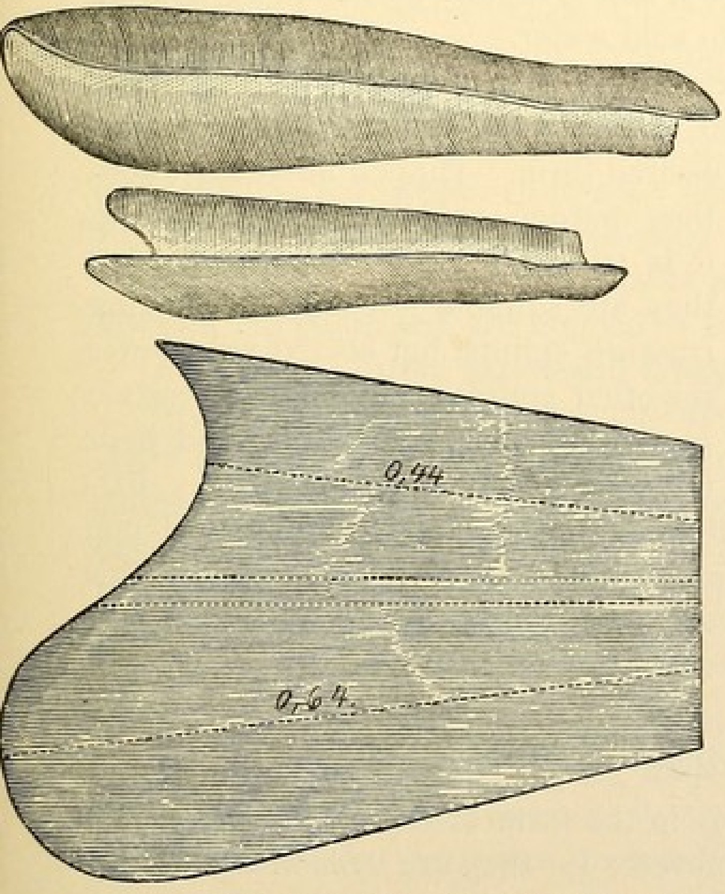


Fig. 175. Merchie's Models for Plastic Splints for the Arm. Fig. 176



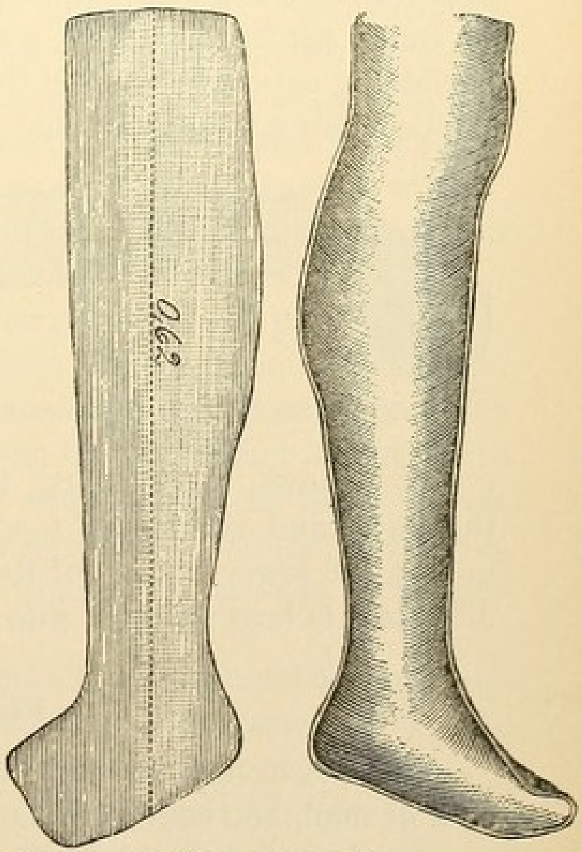


Fig. 177. Merchie's Models for Plastic Splints for the Leg. Fig. 178

These are called: —

6. PLASTIC SPLINTS

Plastic pasteboard, according to *P. Bruns*, is obtained by saturating common pasteboard with a strong solution of shellac; it softens when exposed to the vapor of boiling water or by the dry heat of the oven or hearth, and after a short time becomes as hard as wood.

Plastic cellulose sheets (*R. De Fischer*) consist of thick, factory-made wood-fibre plates, which on one side are saturated with silicious varnish. If they are moistened on the varnished side with boiling water, they become soft and can be exactly moulded to the limb, and rapidly become firm; they are fastened with moist gauze bandages, the moistened side being placed exteriorly. *Glued* cellulose sheets (*Hübscher*) are especially suitable for producing plastic corsets.

Plastic felt (*Bruns*), *poro-plastic felt*, is made of common thick sole felt, painted with an alcoholic shellac solution until it is completely saturated; it is then dried in a warm place. Before it is completely dry, it is ironed and smoothed with a hot flat-iron. Dry or moist heat renders it soft; in this condition, it is moulded to the body, and is rapidly hardened by pouring cold water over it or by dipping it into cold water.

Gutta percha sheets (2–3 millimeters thick) may likewise be rendered flexible by carefully dipping them into hot water at 190° Fhr., so that they can be easily cut and moulded in the desired form. Dipped into cold water, they harden rapidly. These splints, it is true, are rather expensive; but they are suitable not only for making fracture splints, but also as substitutes for other splints mentioned for certain purposes, which, having fulfilled their indication, may again be used. Figure 179 shows, for instance, the **radius splint** according to *Schede*. Upon this the hand rests bent toward the volar and ulnar sides; and by this means, the lower portion of the fracture of the radius, displaced in an upper direction, is best replaced into its natural position.

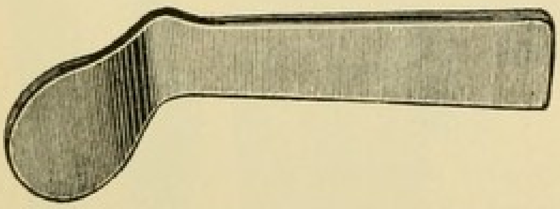


FIG. 179. SCHEDE'S RADIUS SPLINT

PLASTIC DRESSINGS

These surround the limb *completely* in the form of *a firm capsule*, like a coat of mail, and cannot be easily removed; for they are "*inamovible*." By a special procedure, however, during their application, viz. by dividing or separating them, they can be made "*amovible*"; hence, as may be deemed necessary, the limb can either be made freely movable or be fixed in the dressings in an immovable position. The dressings are "*amovo-inamovible*" (*Seutin*).

Fixed dressings of materials that become resistant by hardening have been used for a long time; the procedure, however, in most cases was very complicated (gum arabic, albumen, adhesive plaster, etc.) until starch and plaster of paris were introduced. These essentially simplified the application of such bandages.

THE STARCH DRESSING

was invented by *Seutin* (1840).

Preparation of the starch: Stir starch with *cold* water until an even mass is formed; while stirring it continuously, add sufficient *boiling* water to form a clear thick paste.

Starch bandages consist of strips of shirting drawn through the fresh paste and rolled.

Starch splints are made of strips of pasteboard which are quickly drawn once through hot water; then starch is applied thickly on both sides.

Application of a starch dressing. The limb is first very carefully wrapped with a moist flannel bandage, after the depressions about the joints have been padded with cotton. Over this, a starch bandage is applied, and upon this the soft starch splints are laid and fastened with a starch bandage. Finally, the whole dressing is covered with a dry cotton or gauze bandage.

Instead of the bandages, **strips of paper** may be used. These are drawn through the paste and are applied in the manner of a *Scultet's* bandage.

Burggräve's **cotton pasteboard dressing** is very simple and practical.

Splints of pasteboard are cut according to the contour of the limb. After starch is applied to them, a layer of cotton is placed on one side. The splint is applied with the cotton side next to the limb, to which it is securely fastened with muslin bandages commencing with serpentine turns. Over the muslin bandage, starch paste is liberally applied either with the hands or with a large brush; and finally the whole dressing is covered with a dry calico bandage.

It takes from two to three days for the starch bandage to become perfectly dry and hard; the drying may be accelerated by exposure or by the heat of the sun or the oven.

To make the dressings *removable*, they are divided throughout their whole length with a pair of strong scissors; the capsule is bent apart, and calico bandage strips, painted on one side with starch, are pasted over the margins of the cleft. Next, the dressing capsule is again applied and fastened with a few straps provided with buckles (Fig. 180).

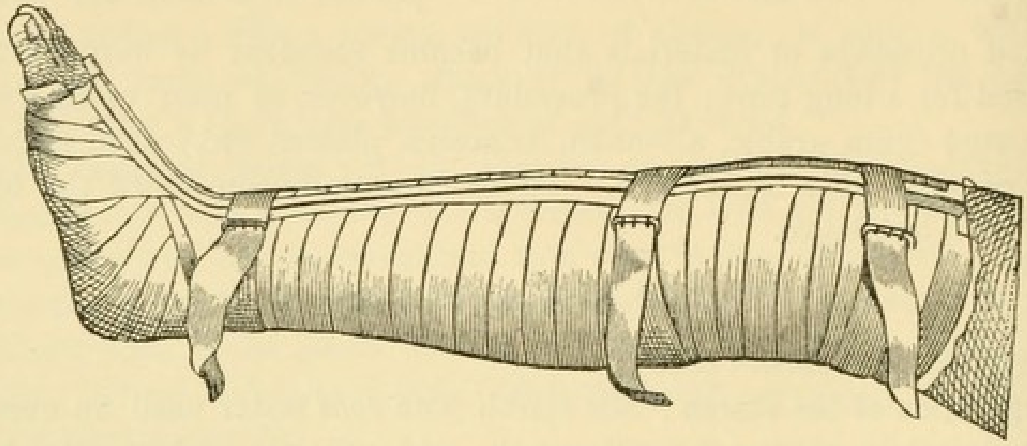


FIG. 180. DIVIDED STARCH DRESSINGS

Of similar construction is the **glue dressing** (*Veiel, Bruns*) in which, instead of starch, common *carpenter's glue* is used for saturating the bandages and the splints; glue dries more rapidly than starch. It is still more difficult to make **gum arabic chalk dressings** (*Bryant, Wölfler*) with a mixture of gum arabic paste and chalk, and **paraffin dressings** (*Lawson, Tait*). The **tripolith dressing** was recommended by *von Langenbeck;* tripolith is an ash-gray powder, used like plaster of paris powder. It has, however, this advantage: it is not spoiled by the addition of water, it hardens more rapidly, and furnishes light porous dressings.

POTASH SILICATE DRESSINGS

If bandages are saturated with a freshly prepared concentrated solution (old solutions irritate and cauterize the skin) of neutralized **potash silicate** (K_2SiO_3), of a specific gravity of 1.35–1.40 (*Böhm*), they can be used for dressings that become perfectly firm and hard, as soon as the water has evaporated.

For accelerating the hardening, it is best to add to the potash silicate finely pulverized chalk or a mixture of slaked lime, $Ca(HO)_2$ and chalk (1 : 10 — *Böhm*), magnesite (*König*), or cement (*Mitscherlich*). The paste thus becomes as thick as honey. Into it, the bandages are dipped, or with it the applied bandages are painted with a large brush. Finally the whole dressing is sprinkled and rubbed with the dry powder. If a little alcohol is applied over it with a brush, a hard glasslike surface is formed. The potash silicate dressings are distinguished especially for their great *lightness*; but, since they need several days to harden completely, they are not generally used.

PLASTER OF PARIS DRESSING

was invented in 1852 by *Mathysen*. It has over all others the advantage of becoming hard and firm in the shortest space of time.

Plaster of paris cream is best **prepared** in a porcelain dish by mixing equal quantities of plaster of paris and cold water under constant stirring, until the mixture has the consistency of *thick cream*. It hardens into a compact mass in about 5 to 10 minutes. The better and finer the plaster of paris powder, the more rapidly the mass hardens. *Alabaster gypsum* is excellent.

If the setting of the plaster is to be *delayed*, more water is used, or a little starch, glue, gum arabic, dextrine, milk, beer, or borax is mixed with the water.

If the setting is to be *hastened*, less water, — or better, hot water, — is used, or some salt, alum, lime water, potash silicate, or cement powder is added.

If the *plaster* has been *spoiled* by absorbing water from the air, it can be *made serviceable again* by *heating* in an open pan, until it no longer yields watery vapors.

Plaster of paris dressing can be **applied** in various ways: —

1. **Strips of plaster of paris bandage**: *strips of bandage material*, dipped into the plaster of paris cream, are (like *Scultet's* bandages) directly applied around the limb, previously lubricated with oil or vaseline, or shaved (*Adelmann*).

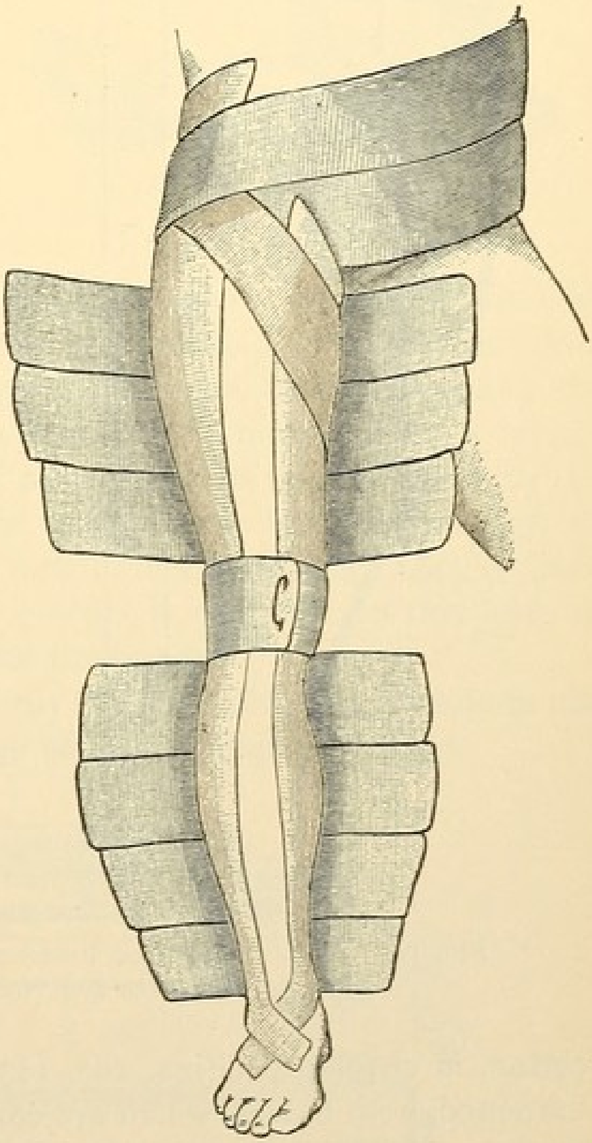


FIG. 181. STRIPS OF PLASTER OF PARIS BANDAGE (according to Pirogoff)

Instead of bandage strips, cut up pieces of *old clothing* (woollen stockings, drawers, undershirts, etc.), or coarse sackcloth may be used; these absorb a great deal of the plaster of paris cream (*Pirogoff* — Fig. 181).

2. **Plaster of paris compresses.** The plaster of paris cream is spread between two pieces of linen or cotton cloth, connected in the middle by a longitudinal suture; with this, the limb, wrapped with a roller bandage or

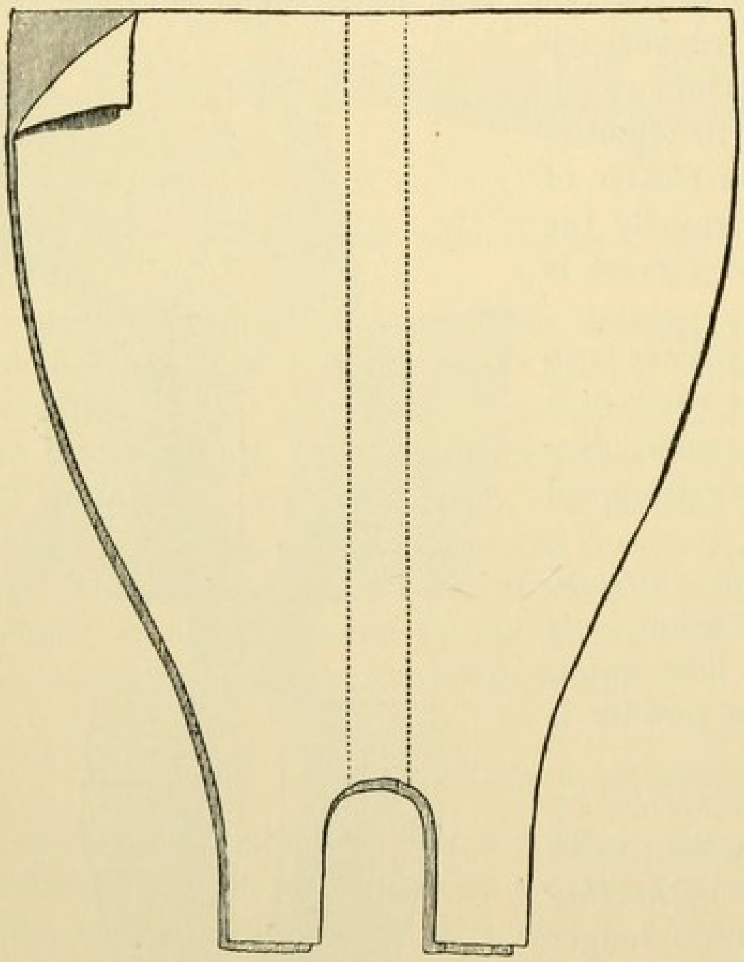


FIG. 182. DOUBLE PIECES OF LINEN FOR PLASTER OF PARIS COMPRESSES FOR THE LEG

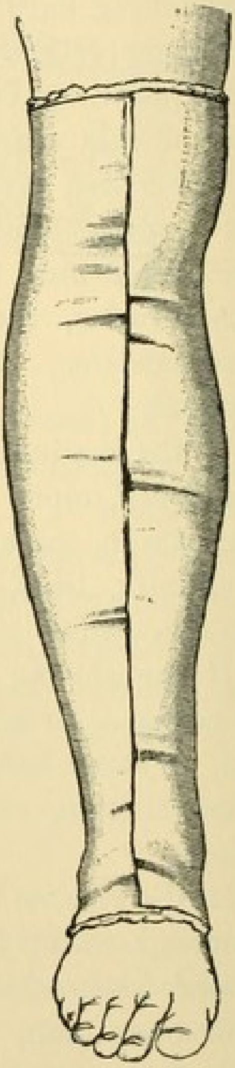


FIG. 183. PLASTER OF PARIS COMPRESS

cotton, is enveloped (Figs. 182, 183). As soon as the plaster of paris has hardened, both halves, which are connected posteriorly by the suture, may be turned aside, exposing the injured place.

In modern times, this kind of plaster of paris dressing, which was formerly very rarely employed, has come into more frequent use through *Fickert's* **plaster of paris plate dressings** and *Breiger's* very practical **plaster**

of paris cotton, which is made in factories and is saturated with plaster of paris powder. The pieces are merely dipped in hot water and fastened to the limb. After eight or ten minutes they become fixed and hard. This is the cleanest manner of applying a plaster of paris dressing, and is, therefore, suitable for making plastic plaster of paris splints (see page 120).

5. **Plaster of paris bandage.** This bandage is, so to say, the model for all plastic dressings; it is the most frequently used, and, for that reason, will

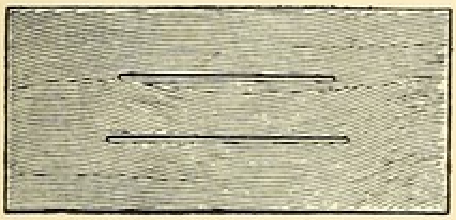


FIG. 184. BOARD FOR MAKING PLASTER OF PARIS BANDAGES

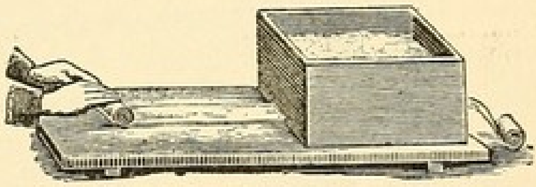


FIG. 185. BEELY'S PLASTER OF PARIS BANDAGE MACHINE

be described more minutely. Over a bandage properly applied to the limb and the bony prominences well protected by cotton, plaster of paris bandages are applied in four to six thicknesses; for hastening the hardening, the whole dressing is finally covered with a layer of the plaster of paris cream.

For the sake of economy, **plaster of paris bandages** may be made by the surgeon himself. Place the end of the head of the bandage through an upright small board provided with two longitudinal slits (Fig. 184), in front of which a quantity of plaster of paris powder is heaped. In this heap of plaster of paris, roll up the bandage with the fingers.

This can be accomplished more rapidly if the bandages are made in one of the numerous **plaster of paris bandage machines** (Figs. 185, 186).

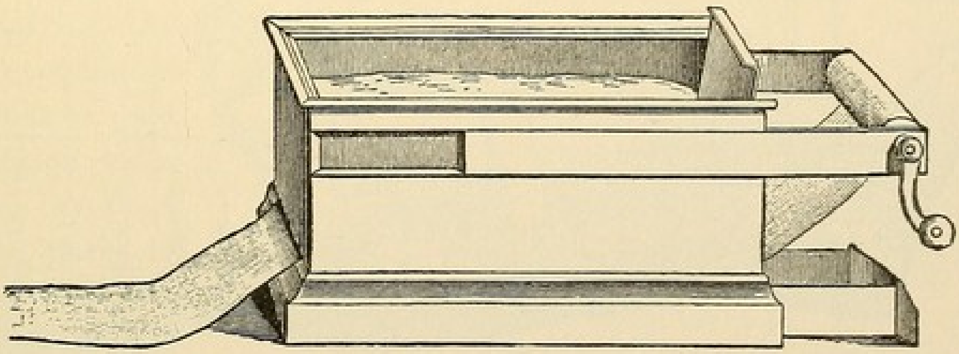


FIG. 186. WYWODZOFF'S PLASTER OF PARIS BANDAGE MACHINE

For plaster of paris bandages (starched), *gauze bandages* (starch-organtin bandages) are used almost exclusively. Plaster of paris bandages and plaster of paris powder are kept together in a *tin box* in the middle of which the above-mentioned board separates the powder from the bandages (Fig. 187).

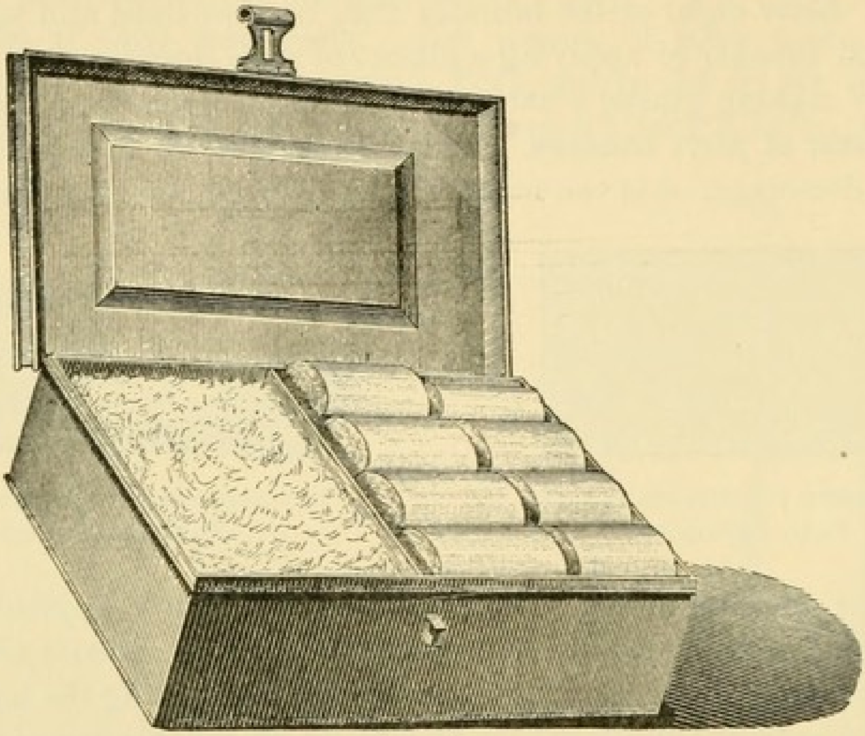


Fig. 187

The plaster of paris bandages made in *factories* are essentially cleaner, but are more expensive; they can be purchased singly, neatly packed in pasteboard or tin boxes.

Plaster of paris bandages are rarely applied over the bare skin. For *padding* the limbs, *cotton bandages* are used as a protection for the limb. If the layers are too thick, the dressings become too cumbersome. It is best to take apart the agglutinative cotton bandages lengthwise and by their

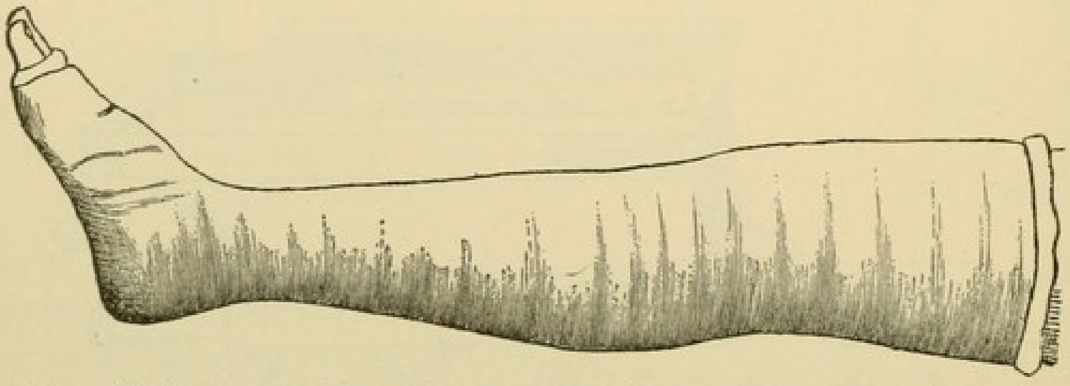


Fig. 188. Plaster of Paris Bandage with Cotton Bandages for Padding

surface, and to apply the halves with the agglutinated side outward (Fig. 188). Dry muslin or flannel bandages are just as suitable.

Application of plaster of paris bandages. Immediately before using the plaster of paris bandage, immerse it in a basin of water until it is completely covered. When all air bubbles have escaped from the bandage, take it out, squeeze it lightly, and commence the bandaging. To prevent constriction, a plaster of paris bandage must be drawn **not too** tightly; for after drying it contracts somewhat. As few reversed turns as possible are made, since too many would produce unevenness in the thickness of the dressings; technical application is avoided; the bandage is applied in spiral tours ascending slowly from below upward; care must be taken that the bandage does not *gape* and does not compress with one margin. For making the dressings everywhere uniformly thick, considerable practice is required; it is best to use as broad bandages as possible (10–15 centimeters); with small bandages an unevenness cannot well be avoided. If, in spite of all care, a place too thin is discovered, the defect can be *remedied* by pasting over it correspondingly long strips of bandage, covering each other completely.

A dressing applied with bandages dries rather *slowly*. In most cases, therefore, it is advisable to apply a layer of plaster of paris cream over the dressings; stir plaster of paris with hot water into a rather thin mass, apply it rapidly and everywhere uniformly. Before it sets completely (which occurs rapidly), it is well to give a good appearance to the surface of the dressing by smoothing the bandages with the hands, which have been dipped in warm water. Any small unevenness is filled with plaster of paris powder, rubbed in with moist hands. If the dressing has hardened, it may be *polished* with a smooth piece of metal (handle of a knife, etc.), while the water is still evaporating; it thereby becomes more durable and the color does not come off.

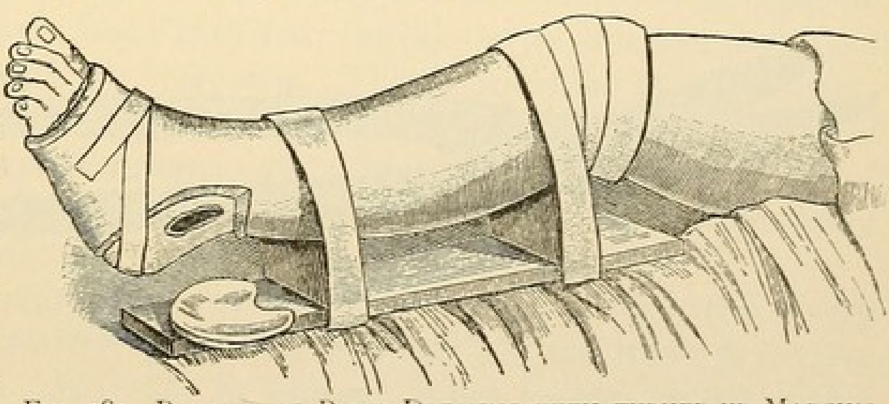


FIG. 189. PLASTER OF PARIS DRESSING WITH TURNED-UP MARGINS

In applying the dressing, especial attention must be paid to **the margins,** since there the layer of plaster of paris in most cases is thin, and hence easily crumbles off. It is most advisable and practical to allow the under layer (cotton, bandages) to project somewhat from under the layer of plaster of paris. After the dressing is finished, these projecting margins are turned up like a *cuff* and fastened upon the plaster of paris with a plaster of paris bandage or some plaster of paris powder (*Ris, Billroth* — Fig. 189).

The **drying of the dressings**, after they have set, requires time of varying length. It is best to leave them *uncovered*, so that the water can evaporate; wherever it is possible, the drying can be accelerated by the heat of the sun or of an oven (or by fanning).

If **cracks** occur in the fresh dressings from awkward movements during transportation or from restlessness of the patient, they should be rapidly cemented by applying a very *thin* plaster of paris cream, which enters deeply into the cracks.

If the dressings are to be made *waterproof*, they are painted, when completely dry, with linseed oil varnish, damar varnish, copal varnish, etc.

For **removing a plaster of paris dressing**, it is best to make a *furrow* in the uppermost layer with a strong short knife (Fig. 190), and to deepen it

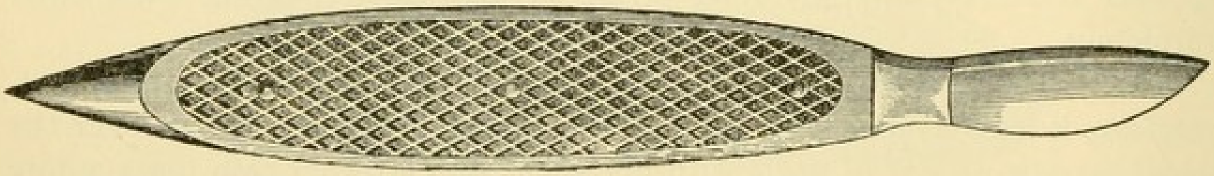


Fig. 190. Plaster of Paris Knife

with the cone-shaped sharp point on the handle by moving it to and fro until the layer of dressings is reached; this is carefully divided with a pair of strong scissors with long arms (Fig. 191). The capsule is then bent apart and the limb is lifted out. The furrow may also be irrigated with strong *brine*, from which plaster of paris quickly softens, and the layer of

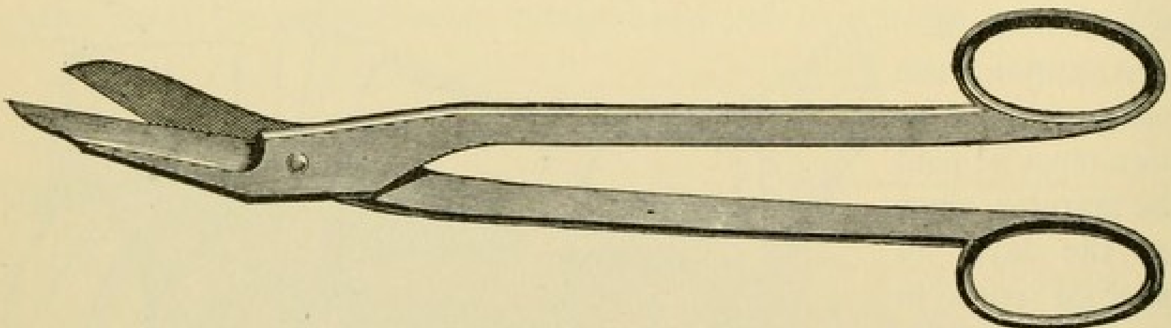


Fig. 191. Plaster of Paris Scissors

bandages can be more easily divided. The desired end is obtained most rapidly, however, by striking the dressings with the point of a slender *hammer;* the strokes should not be conducted vertically, but as *obliquely* as possible (tangentially) in order not to cause pain to the patient. If the capsule of plaster of paris is so thick that it can be bent apart to the required width only with great difficulty, a flat groove is chiselled on the opposite side; in this groove the capsules can move as on a *hinge*.

Moreover, instead of a hammer, a small flat saw (*plaster of paris saw*) may be used for obtaining smoother margins for the cut.

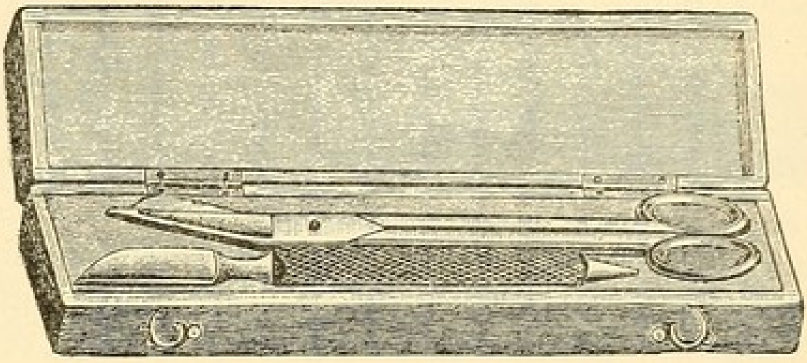


FIG. 192. CASE CONTAINING PLASTER OF PARIS KNIFE AND SCISSORS

Removable plaster of paris dressing. Very frequently a plaster of paris dressing is applied with the intention of having it worn for some time as a removable support (**tutor**), for instance, after resections, especially of the knee joint, or as a **plaster of paris corset** in the treatment of scoliosis. In this case, it is more important that the dressings should fit well and be light and durable. For a cover of the surface, it is best to use *tricot*, which fits well all the contours of the body. Commercial tricot hose is used for the most part; it must be twice as long as the dressings to be applied; one-half serves as an under layer for the plaster of paris dressings; the other is turned over the set dressings as a cover.

For such *tutors only* plaster of paris bandages are used. They are applied according to *Sayre* as follows:—

The bandages, about 5 to 8 centimeters wide, are applied as smoothly as possible around the limb in spiral turns; reversed turns are avoided by cutting the bandage at the place involved; during the application, each turn is well *rubbed together* with the following. This is best done by an assistant, who follows with both hands the descending bandage and strokes it firmly to the limb; thereby greater firmness and a more complete agglutination of the several layers are effected; the thickness of the dressings should rarely exceed half a centimeter.

When the dressing has nearly set, the bandages are divided with a very sharp knife, in a straight line previously marked, and the tricot is divided with a pair of scissors. In order to prevent injury to the patient, which might easily occur, it is well, before applying the dressings, to place a *strip of pasteboard*, or of wood, or something similar, under the tricot at the place where the cut is to be made; a longitudinal roll of cotton or a *cord* may be used instead (*Szymanowski*). After the dressing has been cut, the margins of the splint are carefully turned aside far enough to enable the limb to be removed from it and is then set aside for drying. After 2 to 3 days, it is covered with tricot. Along the margins, the tricot is sewed together with the inner layer so that the whole dressing becomes lined; laces or strips of leather and buckles should be attached to the edges of the slit made in the dressing — preferably by an instrument maker (Fig. 193).

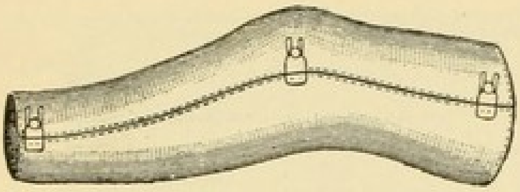


Fig. 193. Plaster of Paris Tutor for the Knee

Common cotton jackets and trousers, which serve for a lining, or long knee-stockings, of which one is used for an under layer and the other for a cover, are generally cheaper than the tricot material. Especially with stockings, **plaster of paris boots**, which look very well, can be applied (for corrected flat feet, club feet resections, etc.).

Plastic plaster of paris splints (*Beely*) are made of rolls of hemp, flax, jute, or straw which has been made soft by beating (*Anschütz*). Having been dipped in the thin plaster of paris cream, they are applied to the limb

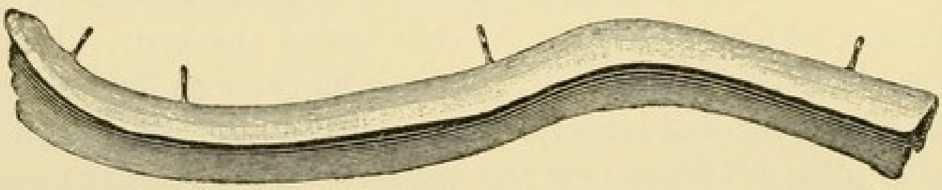


Fig. 194. Beely's Plastic Plaster of Paris Splint

(previously lubricated and wrapped with a moist muslin bandage). The bundles of fibre, only about 1 centimeter thick, are applied one after another, covering each other, and finally the surface is smoothed with plaster of paris cream. These removable plaster of paris splints are especially well adapted to the treatment of compound fractures. If the limbs are to be suspended in them, it is well to insert in the paste, at several places, hooks and eyes of wire (Fig. 194).

Such splints may be applied with *Breiger's plaster of paris cotton* in a still more convenient and cleanly manner; for instance, for radius fractures, *Braatz's* **spiral splint**, which holds the hand securely in flexion and abduction, without limiting the movement of the fingers (Fig. 195).

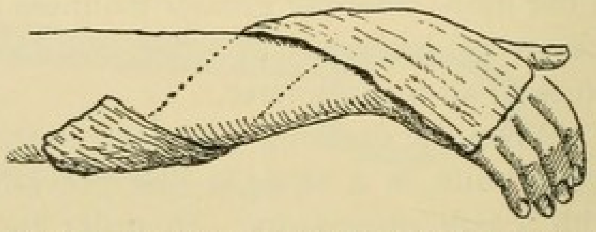


Fig. 195. Braatz's Spiral Splint for Radius Fracture

STRENGTHENING PLASTER OF PARIS BANDAGES

In order to make the plaster of paris bandages more durable, a thicker layer of plaster of paris cream may be applied; by this means, however, the dressings unfortunately become awkward, clumsy, and heavy. It is more practical to give it greater firmness by inserting *strips of wood* (*Völcker's* "tapetenspan" or shoemakers' shavings — *Neudörfer*), narrow splints of veneered wood, strips of tin or wire, without making it thereby essentially heavier.

Of these materials, the strips of wood are most preferred, on account of their lightness and cheapness; hence, for the

WOOD SHAVING PLASTER OF PARIS DRESSINGS

the following rules may be observed: —

(*a*) On the **humerus** (in fractures of the humerus and inflammations of the shoulder joint).

The arm, bent at a right angle in the elbow and abducted, is carefully wrapped with flannel bandages as far as and above the elbow joint; from there the arm and the shoulder are wrapped with cotton bandages. Next, the whole arm from the wrist to the shoulder is wrapped with a plaster of

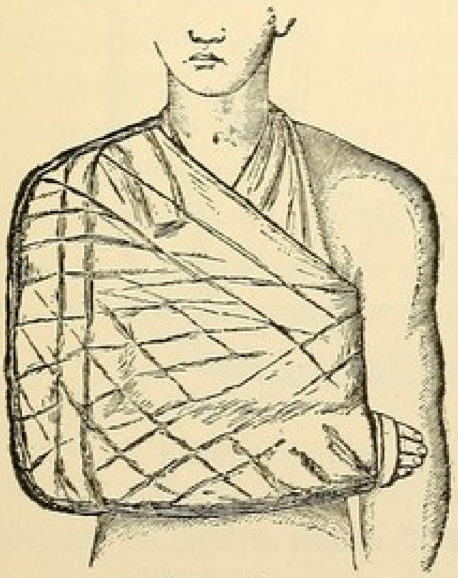


FIG. 196

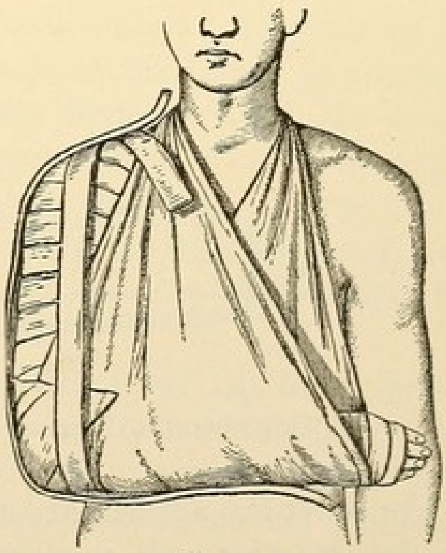


FIG. 197

WOOD-SHAVING PLASTER OF PARIS DRESSING ON THE HUMERUS

paris bandage, brought to the side of the chest, and supported by a mitella. Next, the middle portion of a long "tapetenspan" (strip of wood) is applied under the elbow; its two halves are carried along the anterior and posterior sides of the arm, and its ends are allowed to cross each other over the shoulder. A second long strip of wood is applied along the outer surface of the arm from the wrist to the side of the neck (Fig. 196). Finally, the strips of wood, the arm, and the mitella are enveloped in plaster of paris bandages, applied according to *Desault* (Fig. 197).

(*b*) Fractures of the **forearm** and inflammation of the elbow joint.

After the arm, bent at a right angle at the elbow, has been wrapped with cotton and next with plaster of paris bandages, two long strips of

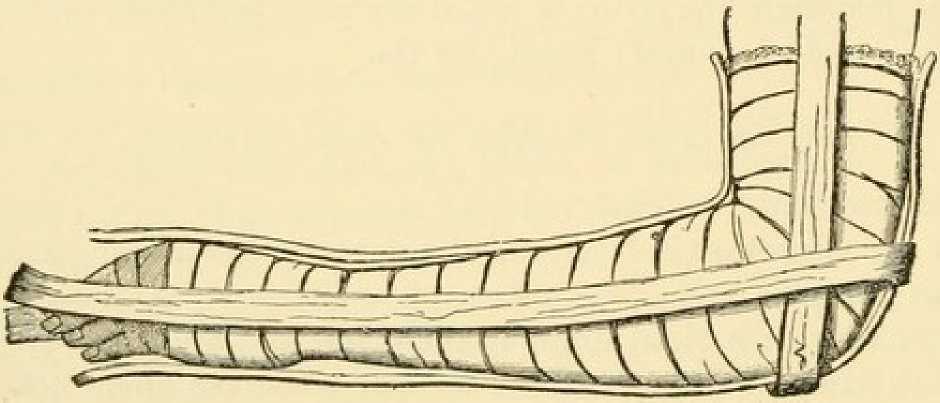


FIG. 198

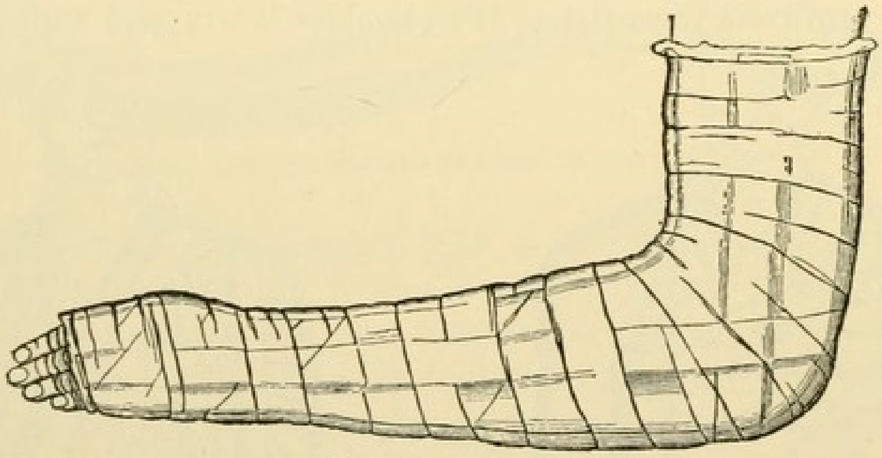


FIG. 199

WOOD-SHAVING PLASTER OF PARIS DRESSING ON THE FOREARM

wood like reins are applied around the joint, of which one takes its course along the anterior and posterior sides of the forearm, while the other ascends around the elbow to the arm. Two strips are added for the superior and inferior surfaces of the arm, and all four are fastened with a plaster of paris bandage (Figs. 198, 199).

In more serious injuries and after *resection* of the elbow joint, the (fenestrated) plaster of paris dressing may be applied, with the joint at a flexion of an obtuse angle and the forearm in semi-supination. Figures 200 and 201 show the arrangement of the strips in such a case.

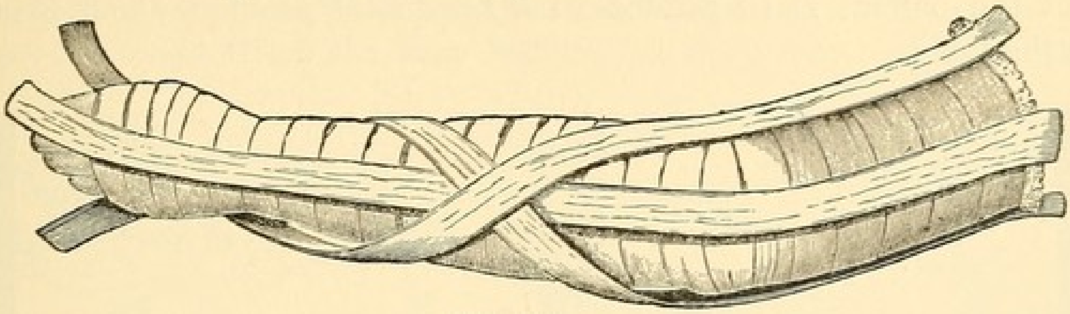


FIG. 200

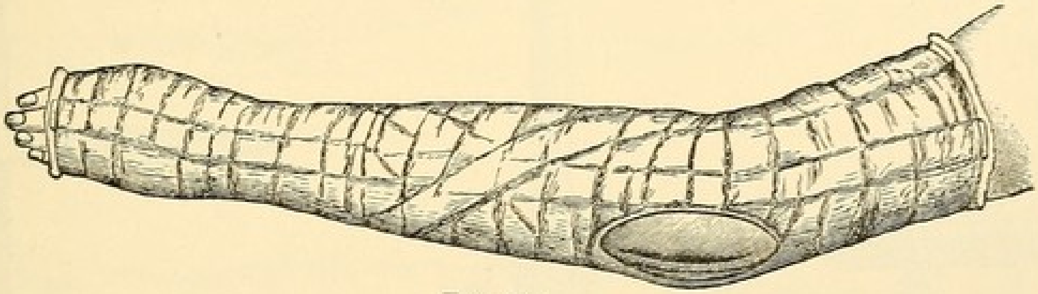


FIG. 201

WOOD-SHAVING PLASTER OF PARIS DRESSING AFTER RESECTION OF THE ELBOW JOINT

(*c*) Fracture of the **leg**.

The plaster of paris dressing in fractures of the leg has recently become materially limited; at the present time it is used only in fractures of the shaft, of the tibia or the malleoli, or of the bones of the foot. In fractures of the femur, the *treatment by extension* yields better results. In severe injuries of the pelvic bones, and especially in order to secure immobilization for the hip joint in inflammation, or to give a firmer support to the leg for after-treatment after resection of the head of the femur, the plaster of paris dressing is still largely used. Likewise, as a light support (*tutor*) after resection of the knee or ankle joint.

If a plaster of paris dressing is to be applied on the leg, to encircle at the same time the pelvis, the patient must be placed in such a position that the posterior side of the pelvis also becomes freely accessible; an ordinary *Volkmann* pelvic support is not sufficient, since it covers too much space. It is better, therefore, to use the **pelvic supports** mentioned for that purpose. They can be screwed to the table (*von Esmarch*, *von Bardeleben* — Figs. 202, 204) upon which the patient is placed, with the sacrum resting, while one (or two) assistants hold his legs, and by making traction upon them the perineum of the patient is drawn toward the iron pole, wrapped with cotton (counter extension). For the support of the heel during the application of the dressings, an adjustable **heel support** (Fig. 203) may be used. The back is supported by a padded pelvic support or a high pillow, so that the patient is suspended in a horizontal position about 8 inches above the table.

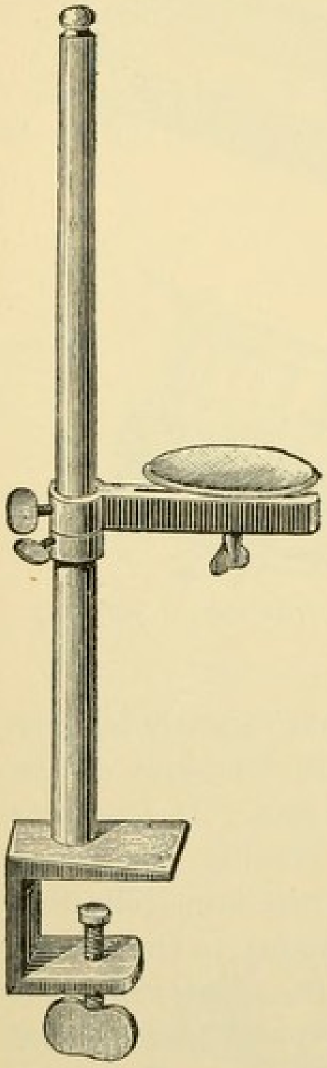


Fig. 202. Von Esmarch's Pelvic Support

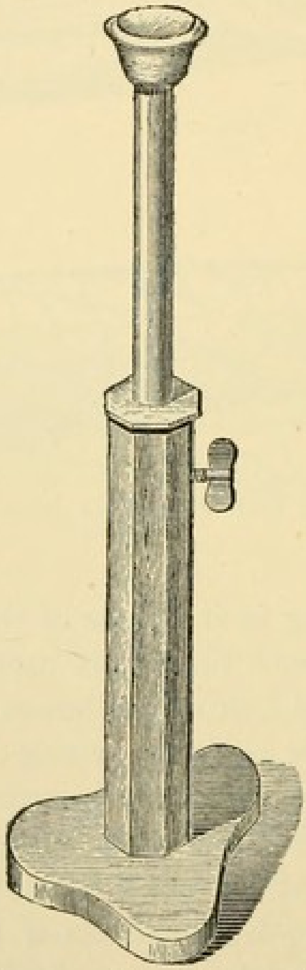


Fig. 203. Von Esmarch's Heel Support

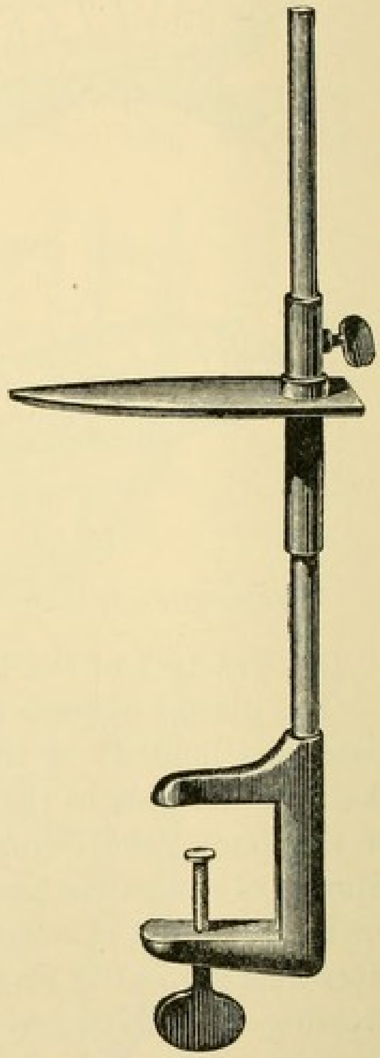


Fig. 204. Von Bardeleben's Pelvic Support

Next, the leg and then the pelvis are wrapped with cotton bandages over which a plaster of paris bandage is applied. Then a long strip of wood is applied along each of the four sides of the leg; the ends are held in position by assistants (Fig. 205). The strips are fastened temporarily with a plaster of paris bandage in serpentine turns (Fig. 206), and over them several broad plaster of paris bandages are applied, surrounding the pelvis in figure-of-8 turns; a layer of plaster of paris cream is spread upon them. Since, in such dressings of the hip, the weakest point is the *groin*, in which by imprudent movements and especially in rising a fracture may easily be produced, it is advisable sufficiently to strengthen the layer of plaster of paris at this place, if necessary, by incorporating a strip of tin or something similar. Wooden strips are here less useful, since they too are flexible on

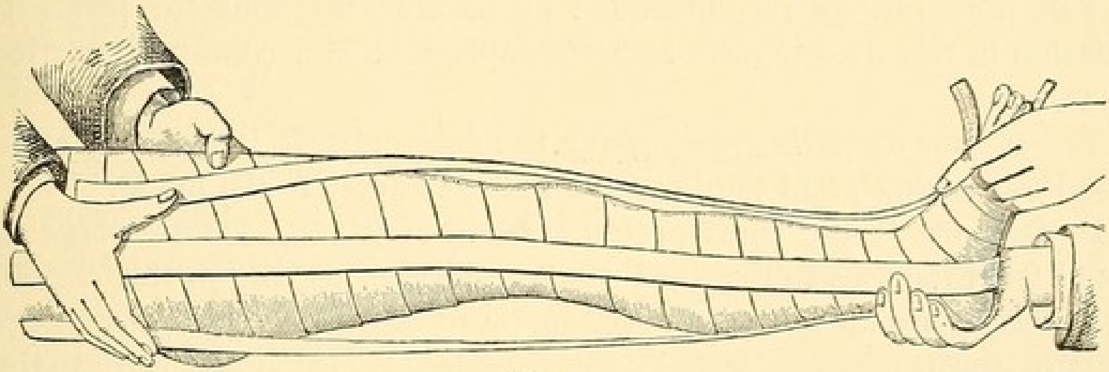


FIG. 205

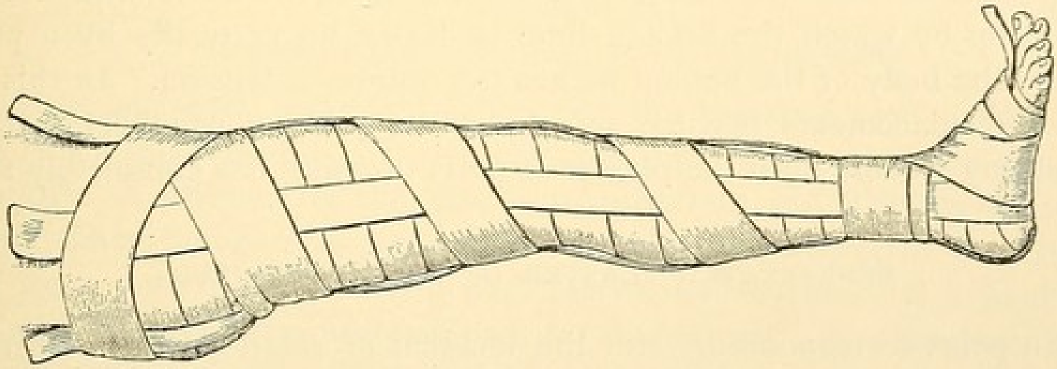


FIG. 206

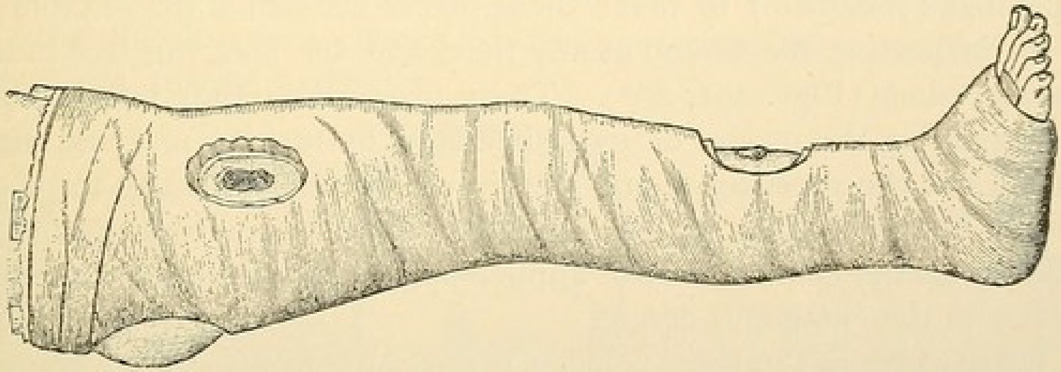


FIG. 207

WOOD-SHAVING PLASTER OF PARIS DRESSINGS FOR THE LEG

their surface. Finally, the projecting ends of the chips are cut off, the margins of the dressings are smoothed, and in any existing wounds or fistulæ, a fenestra is made at the corresponding place (Fig. 207).

Dittel places the patient on two iron rods (gas pipe), which are connected near one end by a movable crossbar as long as the hand. The end is put on the edge of a table, and the patient is placed upon the rods in such a manner that only the head and the chest rest on the table, while the abdomen and the legs are balanced by the diverging rods. After the dressings have been applied, the rods are withdrawn from under the layer of bandages.

The preparations recommended by several surgeons for position and extension in this dressing are rather complicated and cannot be carried out everywhere.

The plaster of paris dressing for the *knee* must, if it is to be effective, extend to the thigh and the leg from the trochanter to the ankle.

In fracture of the shaft or the malleoli of the *leg*, the dressings should extend from the toes to the knee joint. Since, especially in this region, owing to the strong muscular contraction, there may result very great displacements of the fragments, which cannot always be balanced by the strength of the assistant who makes the extension, it is advisable to attach to the foot a loop by which the broken limb is drawn up vertically by a pulley, whereby the body of the patient makes the counter extension. In this position, all displacements become adjusted; the position can be maintained without any trouble until the plaster of paris dressing has completely set.

FENESTRATED PLASTER OF PARIS DRESSINGS

At a point corresponding with the location of small wounds or fistulous openings, the plaster of paris dressings must be supplied with corresponding openings (*fenestrae*), to make these places accessible for suitable treatment, for inspecting the wound at any time, and for securing free drainage for the secretions (Figs. 201, 207). These places are either left free at the time of applying the plaster of paris bandage, by making reversed turns or by cutting out the dressing at one margin of the fenestra to be formed and continuing the bandaging at the other side, or with a sharp knife fenestrae are made after the splint has been applied by cutting out a piece corresponding in size to the cutaneous defect.

In order to reach the right place, it is advisable to place upon the region of the wound, covered thickly with dressing materials, some object which forms a projection and upon which the cuts can be made without hesitation; for instance, a cotton compress, a tampon, cork, small basin, potato, etc.

To prevent secretions of the wound from infiltrating between the skin and the plaster of paris dressings, the margins of the fenestrae must be firmly padded with *common* cotton; this ring of cotton may be made still more waterproof by brushing it with collodion, varnish, shellac, or putty.

Varnished paper does not occlude the wound so well as adhesive plaster, if it is used from the start for making fenestrae. For this purpose, make of it tubes in length of a finger, turn over one end nicked at several places, and apply upon the wound, so that they rest upon the skin like chimneys; next apply the plaster of Paris dressing in the usual manner, so that the lumen of the tubes remains free, and line the uppermost layers with the end that projects over the dressing.

But if the wounds are so large that through a correspondingly large fenestra the firmness of the dressings would become diminished, for instance, after severe compound fractures, or if the whole contour of the limb has to remain free at one place, in order to renew the dressings as often as necessary, as, for instance, after resection of the joints, then the plastic dressings are applied *in two halves*, which are connected with one another by means of a strong arch (stirrup bridge). This is, then, an

INTERRUPTED PLASTER OF PARIS DRESSING

In the antiseptic treatment of wounds, this dressing need hardly ever be used, since the dressing is rarely changed, and since, moreover, a sufficient substitute is offered by the simple wire splints and wooden splints. In former times, however, on account of the frequent change of the dressings, they were more in demand and were essentially instrumental in saving time and work for the physician and pain for the patient. If, therefore, in cases of sepsis or suppuration of the joints, the surgeon desires to proceed conservatively, they may be recommended even now as very convenient dressings, rendering the frequent change of dressings possible in a short time and without any special assistance.

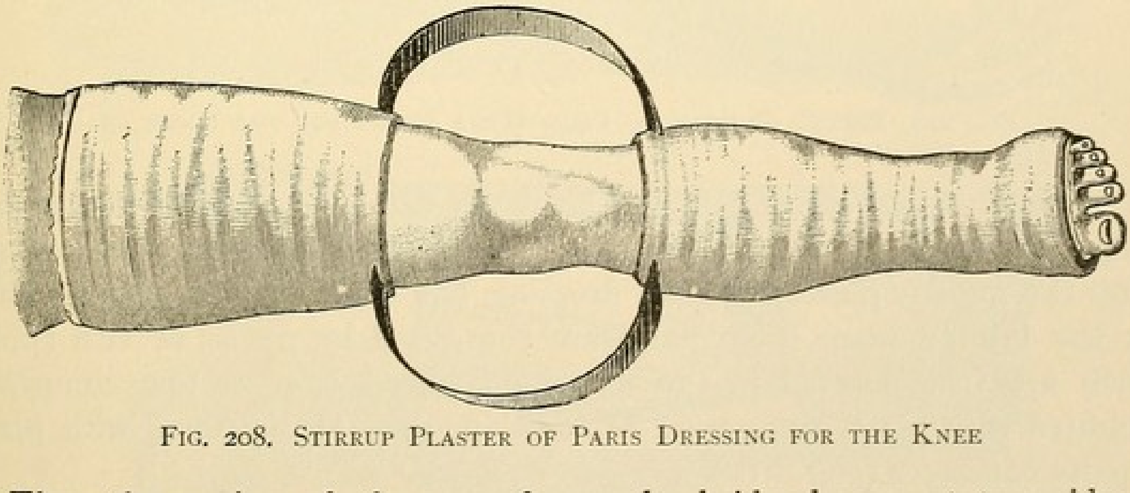


FIG. 208. STIRRUP PLASTER OF PARIS DRESSING FOR THE KNEE

Thus the region of the wound may be bridged over at two sides by strong **arches of sheet iron,** the straight ends of which are incorporated in the plaster of paris dressings (Figs. 208, 209). For lessening the elastic motion of these iron arches, wrap them with hemp or jute dipped in plaster of paris cream. With these *plaster of paris hemp splints* alone, a stirrup dressing can be constructed (*Beely*—Figs. 210, 211), which can be easily suspended by means of a few eyelets fastened in the plaster of paris.

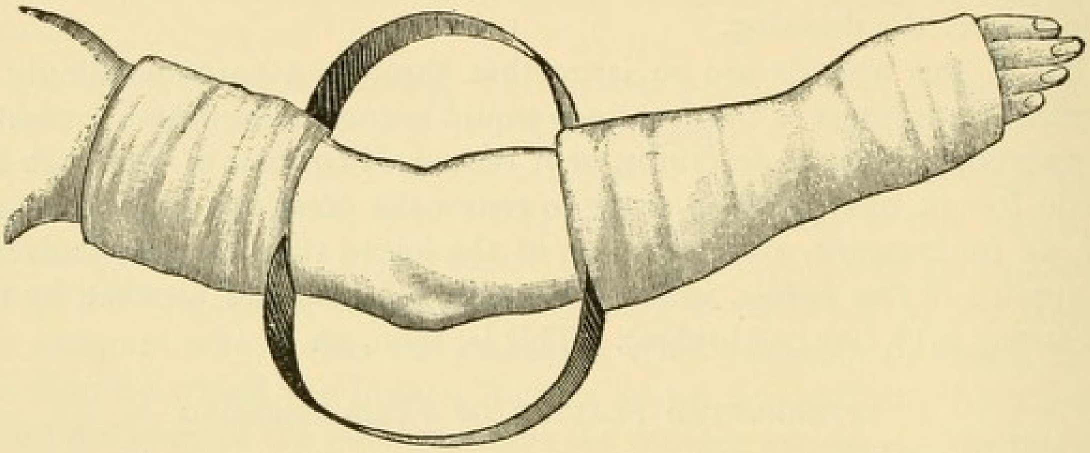


FIG. 209. STIRRUP PLASTER OF PARIS DRESSING FOR THE ELBOW

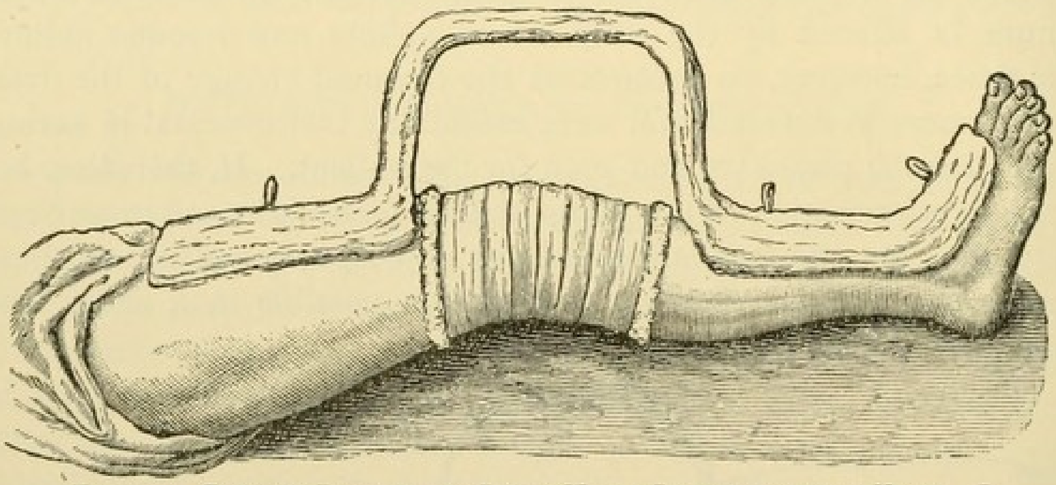


FIG. 210. BEELY'S PLASTER OF PARIS HEMP SPLINT FOR THE KNEE. I.

An interrupted splint can also be made with the straight **wooden laths** bridge, especially if the limb has to be made accessible only on one side. After the regular plaster of paris dressing has been applied, above and below the injured place, both parts are connected by pieces of lath (poles), which are incorporated in the dressings with cotton or tow compresses saturated with plaster of paris; in addition, they are fastened with plaster of paris bandages (Fig. 212).

Similar is *Pirogoff's* **bridge plaster of paris dressing**, which has proved to be very good, especially as a temporary dressing; a piece of coarse

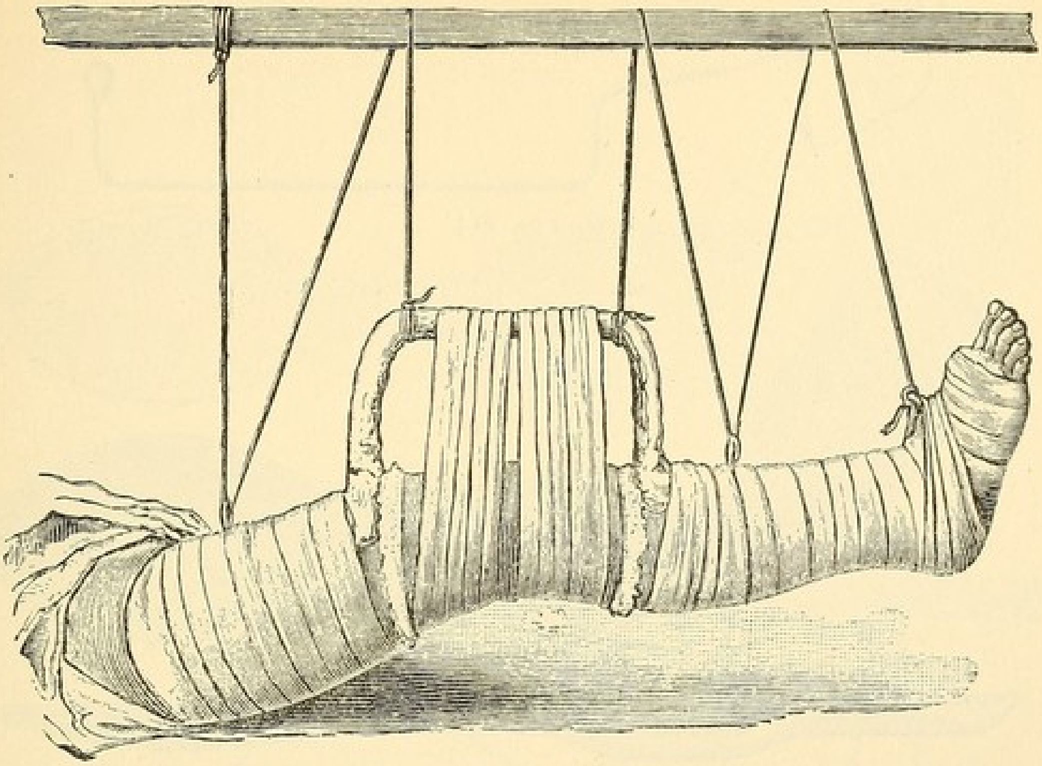


FIG. 211. BEELY'S PLASTER OF PARIS HEMP SPLINT FOR THE KNEE. II.

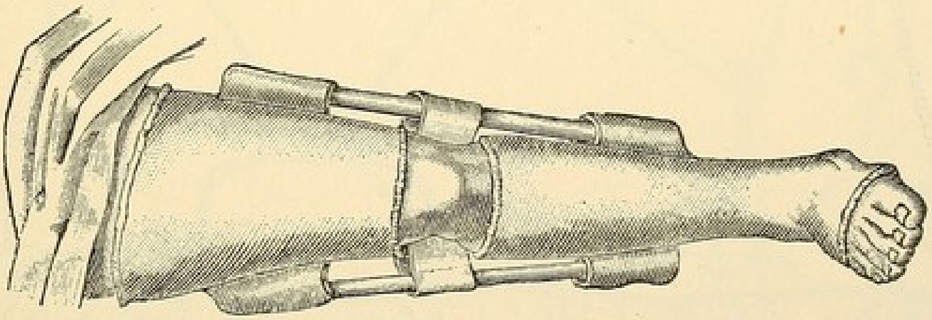


FIG. 212. BRIDGE PLASTER OF PARIS DRESSING WITH WOODEN LATHS

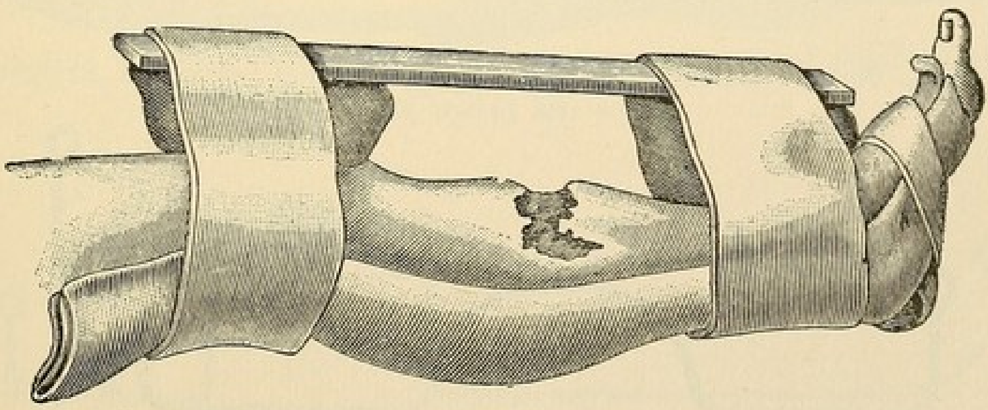


FIG. 213. PIROGOFF'S BRIDGE PLASTER OF PARIS DRESSING

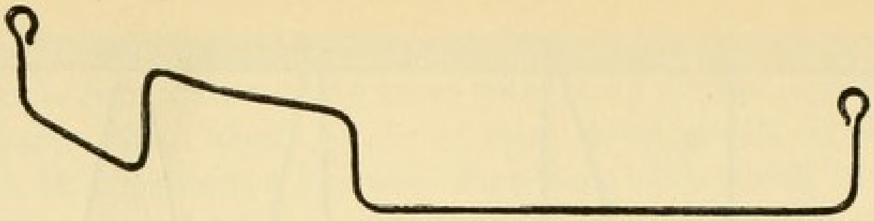


Fig. 214

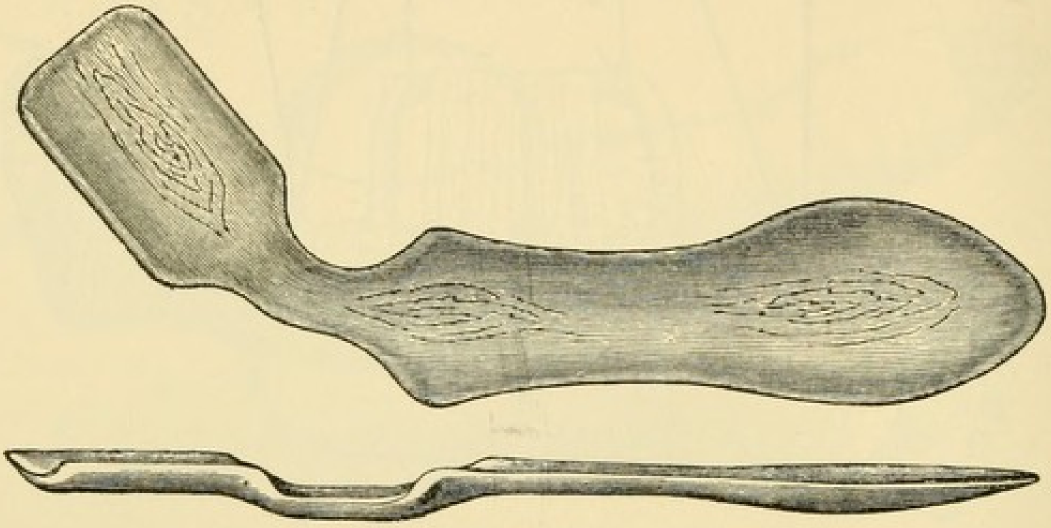


Fig. 215

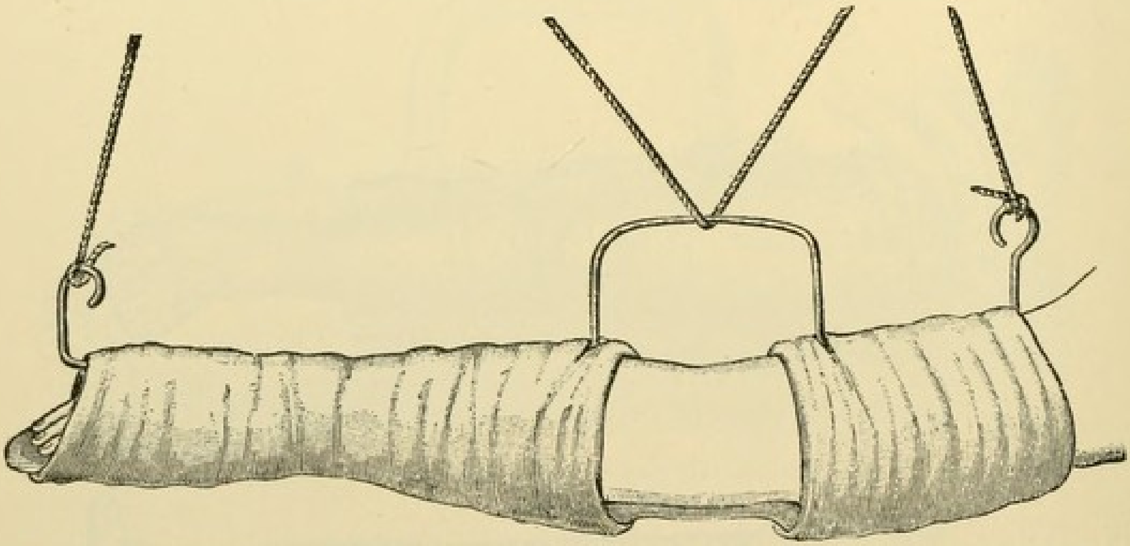


Fig. 216. Von Esmarch's Plaster of Paris Suspension Splint for Resection of the Elbow Joint

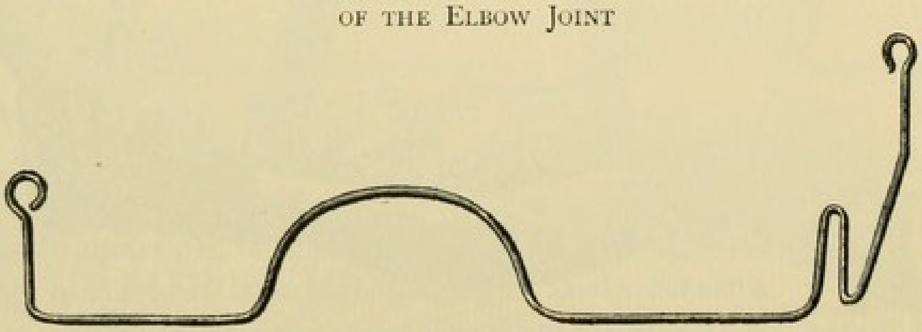


Fig. 217

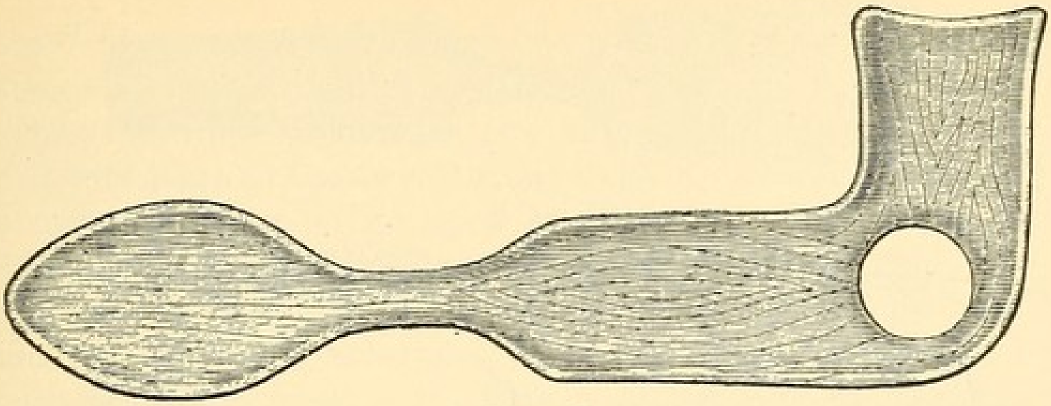


Fig. 218

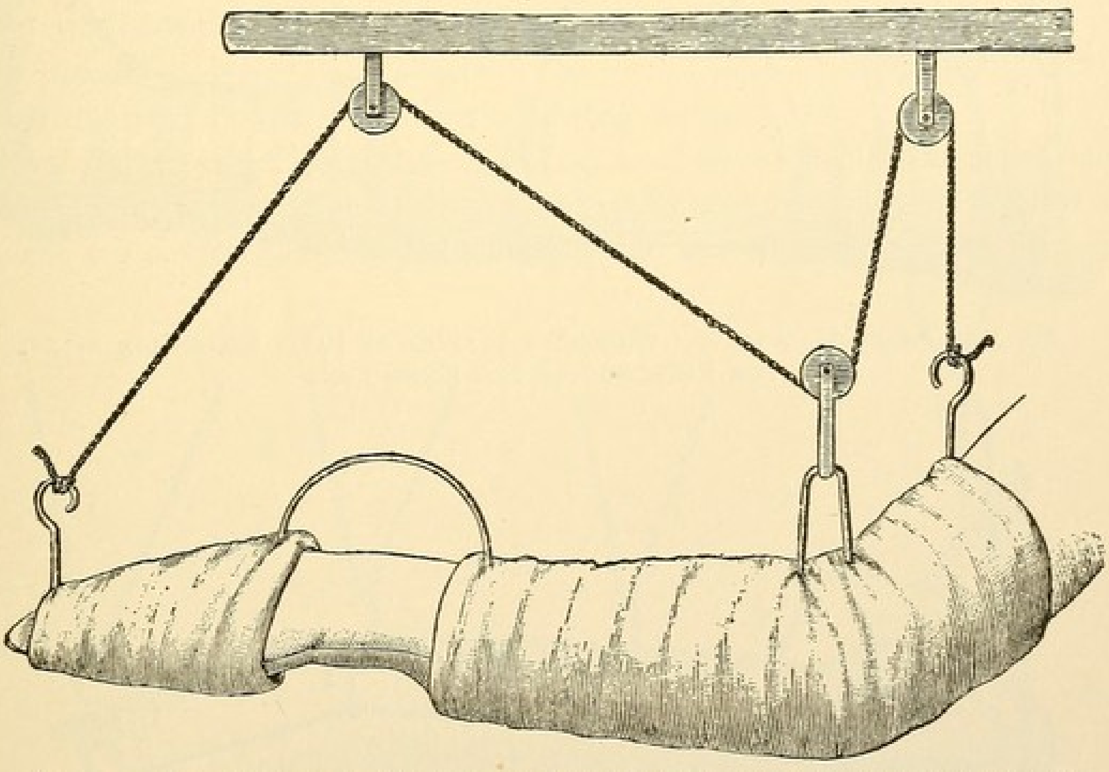


Fig. 219. Von Esmarch's Plaster of Paris Suspension Splint for Resection of the Wrist

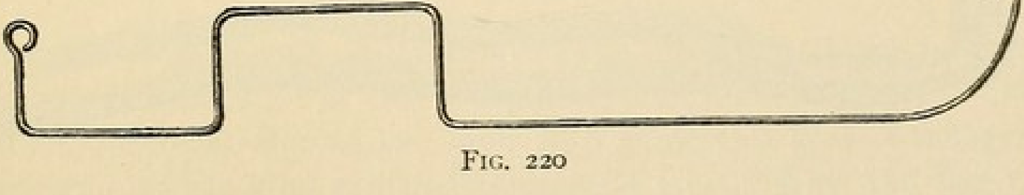


Fig. 220

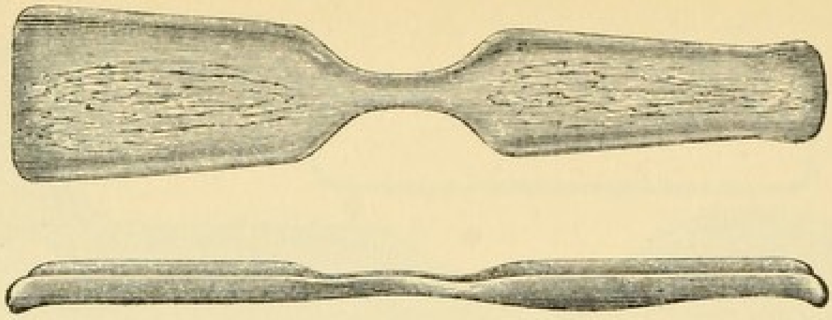


FIG. 221

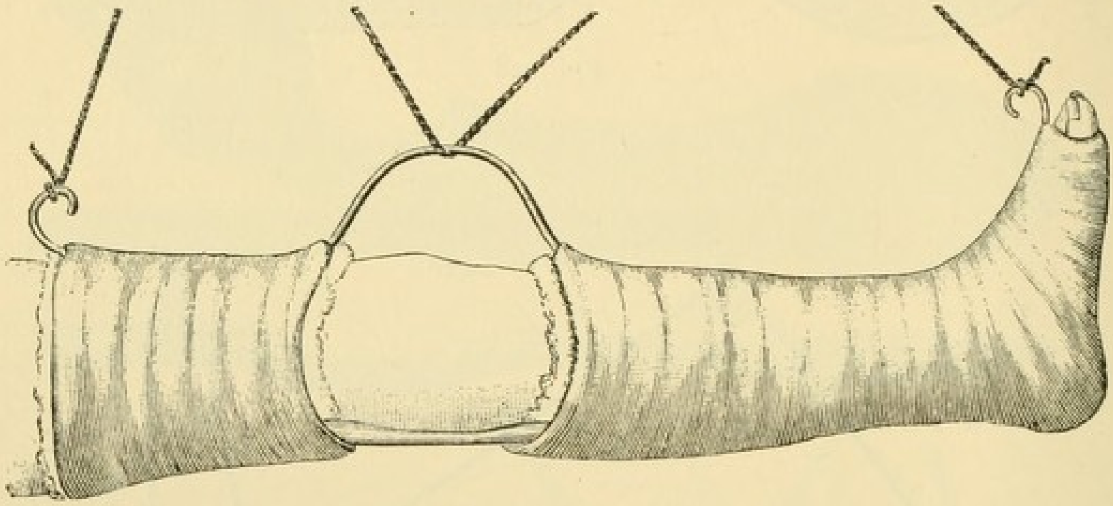


FIG. 222. WATSON'S AND VON ESMARCH'S PLASTER OF PARIS SUSPENSION SPLINT FOR RESECTION OF THE KNEE JOINT

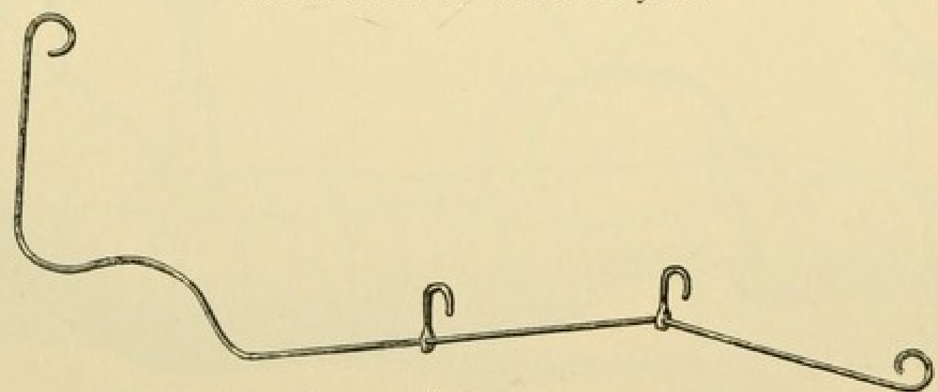


FIG. 223

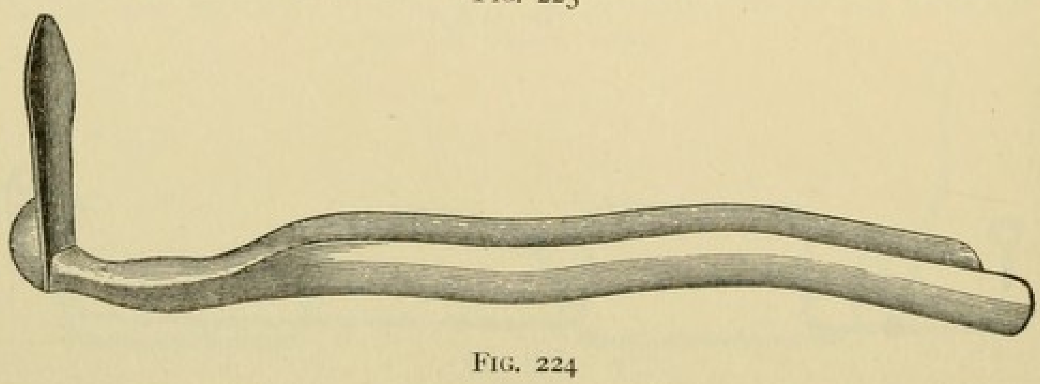


FIG. 224

sackcloth (sleeve, trousers) is dipped in a plaster of paris cream and applied on the lower side of the limb as a strong plaster of paris splint; on the upper side, above and below the wound, two large tow compresses (straw, hay), saturated with plaster of paris cream, are applied, and over them the wooden lath is fastened like a bridge upon its pillars with broad linen strips of plaster of paris bandages (Fig. 213).

Still more convenient and also lighter are the so-called **resection splints** in connection with *suspension wires* (**plaster of paris suspension splints**), which are securely fastened to the limb by plaster of paris bandages. This mode of dressing was first employed for the knee joint by *Watson;* afterwards, for the other joints, by *von Esmarch.*

The splints are made narrow at the place destined for the resection and form a small connecting bridge, while the wire belonging to it forms an arch at this place.

This dressing is applied in the following manner: —

After the diseased joint has been dressed antiseptically and the whole limb bandaged with cotton bandages, the well-cleansed splint is covered with two moss pads, which allow the small bridge between them to remain free.

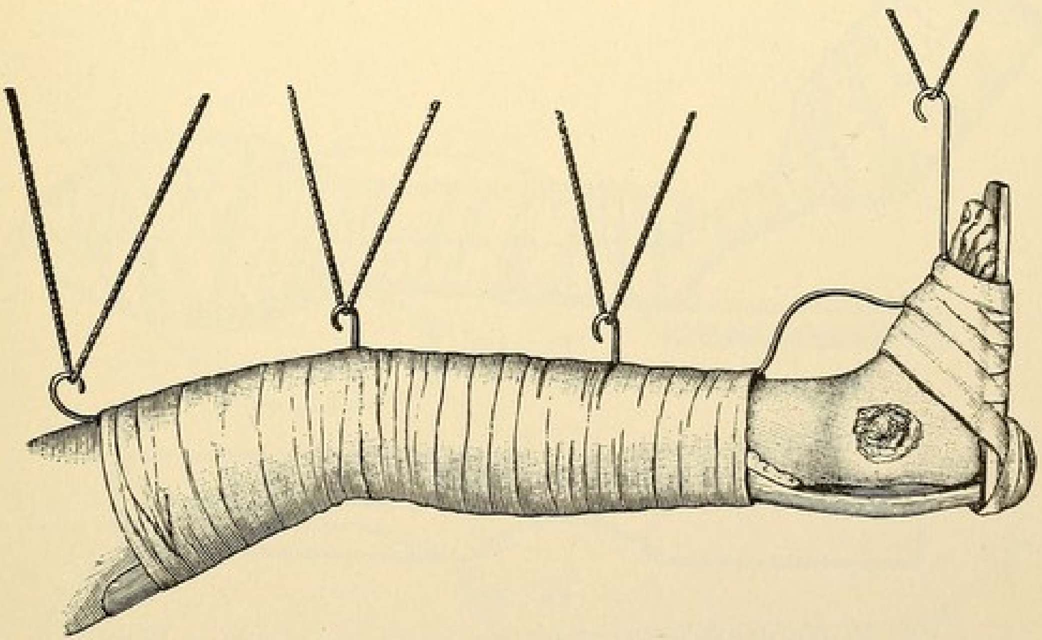


FIG. 225. VON ESMARCH'S PLASTER OF PARIS SUSPENSION SPLINT FOR RESECTION OF ANKLE JOINT

The latter is wrapped with india-rubber cloth, made sterile, or is protected in some other manner from the contact of secretions; next, the splint is fastened on the lower side of the limb with plaster of paris bandages, and thus the region of the joint remains completely free. With the last plaster of paris bandage, the suspension wire is fastened with plaster of paris cream at the anterior surface of the limb, and as soon as the dressing is completely dry, the limb is held by the frame in free suspension. Figures 214–225 show these splints for various joints. Instead of wooden splints, in case of necessity, splints similarly shaped may be cut from strong tin or bent together from telegraph wire (Figs. 226–228).

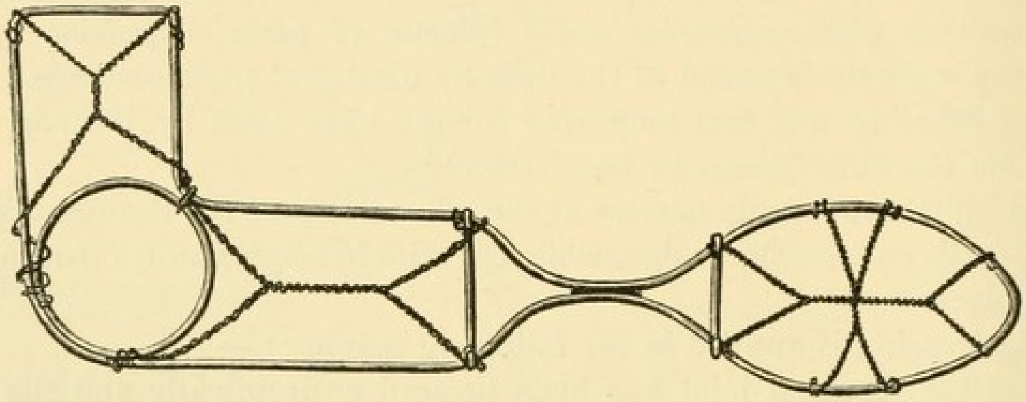


FIG. 226

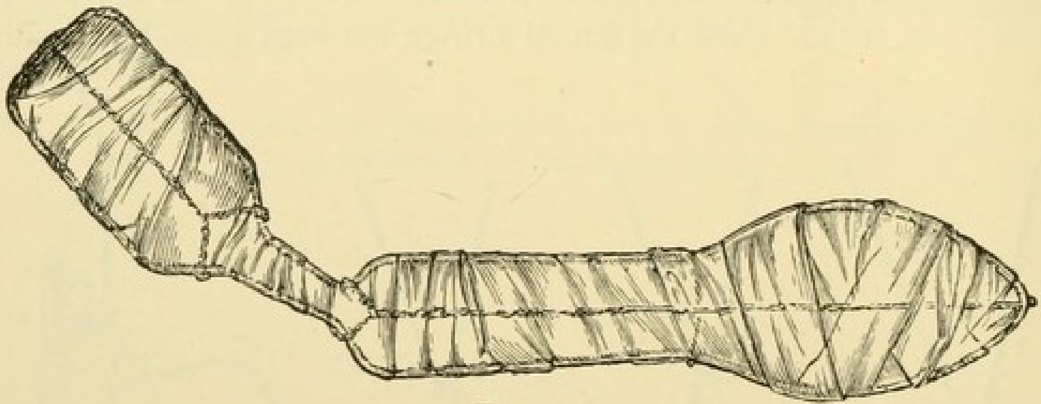


FIG. 227

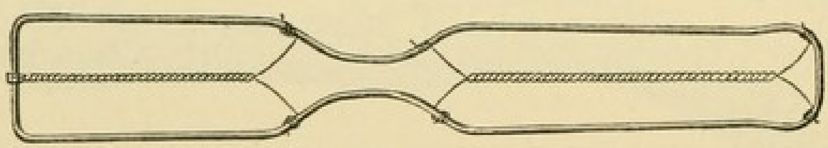


FIG. 228

VON ESMARCH'S SUSPENSION SPLINTS MADE OF TELEGRAPH WIRE

Von Volkmann's **wooden dorsal splint** (Figs. 229, 230), which is firmly applied with plaster of paris or starch bandages at the superior surface of the limb, affords the diseased joint a firm support and is especially suitable for all cases in which large wound surfaces, fistulæ, or decubitus are on the lower side of the limb.

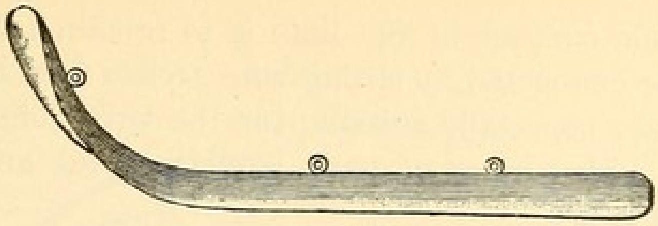


FIG. 229

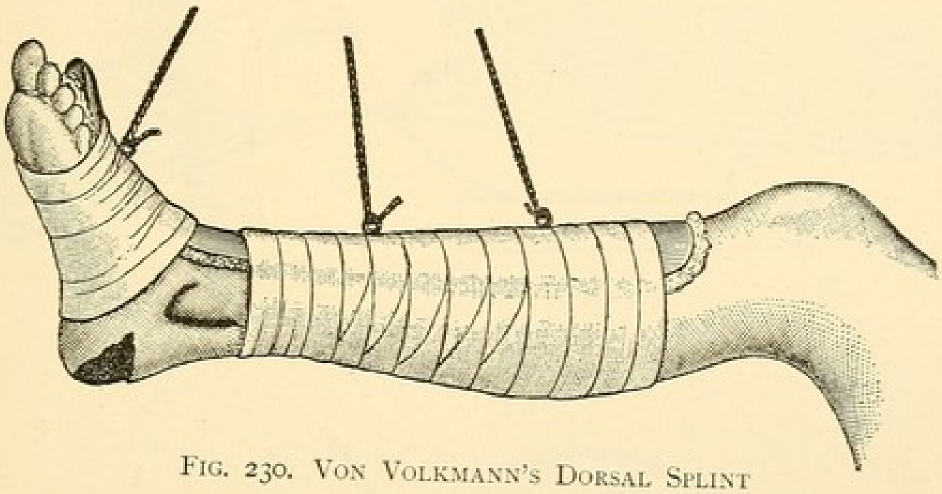


FIG. 230. VON VOLKMANN'S DORSAL SPLINT

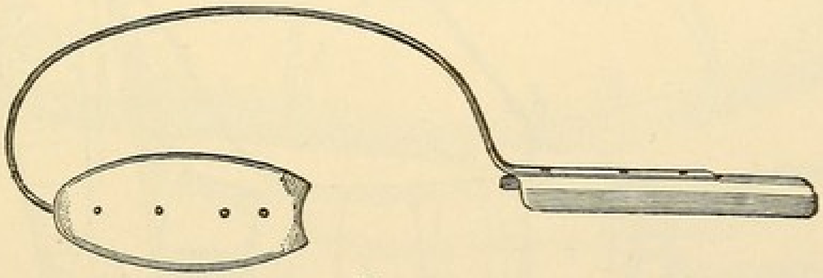


FIG. 231

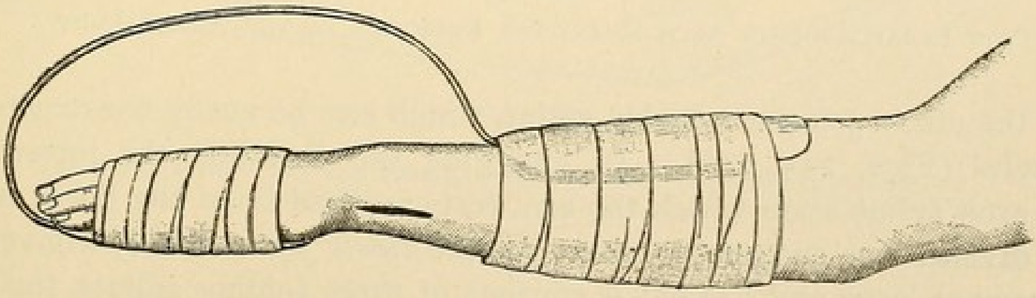


FIG. 232
VON ESMARCH'S IRON ARCH SPLINT FOR RESECTION OF THE WRIST

But if the whole contour of the limb is to remain free, a dorsal and a volar splint may be connected by strong wire arches (*von Esmarch*). These **iron arch splints** are especially suitable for the wrist joint and ankle joint; they are fastened with plaster of paris bandages and are light and comfortable (Figs. 231–234).

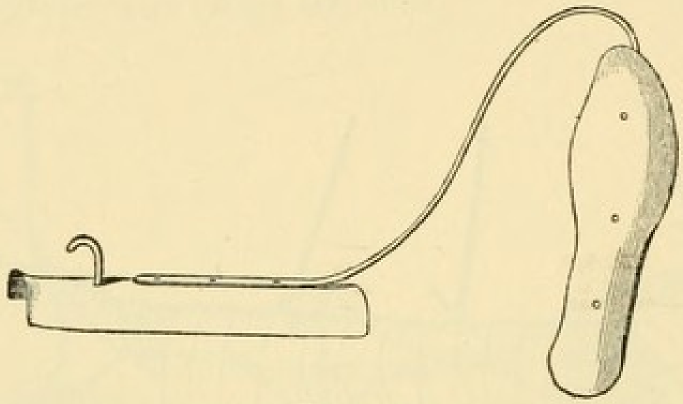


FIG. 233

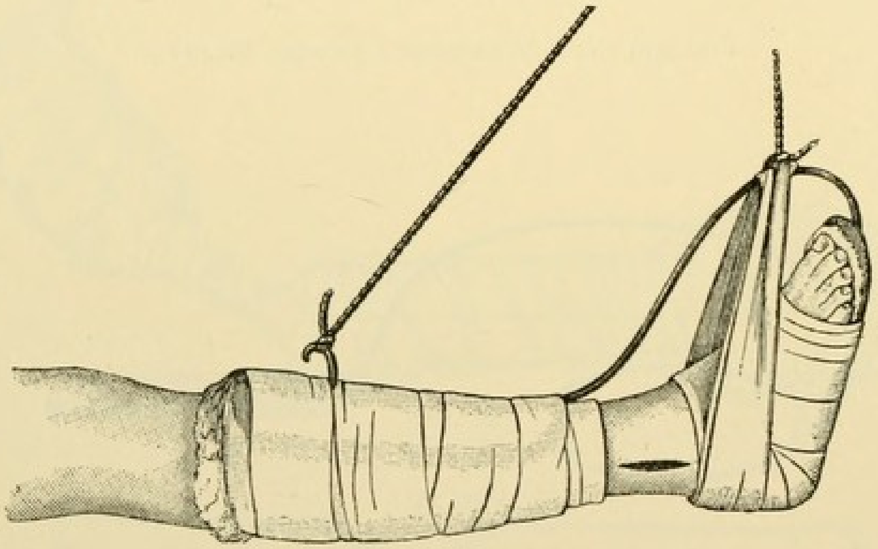


FIG. 234

VON ESMARCH'S IRON ARCH SPLINT FOR RESECTION OF THE ANKLE JOINT

For the elbow joint, my **double splint**, which can be easily constructed, is very useful (Figs. 235, 236). In changing the dressing, the interrupted padded arch splint upon which the arm rests is lifted from the lower board.

My **divided iron suspension splint** for the *elbow joint* is very convenient but somewhat large and heavy; it consists of three folding splints, the arms of which, movable on hinges, are fastened to an iron pole; in applying the dressing, the middle splint is removed (Figs. 237, 238).

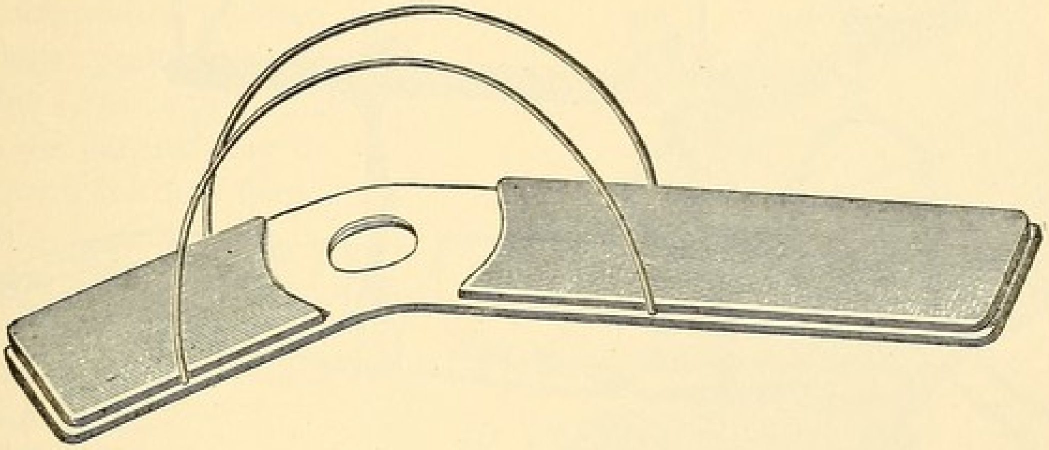


Fig. 235

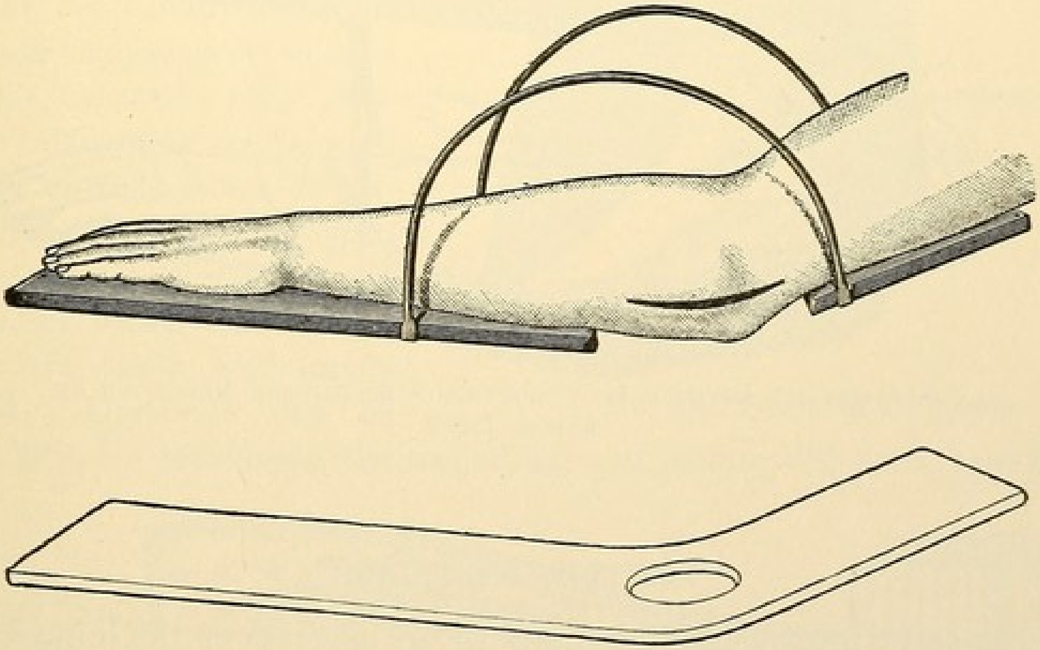


Fig. 236

Von Esmarch's Double Splint for Resection of the Elbow Joint

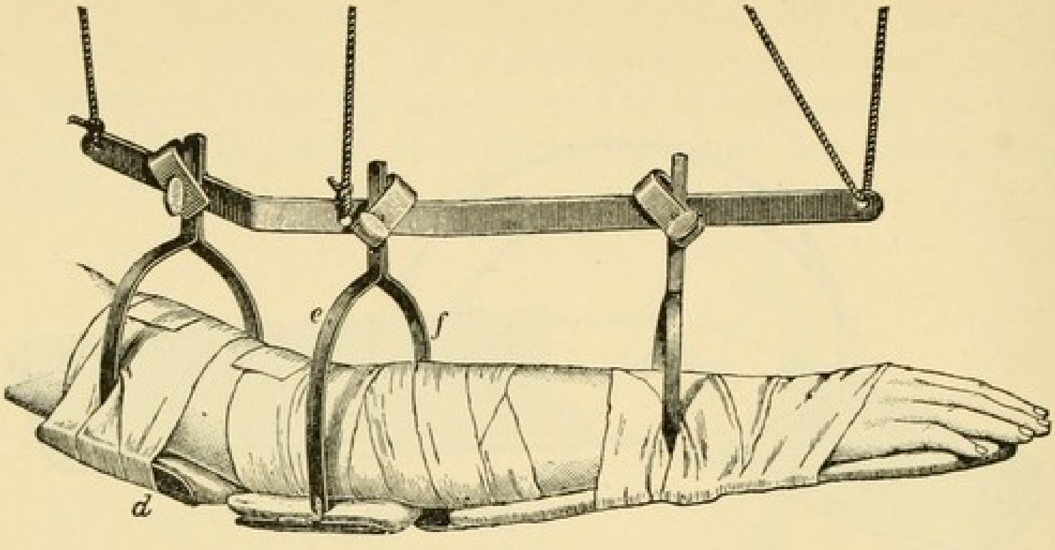


FIG. 237

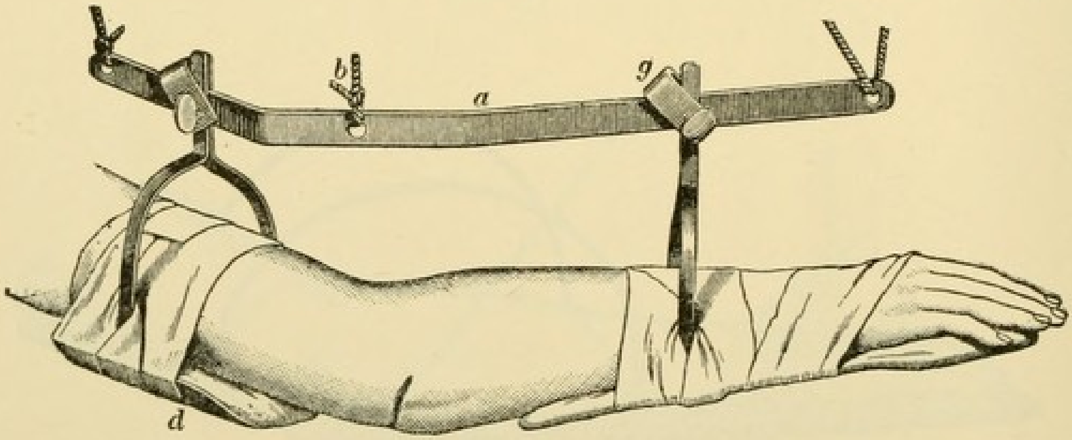


FIG. 238

VON ESMARCH'S DIVIDED IRON SUSPENSION SPLINT FOR RESECTION OF ELBOW JOINT

POSITION DRESSINGS

These serve for a comfortable and secure position of the injured limbs, either alone or in connection with other dressings.

They essentially lessen the sufferings of the patient, especially in extensive and serious wounds. But since they are rather heavy and bulky, they are not so well adapted to transportation as to hospital treatment.

For military service, the most practical are those which are not too heavy, nor too complicated and expensive, and which can be made by any mechanic from a drawing.

If, in serious injuries of the leg, other conveniences are not available, then as the simplest temporary position use the **side position** according to *Pott* (Fig. 239); that is, place the patient's leg on pillows, with the half-bent knee and hip joint on the external side; the muscles thus become relaxed and impediments to circulation are avoided.

If the injured person is to be transported in this position, the pillows are fastened around the limb with cords.

For the further transportation of such severely injured persons, especially when both lower extremities are injured, *Bonnet's* **wire breeches** are useful (Fig. 240). This splint consists of a well-padded wire frame, in which the broken limbs are fairly well immobilized. Openings can be made in it, for bandaging the wound without moving the limb from its position. At the foot end are appliances for extension. This apparatus is very

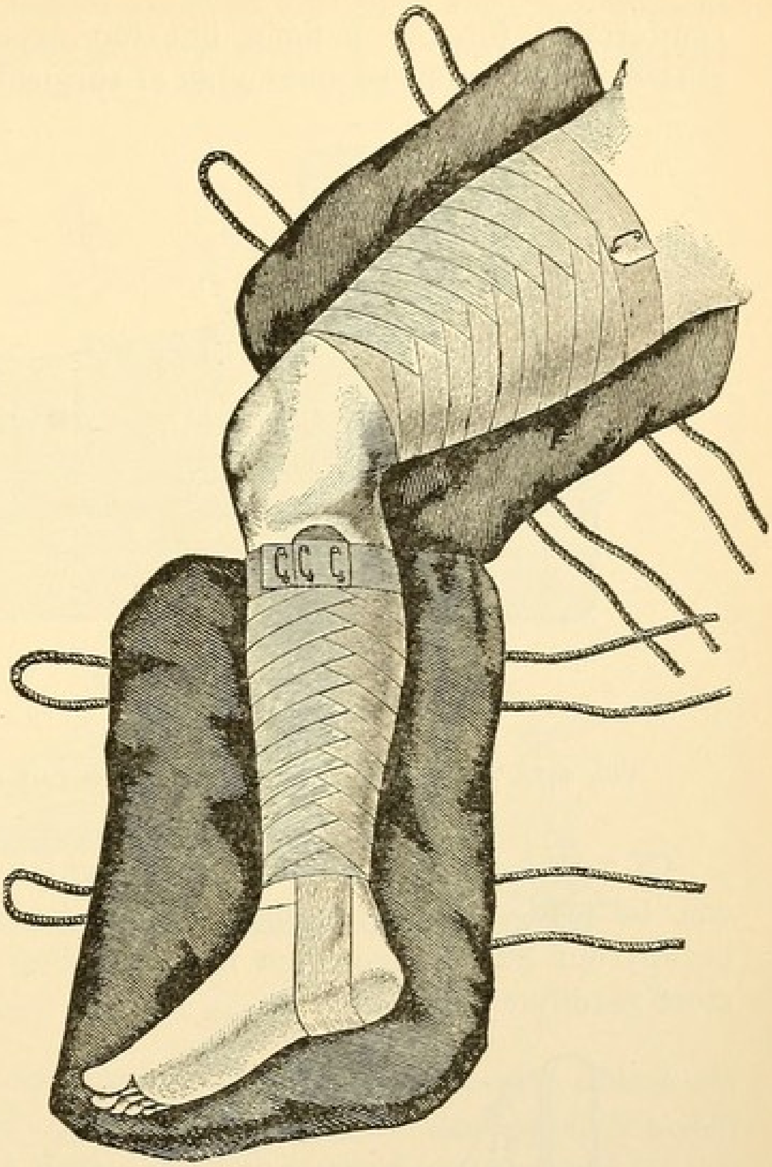


FIG. 239. POTT'S SIDE POSITION

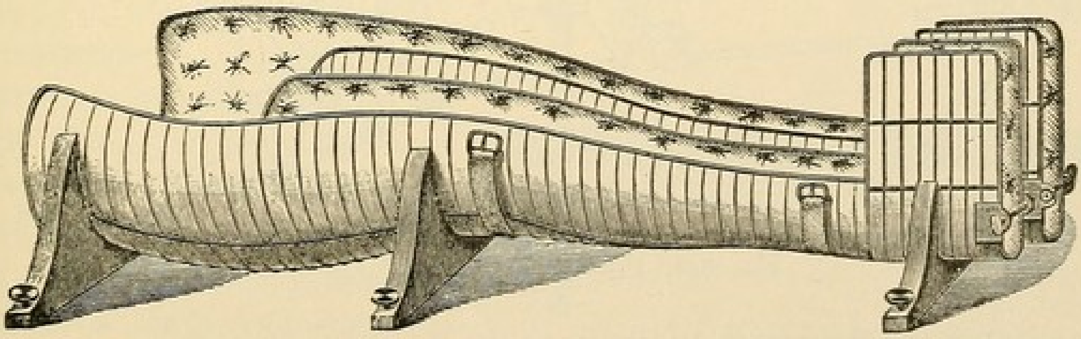


FIG. 240. BONNET'S WIRE BREECHES

comfortable for the patient, but too expensive and bulky, and hardly answers the present requirements of surgical cleanliness.

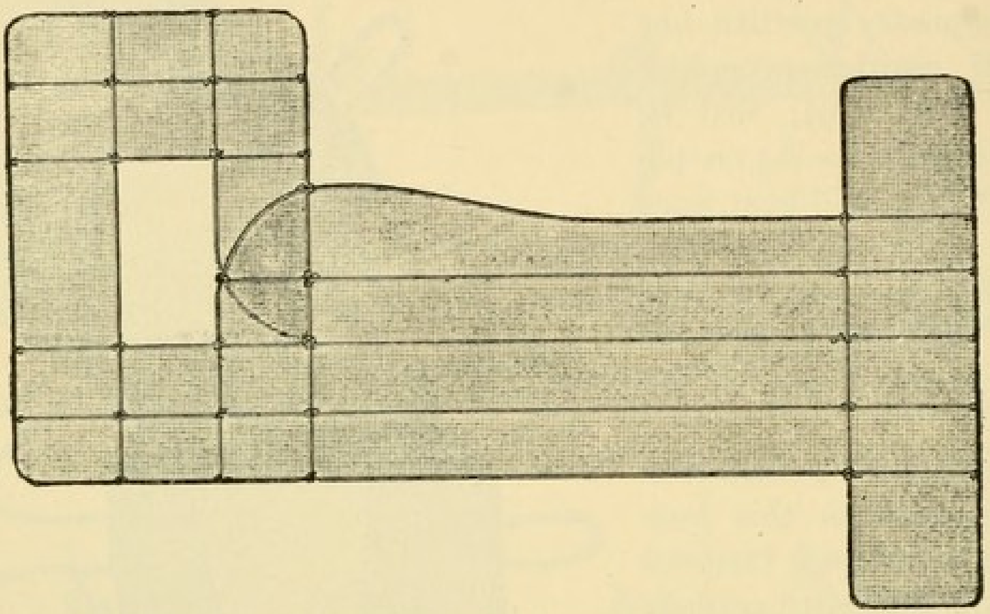


Fig. 241. Wire Breeches flattened for Packing (according to von Esmarch)

Of woven wire cloth (wire gauze), which can be purchased, wire splints can be made, which are lighter than *Bonnet's* and so flexible that they occupy but little space when flattened (Fig. 241). Moreover, they can be more readily cleaned.

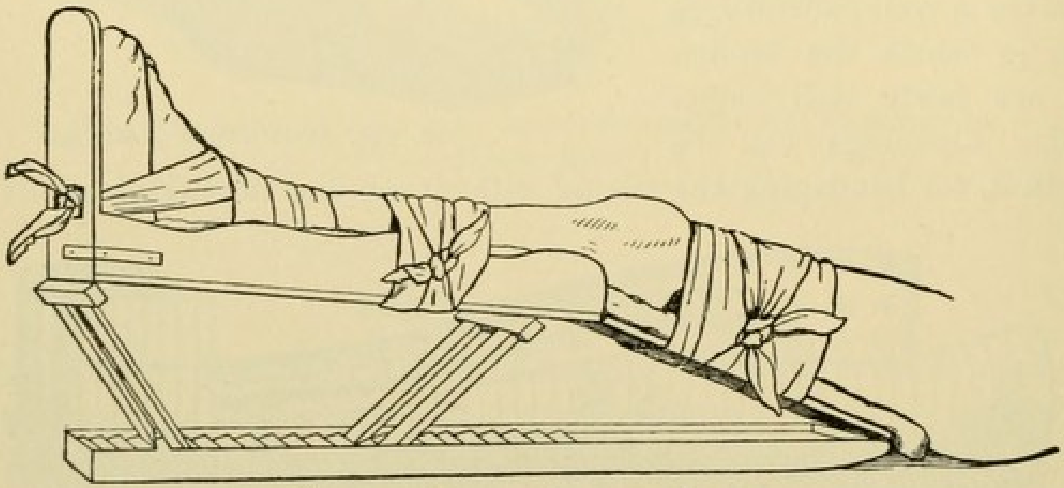


Fig. 242. Double Inclined Plane

The **double inclined plane** (planum inclinatum duplex) is especially suitable for serious injuries and fractures of the leg; it is constructed either, as Figure 242 indicates, according to *Petit's* fracture box, or more simply, as

Figure 243 indicates, of a few boards provided on their lateral margins with wooden pegs by which the margins of the cushion upon which the leg rests are pressed against it.

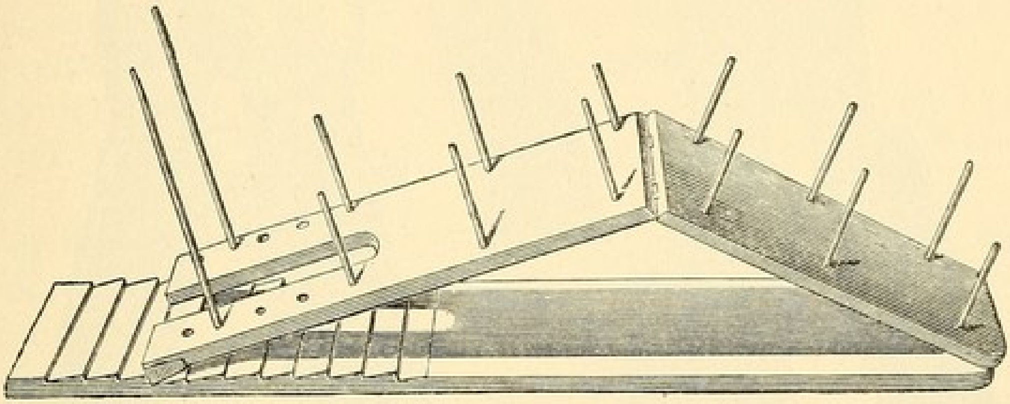


FIG. 243

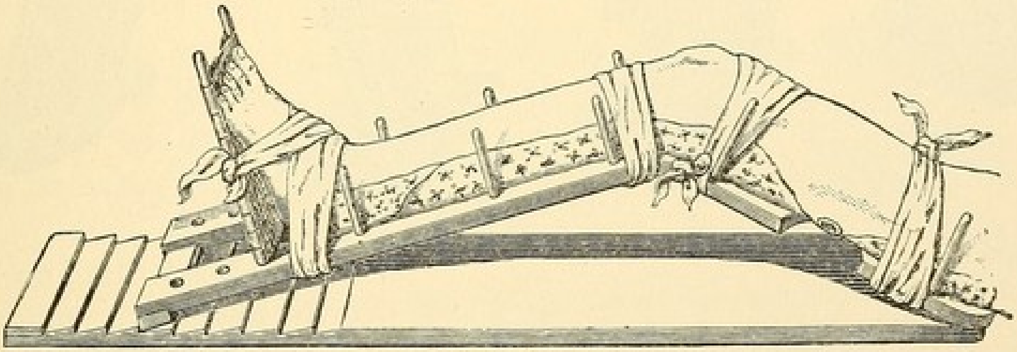


FIG. 244
VON ESMARCH'S DOUBLE INCLINED PLANE

If the wound is on the posterior side of the limb, a piece is sawed out of the board on that side (Fig. 244). Two longer wooden pegs, between which a bandage is stretched in figure-of-8 tours, serve as a support for the foot.

By means of *Dobson's* **wooden frame** (Fig. 245), placed under the mattress in the region of the knee, a practical double inclined plane for both legs can be extemporized.

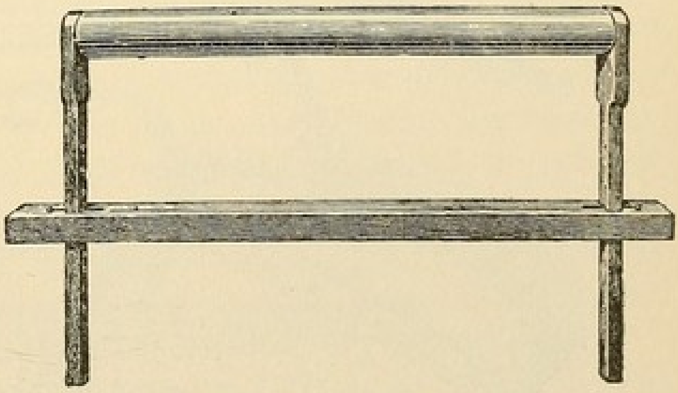


FIG. 245. DOBSON'S WOODEN FRAME

Von Renz's **abduction box** (Fig. 246) is especially adapted to cases of compound fractures of the femur, in which the upper fragment is in a strongly abducted position. Since the splint can

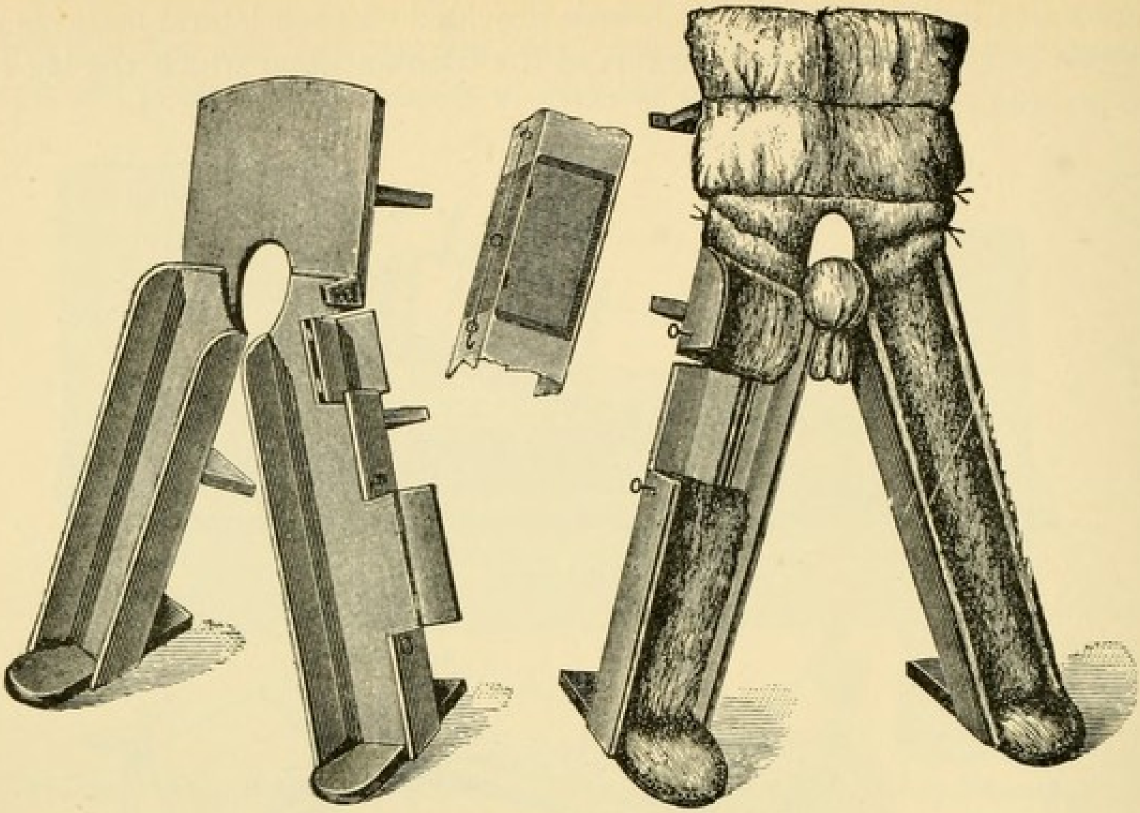


FIG. 246. VON RENZ'S ABDUCTION BOX

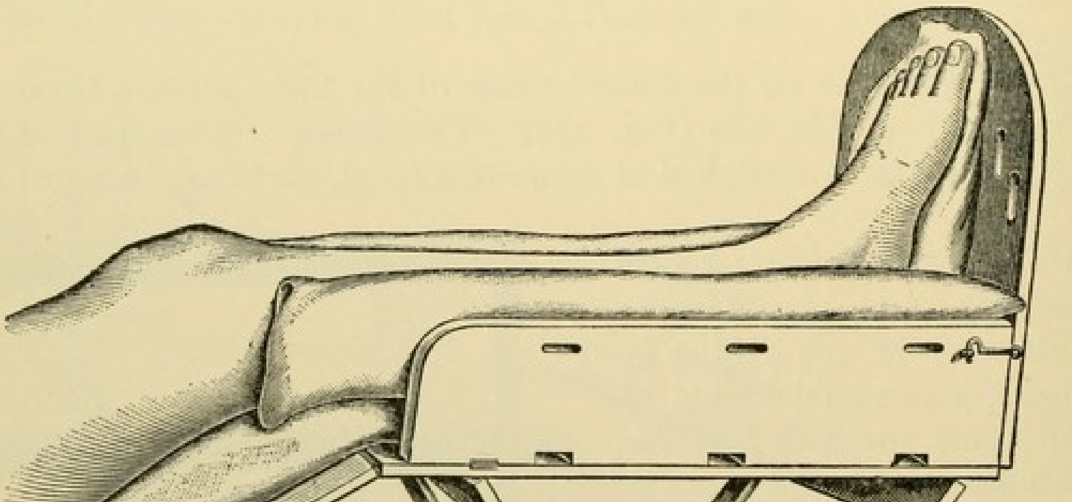


FIG. 247. PETIT AND HEISTER'S FRACTURE BOX

easily be made by any carpenter, it might prove valuable in practice in small places situated at some distance from large cities, where the physician must help himself. Openings are made over the wounds. During defecation, the round pillow, which occupies the part of the splint corresponding with the perineal region, is removed.

For compound fractures of the leg, previous to antiseptic times, *Petit's* **fracture box**, introduced into Germany by *Heister*, was extensively used (Fig. 247).

The leg is wedged in between straw cushions by means of the movable side pieces; for the change of dressings, each side of the lower portion of the leg can be made accessible, one after the other, without changing the position of the leg. By means of the movable supports, the angular position of the knee joint can be easily regulated.

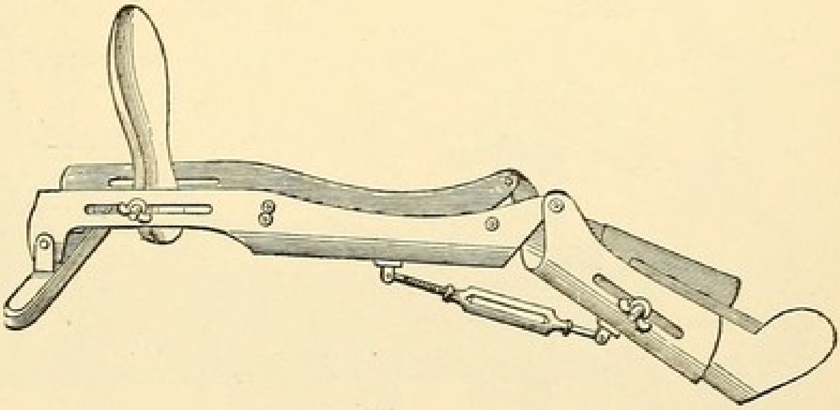


FIG. 248. MACINTYRE'S SPLINT (IMPROVED BY LISTON) FOR COMPOUND FRACTURES OF THE LEG

In England, *MacIntyre's* **splint**, improved by *Liston* and made of sheet iron, is used in preference for the same purpose (Fig. 248). The same has a movable foot board, which can be changed in various directions; by means of a screw on the back, the angular position of the knee joint can be changed very gradually. The transverse board at the lower end gives the splint a secure position. The portion for the thigh can be lengthened or shortened.

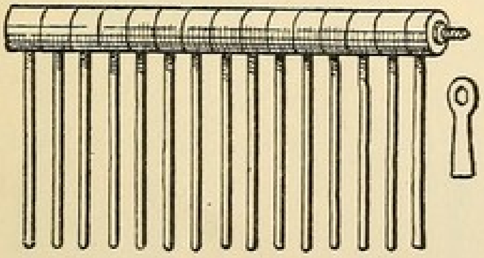


FIG. 249. FIALLA'S ROD SPLINT

Fialla's **rod splint** (Figs. 249, 250) consists of a row of thin rods which, by means of a screw, can be pressed together into any desired position around a common axis. It may serve as a substitute for the leg splints and the double inclined planes, especially since it can be easily folded, occupies little space, and can be placed in various angular positions.

The **fracture box** devised by *Scheuer* has this advantage: it can be very rapidly constructed with a few wooden laths (Fig. 251).

In modern times, the hollow straight splints with foot board (Fig. 155) are probably preferred by most physicians to all kinds of fracture boxes.

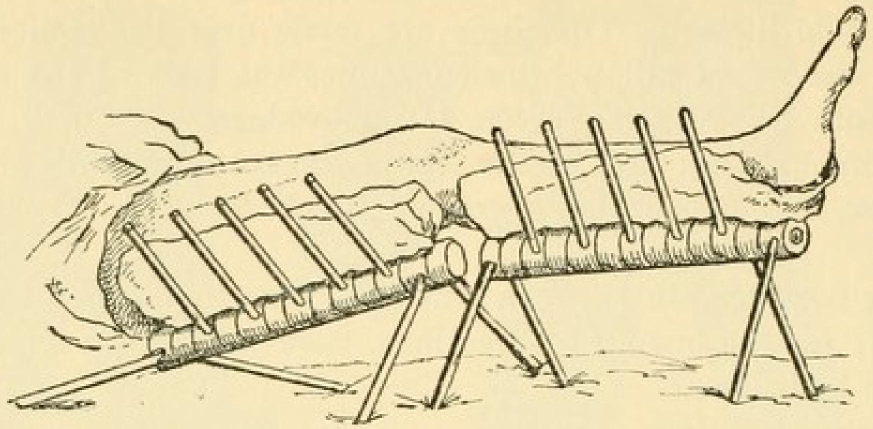


FIG. 250. FIALLA'S ROD SPLINT

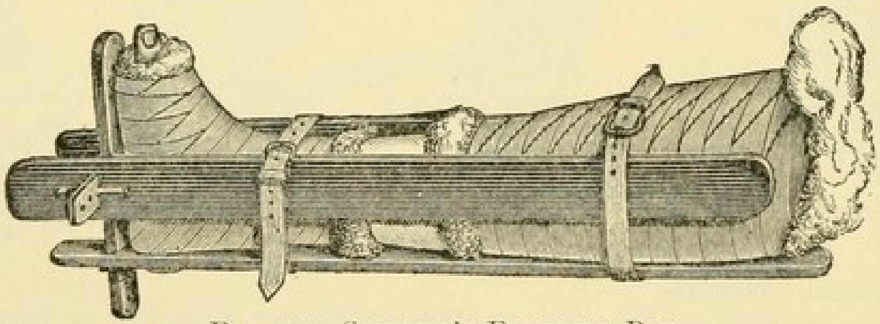


FIG. 251. SCHEUER'S FRACTURE BOX

In compound fractures of the humerus and in injuries of the shoulder joint, *Stromeyer's* **arm pillow** is very useful. This is a triangular soft upholstered horsehair pillow, covered with some waterproof material (Fig. 252). The apex of the pillow edge is placed in the axilla and fastened in front and behind with safety pins to a strip of bandage, which is carried over the opposite shoulder. The arm, bent at a right angle, and the pillow upon which it is placed are fastened together with a sling (Fig. 253).

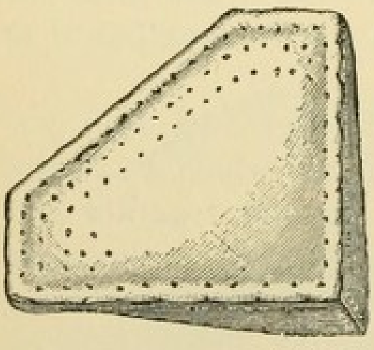


FIG. 252. STROMEYER'S ARM PILLOW

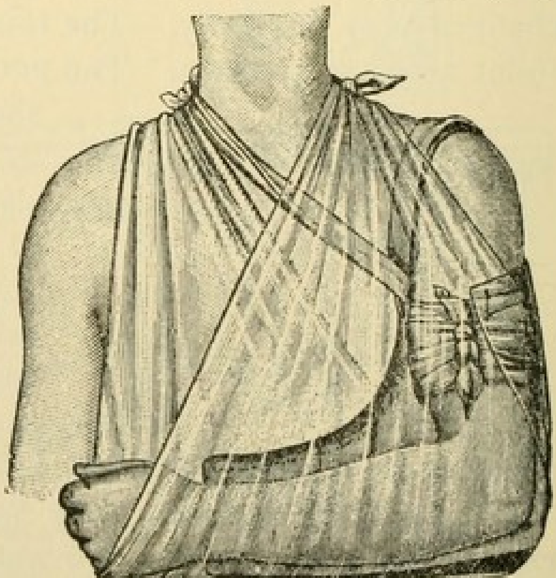


FIG. 253. STROMEYER'S ARM PILLOW

It secures rest for the arm by preventing the movements of breathing from being conducted to the fracture.

In fractures of the upper end of the humerus with an obstinate abduction of the upper fragment, the whole humerus can be placed in an abducted position by *Middeldorpf's* **triangle**, a triangular wedge-shaped pillow (Fig. 254), or a double inclined plane made of three boards (Fig. 255), the base of which is fastened to the trunk with belts or bandages, while the

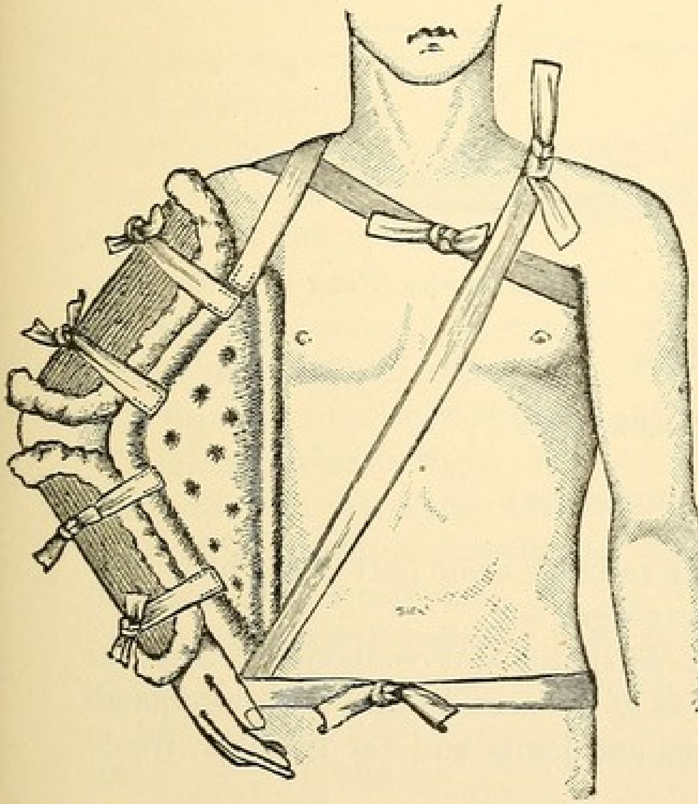


Fig. 254. Middeldorpf's Triangular Pillow

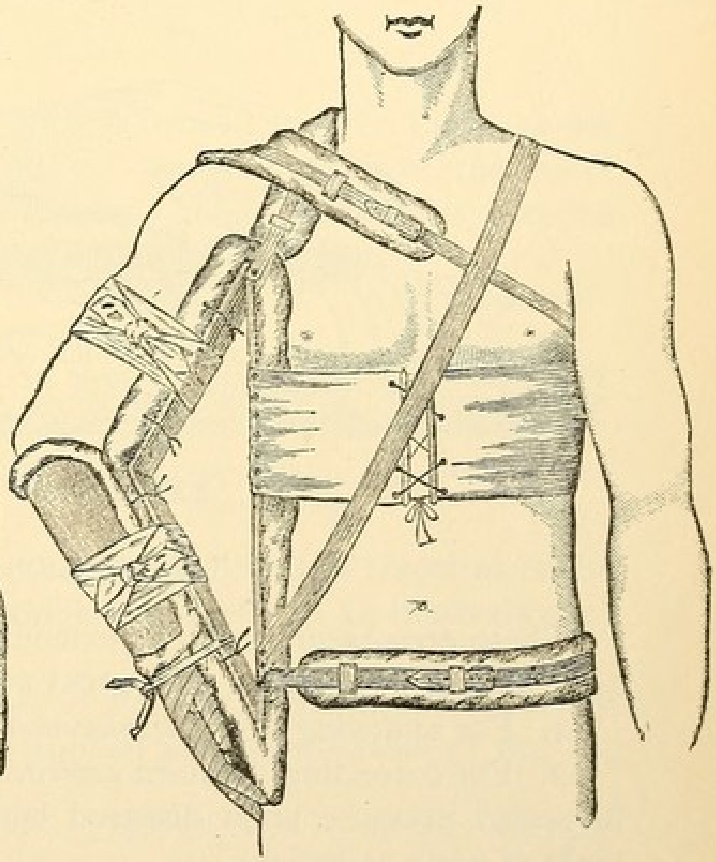


Fig. 255. Middeldorpf's Triangle

arm, bent at an obtuse angle, is placed upon the short sides and fastened there. This triangle can also be made from wire splints. On account of the dependent position of the arm, œdema is likely to ensue; hence, the whole arm must be very carefully bandaged from below upwards.

Lister's leather-covered **wooden splint** (Fig. 256), for *resection of the wrist*, secures a proper position for the hand and the fingers during the after treatment, when more frequent movements of the fingers become necessary. Many of the hand splints described above are superior, consequently it can almost be dispensed with. Modern surgery, especially in the case of *injured* limbs, rarely makes it necessary to resort to all of these position appliances, and contents itself with the cleaner modern splints. For special and very tedious cases, they might be used advantageously even to-day.

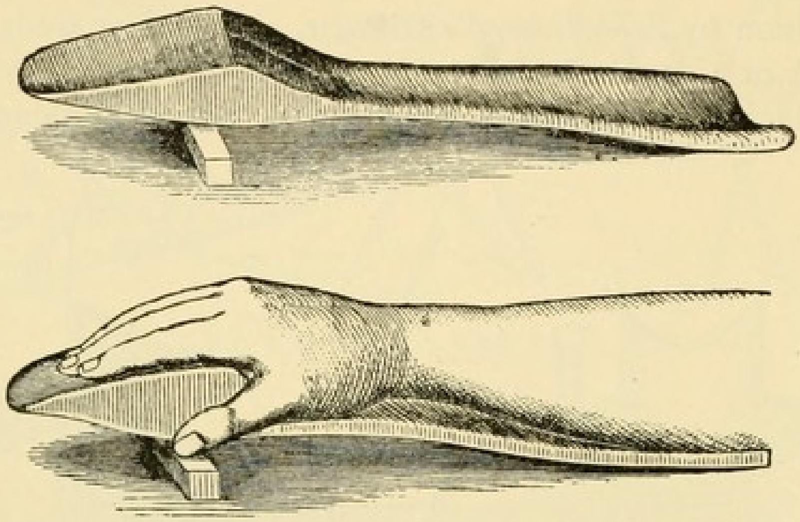


FIG. 256. LISTER'S WOODEN SPLINT FOR RESECTION OF WRIST

EXTENSION DRESSINGS

(DISTRACTION DRESSINGS)

These *permanently* exert an extending force on some part of the body and are frequently employed with great advantage: —

1. For removing great *displacements* in simple and compound fractures.
2. For correcting diseased *contraction of the muscles* and the consequent increased pressure upon diseased bones and joints and for the after treatment of some resections.
3. For removing or rather stretching *curvatures*.

To the incomplete but simple extension appliances, which may eventually be used as a temporary dressing for transportation, belongs *Desault-Liston's* **wooden splint** for *femoral fractures* (Fig. 257). A cloth fastens the foot to the lower end — improved by *Haynes Walton* (Fig. 257, *a*) — while a second cloth conducted over the perineum secures counter extension. By means of a third cloth (girdle cloth), the upper end of the splint is fastened to the pelvis. By means of a fourth and a fifth cloth, the thigh and leg are fastened laterally to the splint. Similar is *Dupuytren's* **splint for fracture of the ankle.** This splint, provided with a thick pad, is fastened laterally to the calf of the leg, while by means of cloths or bandages, the foot is fastened

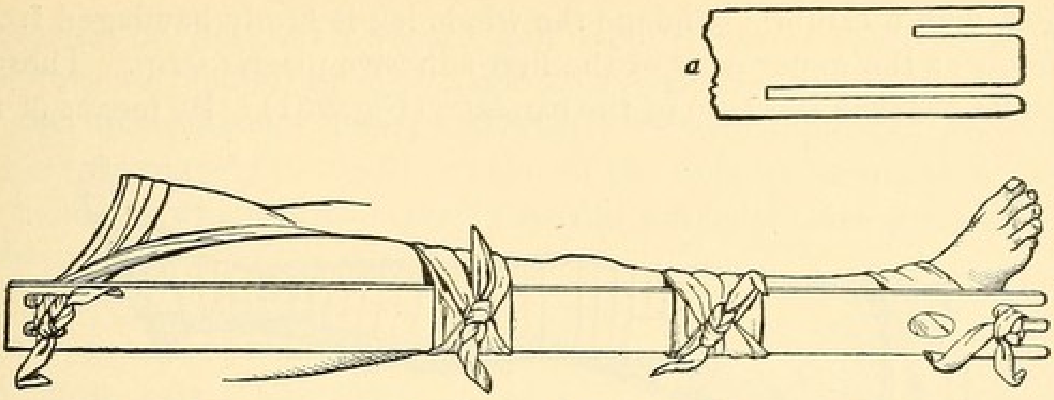


FIG. 257. DESAULT-LISTON'S WOODEN SPLINT FOR FEMORAL FRACTURES

at the lower end in such a manner that the broken ends of the bone are brought in proper position (Fig. 258). For extension, however, the use of *weights* and *elastic extensors* is much better. To make these means effective it is necessary, by a careful distribution of the points of attachment over a large surface, to make the permanent extension endurable for the patient. This has been accomplished by *Crosby's* **adhesive plaster loop**. Since this method is preferably and most frequently employed in fractures of the femur, the **extension dressing for the thigh** may serve as an illustration of this method of treatment.

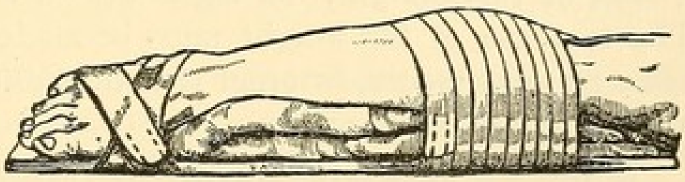


FIG. 258. DUPUYTREN'S SPLINT FOR FRACTURE OF THE ANKLE

Crosby's **adhesive plaster loop** consists of a strong, broad strip of adhesive plaster (spread upon canvas), which is applied along both sides of the leg as far as the fractured part of the femur. In the loop against the plantar surface of the foot is placed a small foot board provided with a ring (Fig. 259), to prevent pressure against the malleoli and furnish a point of attachment for the cord, and by means of a second strip of adhesive plaster, which encircles the leg spirally, the two strips of plaster are held in place (Fig. 260).

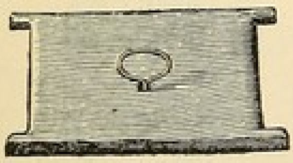


FIG. 259. FOOT BOARD

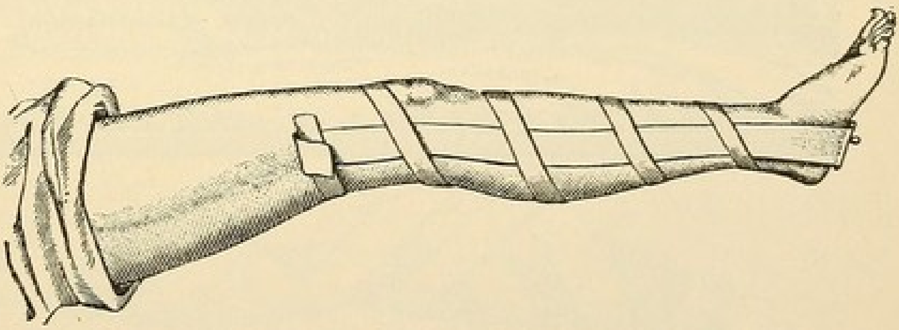


FIG. 260. APPLYING STRIPS OF ADHESIVE PLASTER

Next, with a cambric bandage the whole leg is firmly bandaged from the toes as far as the upper ends of the first adhesive plaster strip. These ends are turned over the last turn of the bandage (Fig. 261). By means of a cord

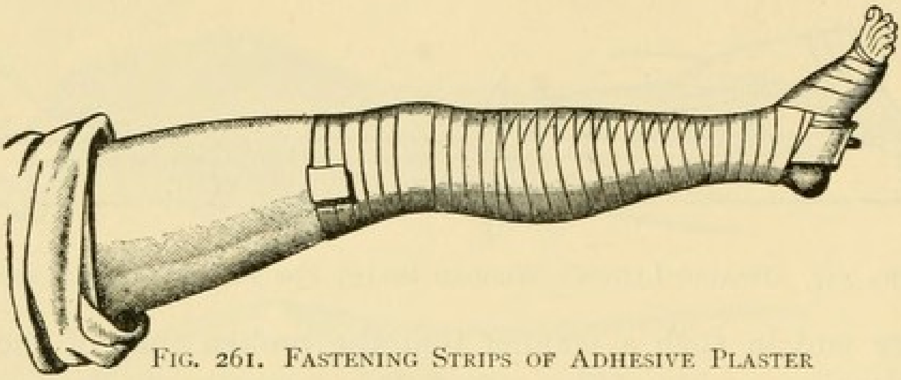


Fig. 261. Fastening Strips of Adhesive Plaster

running over pulleys, a weight is fastened to the ring of the foot board; by means of this weight, the leg is drawn toward the lower end of the bed. The increase of the weight must be made very gradually; preferably only after 10 to 12 hours, in order that the adhesive plaster may become firmly attached to the skin.

If the leg were left without any further support, it would sink into the mattress, and the friction would either entirely or partly neutralize the effect

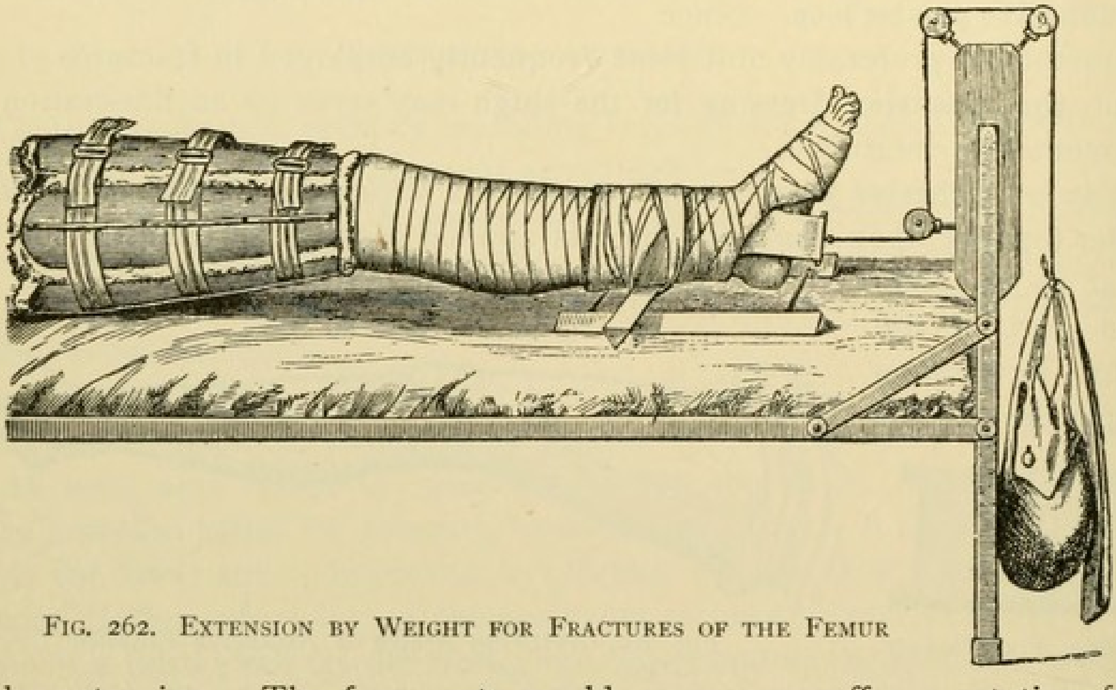


Fig. 262. Extension by Weight for Fractures of the Femur

of the extension. The fragments would, moreover, suffer a rotation from the lateral movements of the foot.

To prevent both these results, the leg may be placed on *von Volkmann's* **sleigh apparatus** (Fig. 263), a short, hollow, iron splint provided with an opening for the heel, a foot board, and under the same a narrow transverse bar, resting and sliding upon two smooth, triangular wooden bars.

If this splint is not at hand, a prismatic transverse piece of wood may be fastened transversely to the dorsal side of the tibia by means of a plaster of paris bandage, which is also carried around the foot; this transverse piece is allowed to slide on the two wooden prisms connected by parallel iron wires (Fig. 262).

In most cases, however, *von Volkmann's* tin splints are provided with such prismatic transverse pieces of wood.

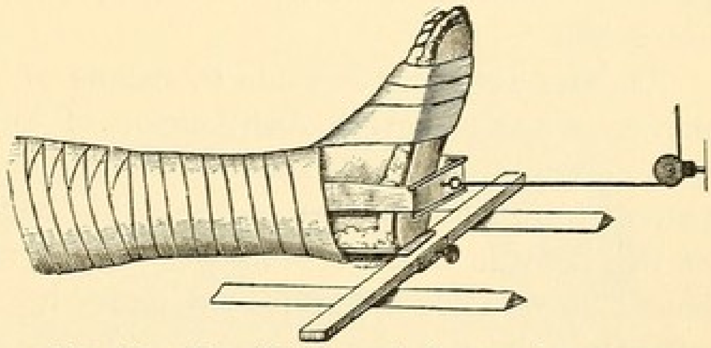


FIG. 263. VON VOLKMANN'S SLEIGH APPARATUS

In many patients, common adhesive plaster causes a troublesome itching of the skin and eczema; hence, it is better to use non-irritant adhesive plaster; for instance, the excellent though expensive adhesive *india-rubber plaster*, or the zinc plaster muslin.

In cases where not even this is well borne, or where no adhesive materials can be used, a substitute must be found. The extension splint can be fastened very well by two *wet bandages*, each double the length of the whole leg, in the middle of which a small slit is cut for the ring of the foot board. Two of the four ends hanging therefrom are carried in an anterior and the other two in a posterior direction in serpentine turns around the limb (Fig. 264). If another dry bandage is carefully wrapped over them as far as the fracture, considerable extension is secured without causing the bandages to slip; by coating the bandages with paste or flour, they can be made still more

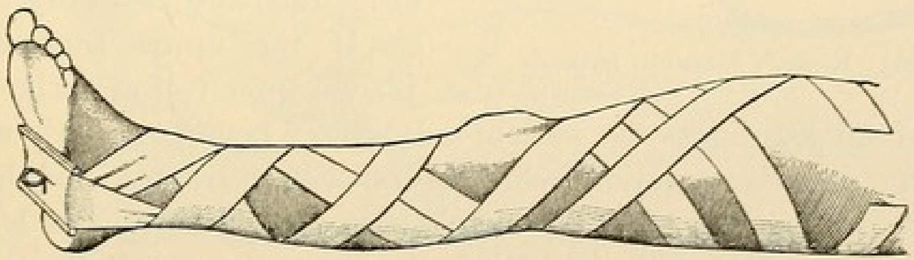


FIG. 264. FASTENING THE EXTENSION SPLINT BY TWO WET BANDAGES

secure. By *sewing* or *fastening* the several turns of the bandage with safety pins, a firm hold is secured even with a common bandage.

Likewise, the trellis finger catcher, made of fibres of the palm leaf (" Fingerfänger," " Mädchenfänger "), which under tension becomes tighter, and which cannot be stripped again from the limb, can be used in case of necessity as a substitute for adhesive plaster. Although a plaster of paris bandage applied on the bare skin adheres, it is less to be recommended.

The traction by the attached weight varies from 2 to 12 kilograms, according to circumstances; for most cases 5 to 8 kilograms are sufficient. Very powerful muscles sometimes cannot be overcome by means of weight extension.

Counter extension is made by means of a padded cord carried over the perineum and the groin, or by means of a thick India rubber cord wrapped with cotton, and fastened laterally to the head of the bed; this prevents the patient from being drawn down in his bed by the weight. Or the weight of the body is used for this purpose by raising the foot of the bed with blocks of wood or bricks placed under it. In the treatment of coxitis by extension, the counter extension is made in the abducted position of the limb on the *diseased* side, and in the adducted position on the *healthy* side. After resection of the hip joint, extension must be made with the limb in the abducted position.

Von Dumreicher used the weight of the limb for an extension by placing it upon a single inclined splint with rollers (**railway apparatus**). Much simpler and more practical is *König's* **gliding stirrup** (Fig. 265), a dorsal splint which allows the leg to be suspended upon two iron arches fastened laterally. To prevent outward rotation of the fragments, the thigh is fixed with short splints; for instance, those of *Gooch* (Fig. 140) and *Bell* (Fig. 151).

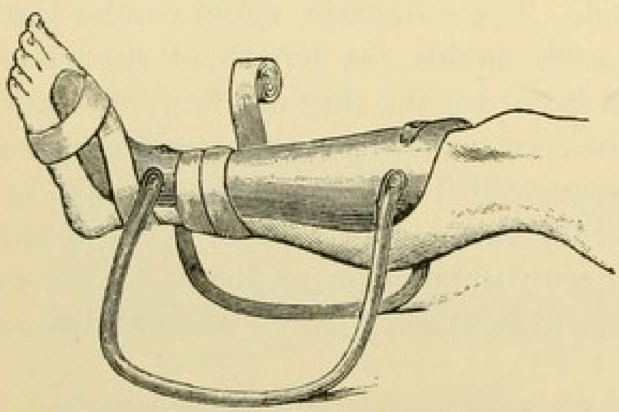


Fig. 265. König's Gliding Stirrup

If the upper fragment is displaced much anteriorly, or if on account of uncleanliness the patient's dressings become greatly soiled from the prolonged supine position (which is the case in fractures of the femur in little children), it is advisable to make vertical extension. The leg is drawn up straight on a gallows, so that the body exerts the *extension* (*Schede*).

For **extension of the arm**, the adhesive plaster strips are fastened on the internal and external side of the arm, so that the cross-board is placed under the elbow, with the forearm bent at a right angle. If the forearm is supported by a sling, the weight can be fastened to the cross-board, and the patient can walk about. Or the arm is fastened on a *suspension splint*, similar to *von Volkmann's*, at the elbow part of which the extension cord is carried over a pulley; the patient must then remain in bed.

For extension of the wrist in the treatment of inflammation, as well as resection of the same, loops of equal length of adhesive plaster strips are fastened to all the fingers in the form of a gauntlet (Fig. 88), and through these loops a thin rod is inserted. A weight carried over a pulley is fast-

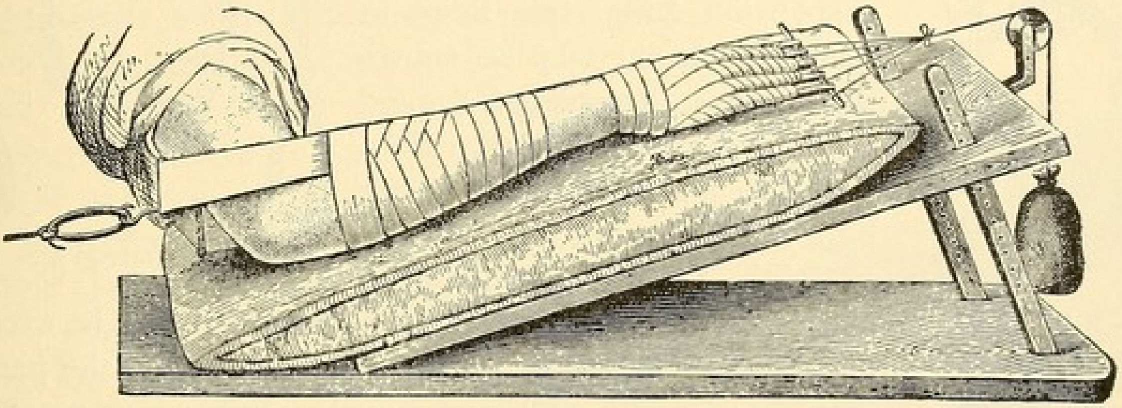


FIG. 266. EXTENSION OF THE WRIST

ened to this by means of fine cords. The counter extension can be effected by a large adhesive plaster loop, applied to both sides of the forearm, and fastened by means of a cord with an India rubber ring to the head of the bed. The arm rests on an inclined plane (Fig. 266).

Extension of the trunk is resorted to more especially in the treatment of diseases or curvatures of the spine, and can only be accomplished by a complicated apparatus. Among these numerous appliances, the following will be mentioned briefly: —

Von Volkmann's **extension apparatus for the cervical portion of the spine** in the treatment of spondylitis (Fig. 267).

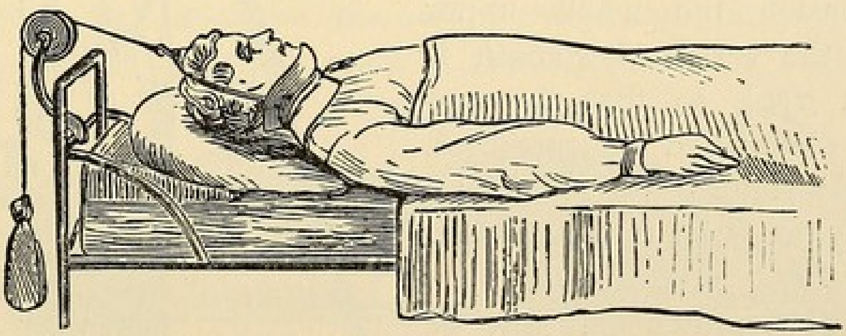


FIG. 267. VON VOLKMANN'S EXTENSION APPARATUS FOR THE CERVICAL PORTION OF THE SPINE

The head is extended in a horizontal direction by means of *Glisson's* sling, which encircles the chin and the occiput; to this sling, provided with a curved iron cross-bar, the extending weight is fastened and carried over a pulley at the head of the bed. If it becomes necessary to increase the extension, this can be done by attaching weights to both lower extremities. Instead of the weights, counter extension is made by raising the head of the bed. For *Glisson's* suspension sling, two loops of adhesive plaster may be substituted; these are placed around the chin and the occiput, united over the head, and kept apart by a transverse piece of wood.

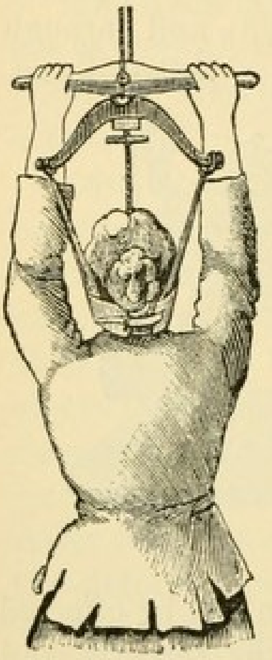


Fig. 268. Extension for Scoliosis

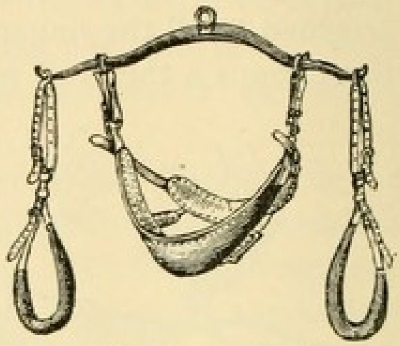


Fig. 269. Glisson's Sling

With *Glisson's* suspension sling, according to *Sayre*, an extension can also be exerted on the *scoliotic* spine. By means of a pulley the patient lifts himself with both arms until only his toes touch the floor, the weight of the body becoming thus the extending force (Fig. 268). In this position, in which the spine is stretched as much as possible, a fixative dressing (plaster of paris felt corset) is applied in cases in which such treatment is indicated. The extension is more endurable and still more effective if axillary extensors are added to *Glisson's* sling (Fig. 269). By this combined extension the whole upper section of the vertebral column is lifted (Fig. 270), so that the curvature is diminished or corrected. These suspension exercises are repeated daily, and the time is gradually increased.

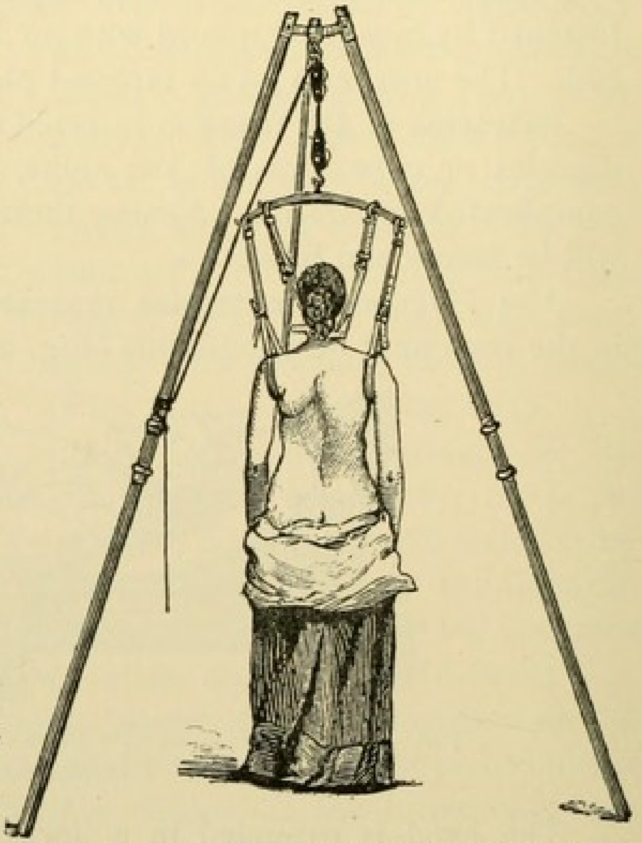


Fig. 270. Sayre's Extension Apparatus for Scoliotic Spine

Scoliotic curvatures may also be removed temporarily by a *lateral* extension. *Barwell* places the patient with the prominence of the curvature into a girth sling, which, when traction is made by weight and pulley, presses the curvature into its normal position (Fig. 271). This position is also suitable for applying plastic corsets in an "over correction" (*Peterson*).

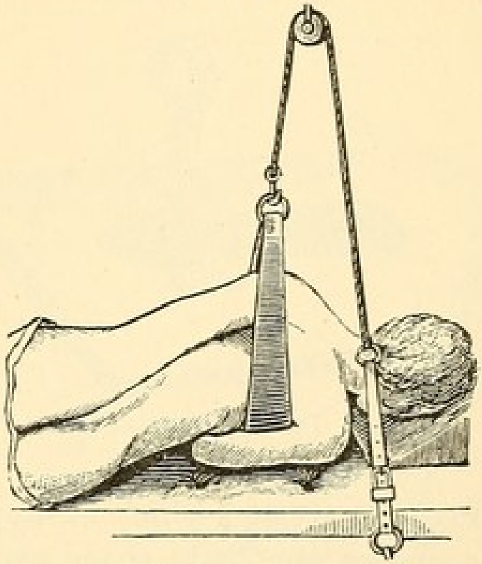


FIG. 271. BARWELL'S LATERAL EXTENSION IN SCOLIOSIS

DRESSINGS WITH ELASTIC EXTENSION AND WITH ADHESIVE PLASTER

Although elastic extension becomes very effective on account of its active force, its effect can be less easily gauged than that of extension by weight and pulley; on the other hand, it has the advantage of being lighter and more comfortable.

For elastic extension, either strong *india-rubber rings*, such as can be bought everywhere, are used; or, if such are not available, a piece of *india-rubber hose.* Small grooved wooden plugs, provided with hooks, are fastened at both ends (Figs. 272, 273). The simple knotting of the ends is less secure, since these knots easily get loose.

FIG. 272. GROOVED WOODEN PLUG

For a distant transportation, the wounded person is placed at once *upon a stretcher* and supplied with such an elastic extension by fastening with an

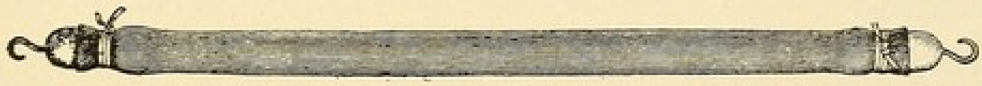


FIG. 273. INDIA-RUBBER HOSE WITH HOOKS

india-rubber ring the carefully bandaged limb to the lower end of the stretcher; for counter extension, the belt of the patient, or, in case of necessity, the leg of his trousers, cut open at the inner and the outer seam and

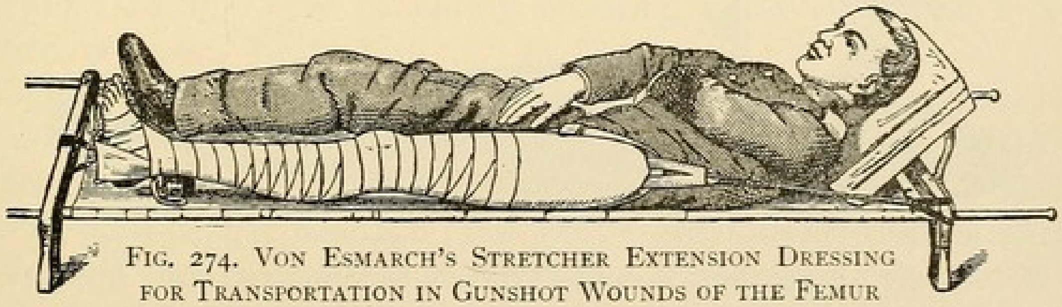


FIG. 274. VON ESMARCH'S STRETCHER EXTENSION DRESSING FOR TRANSPORTATION IN GUNSHOT WOUNDS OF THE FEMUR

rolled up to the perineal region, is fastened with an elastic cord or a suspender to the head of the stretcher (Fig. 274).

For the same purpose, the **separable wooden splint** (Fig. 139) can be used ; five sections of the same joined together are sufficient. An iron hook, to which the extension ring is fastened, is applied, when used, at the lowermost part (Fig. 275).

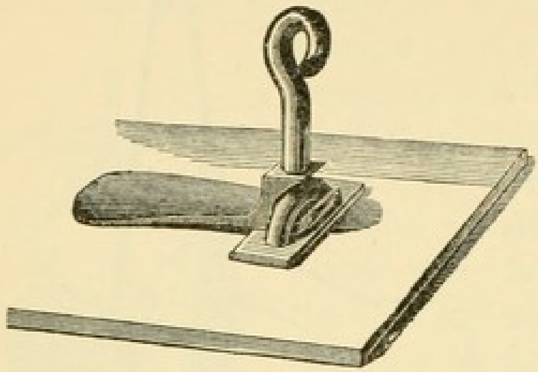


Fig. 275. Iron Hook for Separable Wooden Splint

At the upper section are two slots, to which are fastened both the pelvic belt and, by means of a second india-rubber ring, the perineal band. If the leg of the trousers is not used for a counter extension, it is carefully folded and used as a padding between the splint and the leg (Fig. 276). The splint, which can be taken apart and which is supplied with a hook and two india-rubber rings, occupies very little space and can be easily packed.

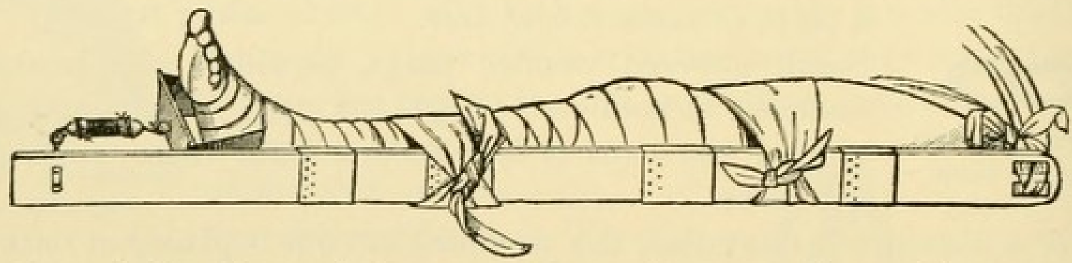


Fig. 276. Von Esmarch's Separable Wooden Splint for Elastic Extension of the Thigh

In the same manner the *wrist* can be provided with a very effective elastic extension. The hand and the forearm, after having been bandaged as described above (Fig. 266), are placed upon a hand splint provided in front and behind with rollers. Next, the extension cords under the splint

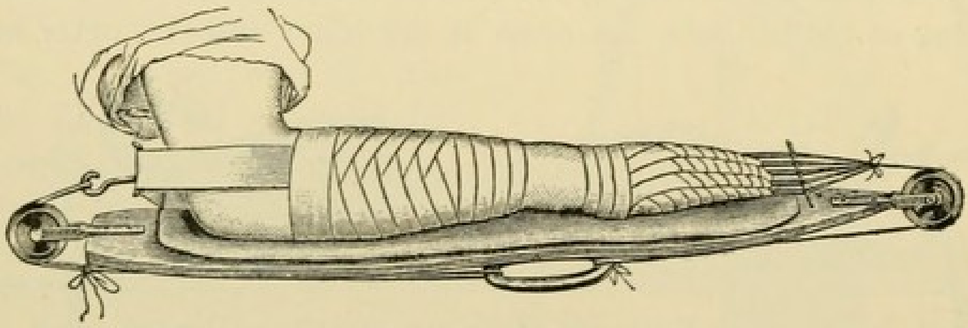


Fig. 277. Elastic Extension of the Wrist

are stretched tight by means of an india-rubber ring (Fig. 277). The patient can walk about with this dressing.

Sayre's **adhesive plaster dressing** for *fractures of the clavicle* is also an extension dressing, as by lifting the shoulder outward, backward, and upward, it corrects the overlapping of the fragments. Cut two strips, 8 to 10 centimeters wide, of strong adhesive plaster spread upon canvas, one strip long enough to be carried around the arm and also around the thorax, the other long enough to be carried from the healthy shoulder over the elbow of the diseased side, and thence back to the healthy shoulder.

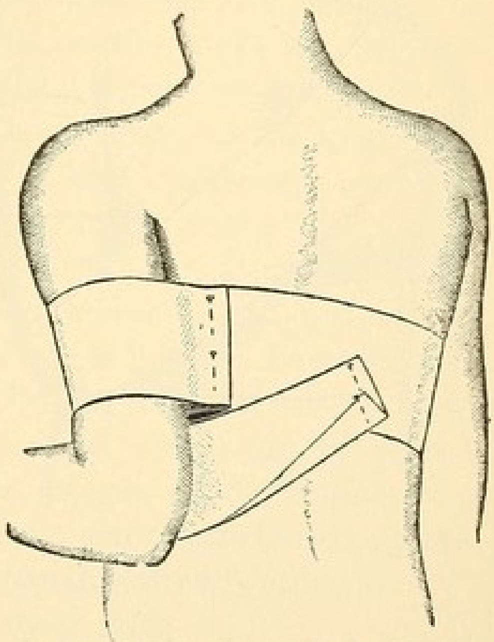
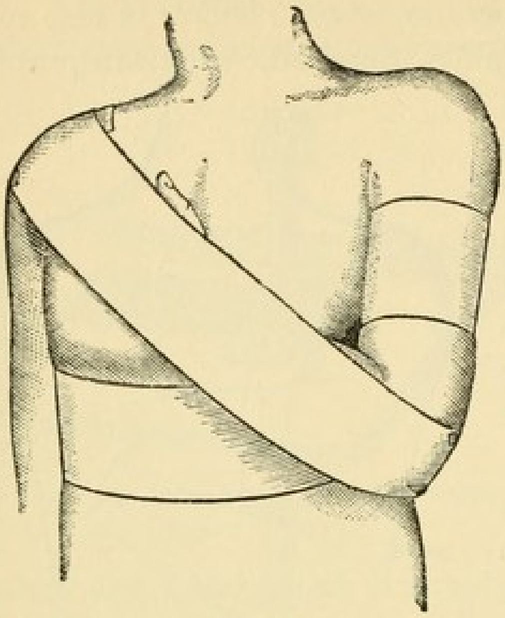


FIG. 278. SAYRE'S ADHESIVE PLASTER DRESSING (First Strip)

Apply the first strip below the margin of the axilla around the arm; next, on the posterior side of the arm, sew it together to form a loop wide enough to leave posteriorly a portion of the arm free; this prevents strangulation. By means of this loop, draw the arm downward and backward, until the internal sternal fragment of the clavicle has been drawn sufficiently downward by stretching the pectoralis major muscle. Fix the arm in this position by carrying the strip of adhesive plaster around the chest and fasten its end posteriorly to the strip (Fig. 278).

Cut in the middle portion of the second strip a small longitudinal slit to receive the olecranon process. Next, place the patient's forearm, bent at an acute angle, upon his breast; (while an assistant forces the elbow forward and inward, completely reducing the fracture) fix the arm in this position by the second strip, the middle of which receives the tip of the elbow. Carry both ends across the breast and back over the opposite shoulder, where they cross each other, and fasten them with a few safety pins (Figs. 279, 280). In the case of unruly children, apply over this a *Desault* starched bandage.

Similar is *Landerer's* **adhesive plaster dressing** for *fractures of the clavicle*. Sew a broad strip of adhesive plaster, cut several times lengthwise at one end, together with another strip of equal length by means of a broad piece of strong india-rubber bandage (Fig. 281). Next, apply the first strip upon the diseased shoulder so that its fingerlike attachments come to lie anteriorly, carry it posteriorly and obliquely across the back, and apply the second strip of adhesive plaster, under strong tension, like a girdle around the healthy side, and fasten it there. The elastic bandage then draws the



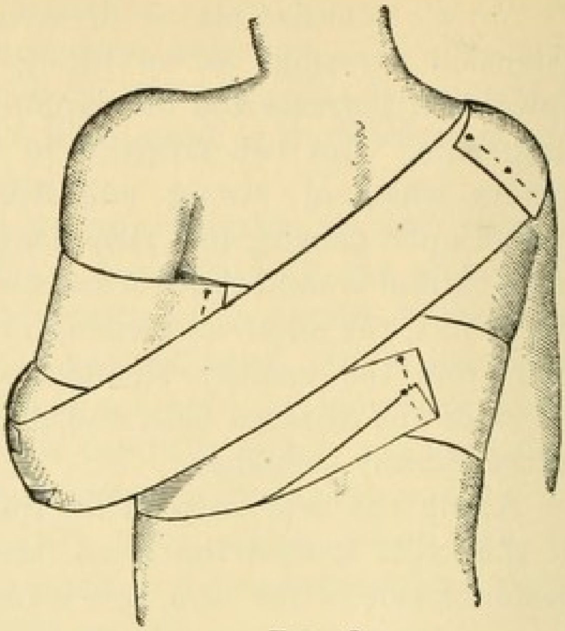
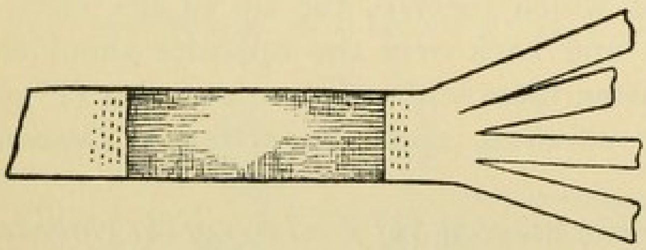


Fig. 279 Fig. 280

Sayre's Adhesive Plaster Dressing (Second Strip)

diseased shoulder backward, and hence produces an extension force upon the fragments.

In the same manner *Landerer* applies his *extension dressing for genu valgum* (*knock-knee*). Two broad strips of adhesive plaster encircle the thigh and the leg; at the inner side of the knee a broad elastic band is stretched tensely between them, or into the ends of the bands of adhesive plaster, at the knee, transverse pieces of wood are fastened and are gradually



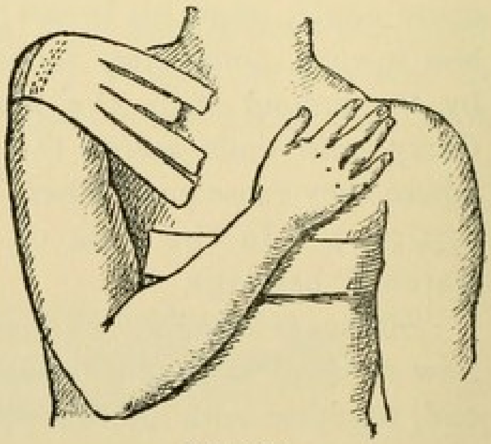


Fig. 281 Fig. 282

Landerer's Adhesive Plaster Dressing with Elastic Extension

contracted more and more by india-rubber rings. The same end may be obtained also by means of a buckle arrangement in the elastic middle piece.

More effective, however, is *Miculicz's* **extension dressing for genu valgum** (Fig. 283). The whole leg is bandaged with a plaster of paris dressing, into the posterior and the anterior sides of which iron splints with hinges are incorporated, so that the hinges correspond to the region of the knee joint; at the inner side of the plaster of paris dressing, over the thigh and leg, a hook is fastened with a plaster of paris bandage; after the dressings have set, a wedge is cut out of the dressings in the region of the knee with its base inward; thereby two plaster of paris dressings are formed, which can be moved *laterally* on the hinges of the splints; by means of an elastic extension connecting the two hooks, the leg is gradually straightened.

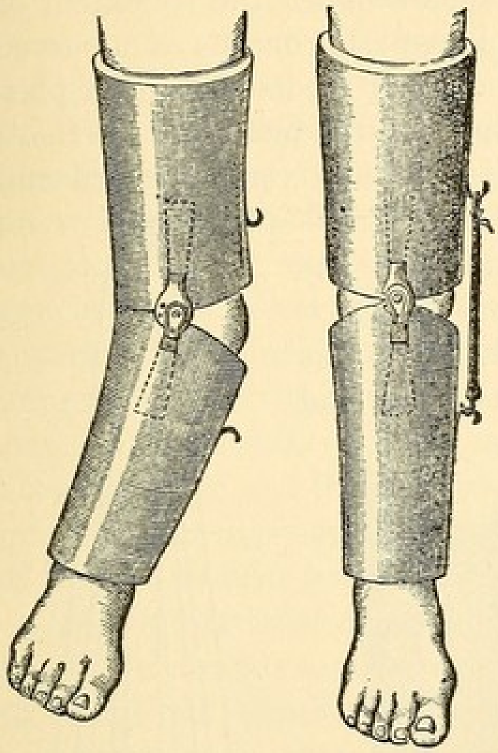


Fig. 283. Miculicz's Extension Dressing for Genu Valgum

Club-foot shoe with elastic extension (Fig. 284), used in the after treatment of corrected club-foot, consists essentially of a solid lace shoe, with lateral steel braces, from the upper end of which an elastic cord extends to the point of the shoe. This extension is to replace artificially the muscles which have become atrophied. According to these principles, it may be changed to meet the requirements of individual cases.

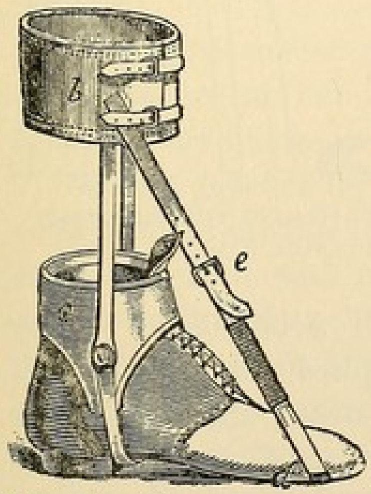


Fig. 284. Club-foot Shoe with Elastic Extension

Finally, in connection with more or less complicated appliances, extension can be made by means of **screw splints**; as examples, may be mentioned here: —

Sayre's **extension dressing** for the **knee joint** (Fig. 285). Thigh and leg are covered with adhesive plaster strips in the manner of *Scultet's* bandage; these two separate dressings are screwed

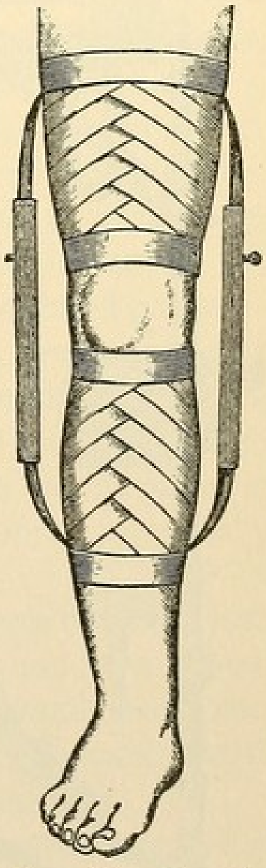


Fig. 285. Sayre's Extension Dressing for the Knee Joint

apart by means of an iron splint, attached on both sides at their extreme ends.

Fig. 286. Sayre's Jurymast

Sayre's **portable extension apparatus** for the treatment of **cervical spondylitis** (Minerva, Jurymast) consists of a curved steel rod incorporated in the posterior median line of a plaster of paris jacket, giving support to the head in a *Glisson's* sling. By means of screw action the rod can be raised and lowered (Fig. 286).

Taylor's **extension apparatus** for the ambulant treatment of *coxitis* (Fig. 287) consists of a strong steel shaft as long as the leg, with a pelvic belt at its upper end and a foot support at its lower end. By means of a screw, the splint can be extended, thus stretching the leg fastened to it. The apparatus is fastened by means of a five-headed strip of adhesive plaster, so that its broad end comes to lie in a downward direction and somewhat across the inner malleolus (Fig. 288). Over it, the whole leg is covered with a bandage. After the apparatus has been applied, the patient *rides* or *sits* on the perineal strap; the foot hangs suspended in the air and the diseased joint is thus relieved from the weight of the body. This original apparatus has undergone numerous

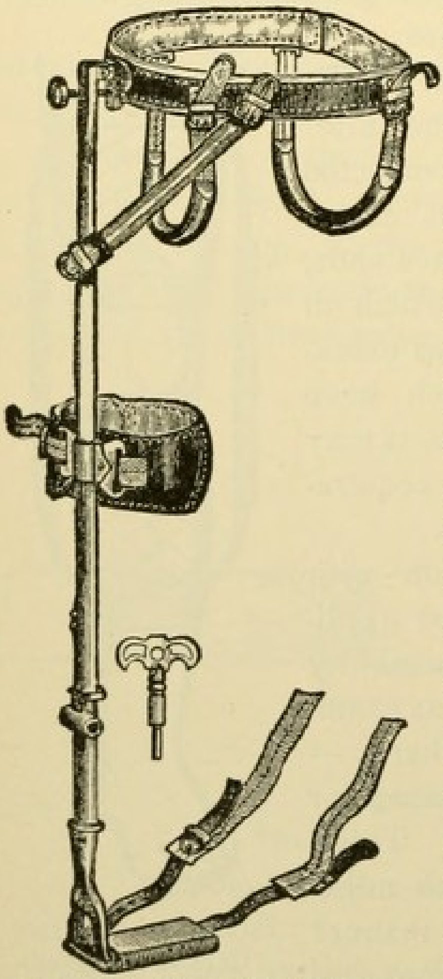


Fig. 287. Taylor's Extension Apparatus

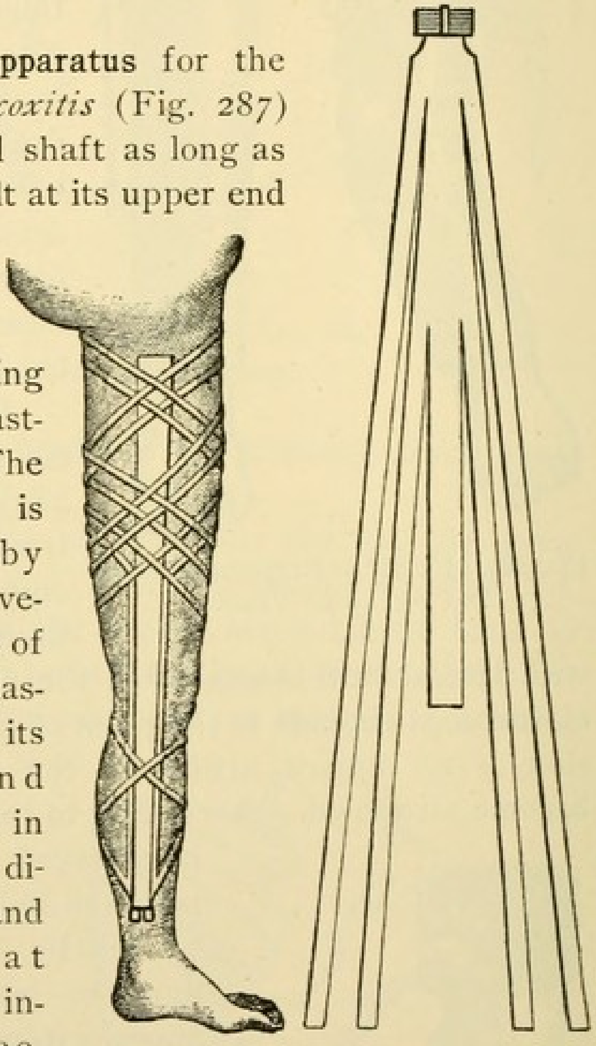


Fig. 288. Fastening the Adhesive Plaster Strips

improvements and has been largely changed (*Sayre*, *Schaffer*, *Whitehead*, and others).

TEMPORARY DRESSINGS

If the ordinary articles of dressings so far described are not available for dressing wounds, arresting hemorrhage, immobilizing fractures of bones, the physician or the trained layman (Red Cross nurse, Samaritan) has to extemporize a dressing quickly with *whatever material is at hand*. Such emergencies occur often enough in *time of peace* (it is said that in Prussia alone considerably more than 100,000 serious injuries occur annually). Especially important, however, is the art of improvising rapidly and well in *time of war*. After large battles, with the murderous destructions which the most recent firearms cause and the infinite number of wounds, even the largest supply of materials for dressings becomes exhausted, and the otherwise ample number of trained persons becomes insufficient at least for the moment.

In the **treatment of wounds,** the first principle to be observed is not to touch the wounds *unnecessarily*, especially with *unclean* (non-aseptic) hands, to forego all indiscreet examinations, probing, removing of foreign bodies, and not to apply any dressings which are not known to be *surgically clean*; for to leave the wound open and unprotected from every dressing (the open treatment of wounds) is less hazardous than to cover it with unclean materials. Slight hemorrhages also are more easily arrested by means of the scab which forms in the open air. In the neighborhood of inhabited places — in houses, however, with scanty means — an *aseptic dressing* can be made by *boiling* water for some time; with this, the wound is cleansed from all impurities; next, it is covered with a clean (washed and ironed) cloth (handkerchief) and this dressing is fastened with another cloth. If no aseptic dressing materials are at hand, they may be obtained in a very simple manner by *boiling* some pieces of gauze, etc.

Wound douches for a sufficient irrigation of the wound may be made with vessels open on the top (cooking utensils), into which the end of a rubber hose, weighted with a stone or some similar object, is lowered, while suction is produced at the other end; or by making a glass douche according to Fig. 28. Funnels and cans can also be used for this purpose.

For *bandages* may be used strips of table cloths, sheets, and shirts. The *cloth bandages* may be made of a napkin or a handkerchief. An *arm sling* may be improvised, in want of cloths, from the skirts of a coat, the sleeves of a coat or a shirt cut open, or the uninjured sleeve fastened to the breast with safety pins (Figs. 289–291). In the case of women place the arm into the apron thrown over the shoulder.

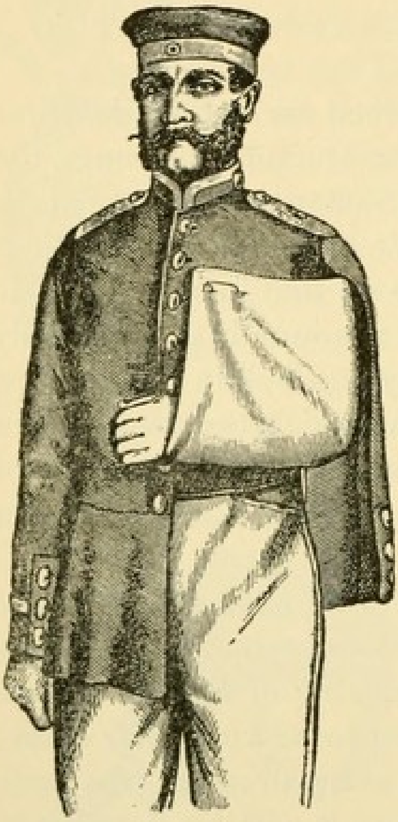


FIG. 289
CLOTH BANDAGE OF SKIRT OF COAT

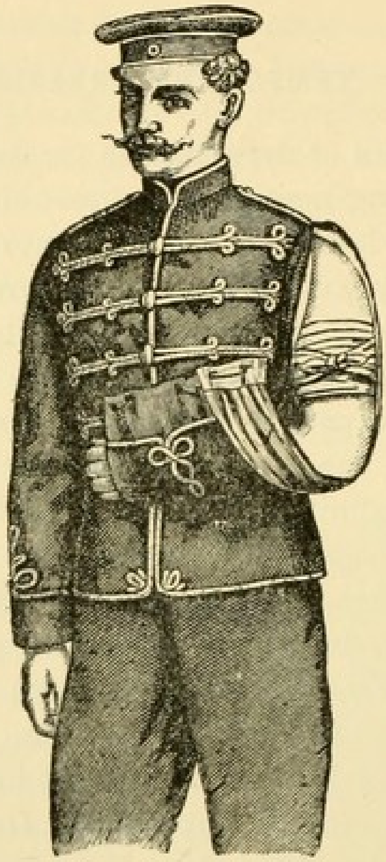


FIG. 290
BANDAGE OF COAT SLEEVE CUT OPEN

FIG. 291
BANDAGE OF SLEEVE FASTENED BY SAFETY PINS

When **hemorrhages** cannot be arrested by means of a firmly applied dressing, then, first of all, elevate the limb; in case of necessity, compress the bleeding artery above the wound with the finger or with a tourniquet quickly improvised. In serious injuries of the large vessels, constrict the whole limb between wound and heart with an elastic tube, suspender, or a bandage which is subsequently moistened.

If **bones are fractured**, in addition to the greatest gentleness and circumspection possible in touching and moving the injured person, splints should be quickly procured.

For **temporary splints** may be used: —

(*a*) *Wooden splints*, rulers, laths, poles, boards (Fig. 292), strips of wood, trellis of flower pots (Fig. 293), flexible wooden covers (like *Gooch's* flexible wooden splints — Fig. 140). Useful, also, are twigs or small *branches*, tied together in bundles (Fig. 294), or arranged side by side smoothly, fastened by tying them together with transverse pieces of wood (Fig. 295), or with

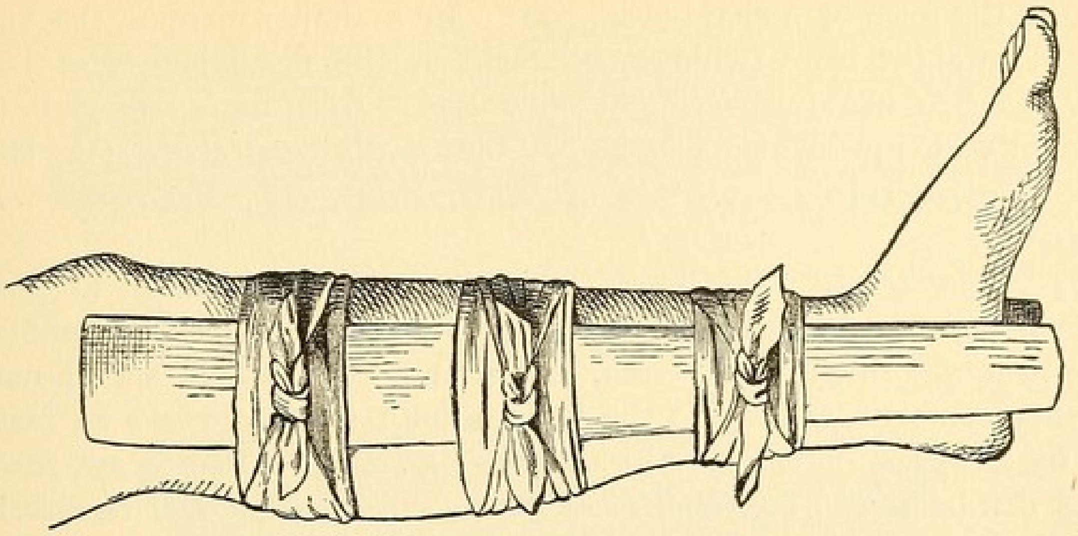


FIG. 292. TEMPORARY SPLINTS FOR FRACTURED LEG

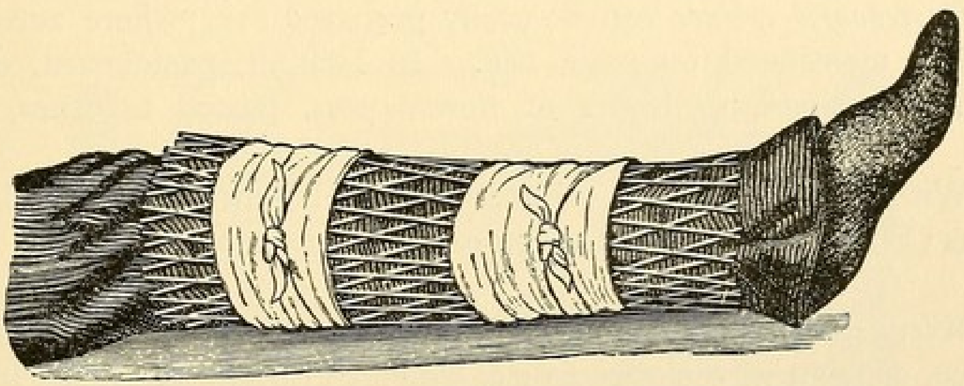


FIG. 293. SPLINT OF TRELLIS OF FLOWER POT

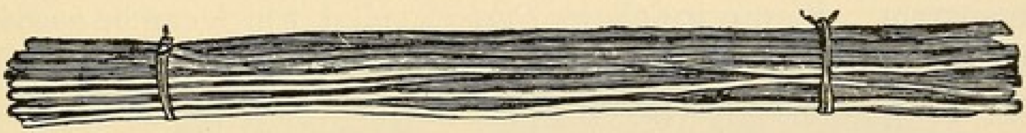


FIG. 294. SPLINT OF SMALL BRANCHES TIED IN BUNDLES

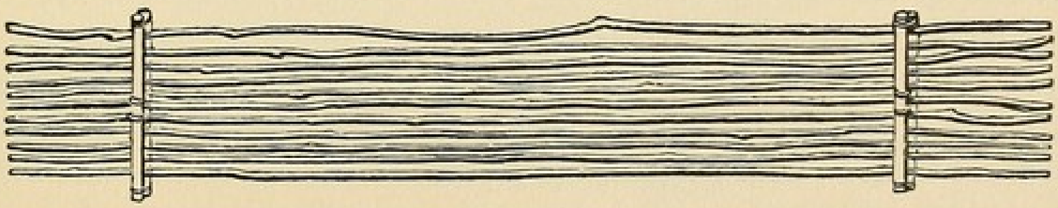


FIG. 295. FLAT SPLINT OF TWIGS ARRANGED SIDE BY SIDE

twine in the form of a chain (Fig. 296). In a similar manner, the smooth bark of straight trees (willows, beeches), or the dried leaves of banana trees, or thin, flexible veneering may be used. Also, the splint cloth (illustrated in Fig. 142), which can be cut, may easily be prepared; in lack of some adhesive substance, strips of wood, twigs, etc., are sewed to the material.

(*b*) *Straw splints*. Stalks of straw in as good condition as possible are tied together in bundles (Fig. 297). Two of these straw splints are wrapped into both ends of a cloth, placed under the limb in such a manner that they come to lie close to the limb on both sides, and can be fastened to it by means of boards (*straw splint*—Fig. 298). Also, straw, reeds, or rushes can be sewed into mats (*von Beck*), and the limb can be enveloped with them and a bandage applied over them; when rolled up on each side they can also be used for lateral splints (Figs. 299, 300). Door mats, linoleum, strips of carpet, etc., can be used in the same manner.

(*c*) *Pasteboard splints* can be easily prepared everywhere according to the models mentioned on page 128. In lack of pasteboard, old book covers, maps, boxes, or layers of newspapers, pasted together, may be used.

(*d*) With a pair of strong scissors, *tin* can be cut into any desired form of splints (Figs. 156, 157). A piece of roof gutter makes a very practical splint.

(*e*) *Wire splints* are prepared from strong wire taken from fences, enclosures, or from woven wire gauze, which can be purchased. In time of war, the use of telegraph wire, from lines broken during battle, is of especial importance. With a strong pair of pincers and a file, even with little experience, simple splints may be quickly prepared. They are light, clean, and transparent. Figure 301 shows *Porter's* splint, which can be easily made. Figure 302 shows a protecting frame for wounded limbs. The construction of other splints from wire presents greater technical difficulties (see Figs. 164, 165).

(*f*) Objects which the wounded man has on his person sometimes furnish very useful material for splints.

Articles of clothing (for instance, coats, trousers, cloaks, bootlegs) may be employed. A military cloak, for instance, is rolled up on both sides and fastened to the limb by a belt or a cloth (Fig. 303). The sleeves, filled with straw, moss, or earth, can be used as splints. A boot cut open lengthwise and in front in its middle portion, the leather of the leg of which is wrapped about a piece of wood applied exteriorly, provides a *foot splint*, which,

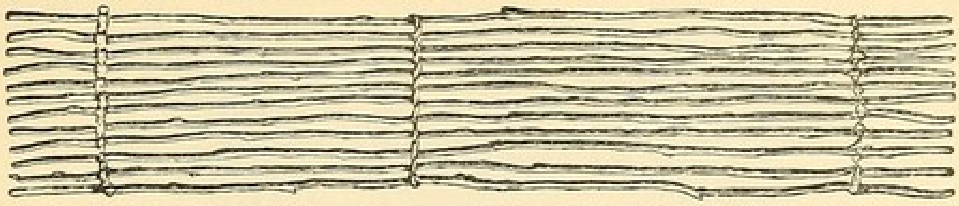


FIG. 296. SPLINT OF TRANSVERSE PIECES OF WOOD FASTENED WITH TWINE

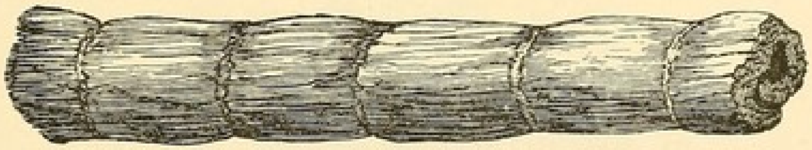


FIG. 297. STRAW SPLINT

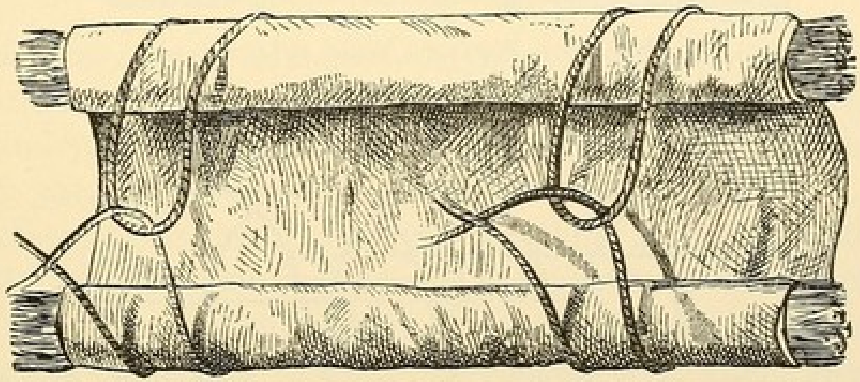


FIG. 298. STRAW SPLINT

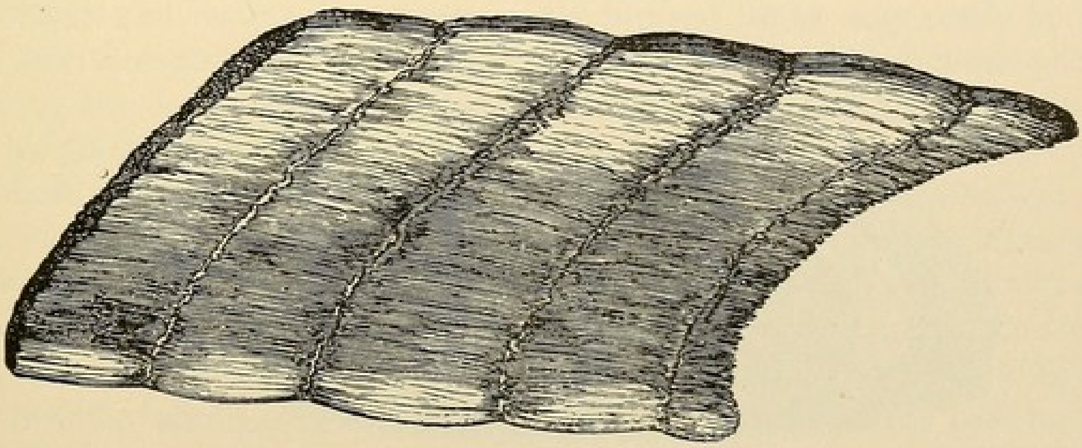


FIG. 299. STRAW MAT FOR SPLINT

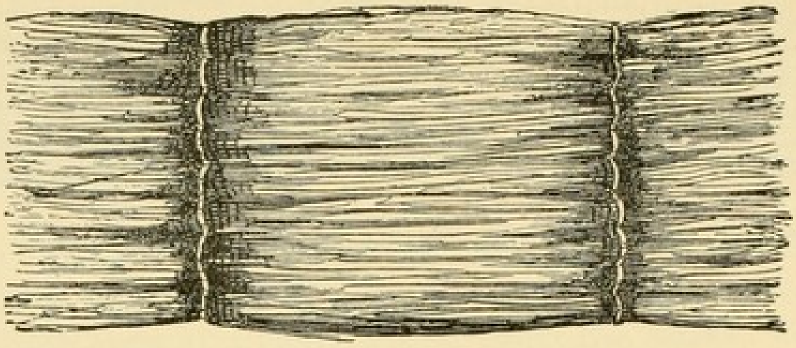


Fig. 300. Reed Mat for Splint

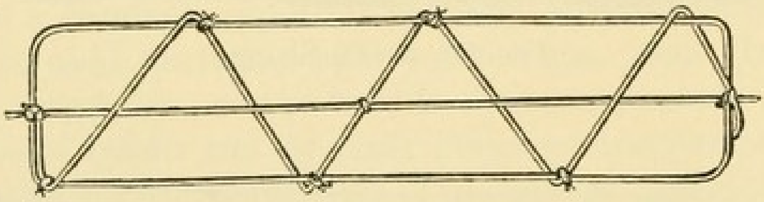


Fig. 301. Porter's Wire Splint

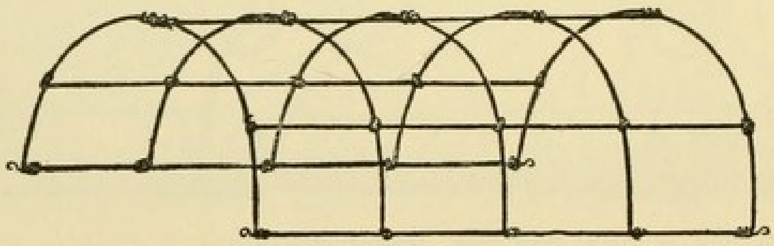


Fig. 302. Protecting Frame for Wounded Limb

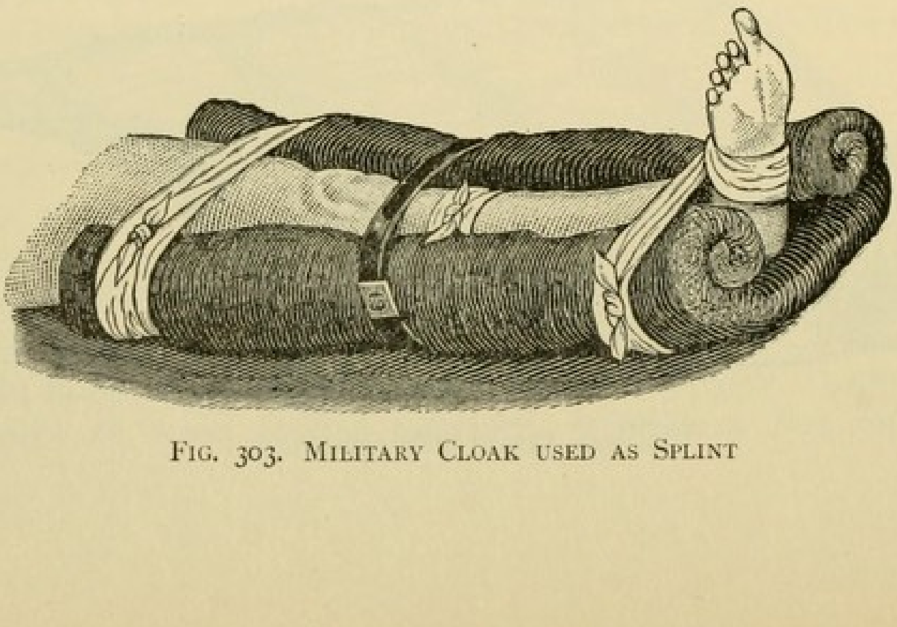


Fig. 303. Military Cloak used as Splint

like *Volkmann's* T, prevents the lateral movements of the injured foot (Fig. 304).

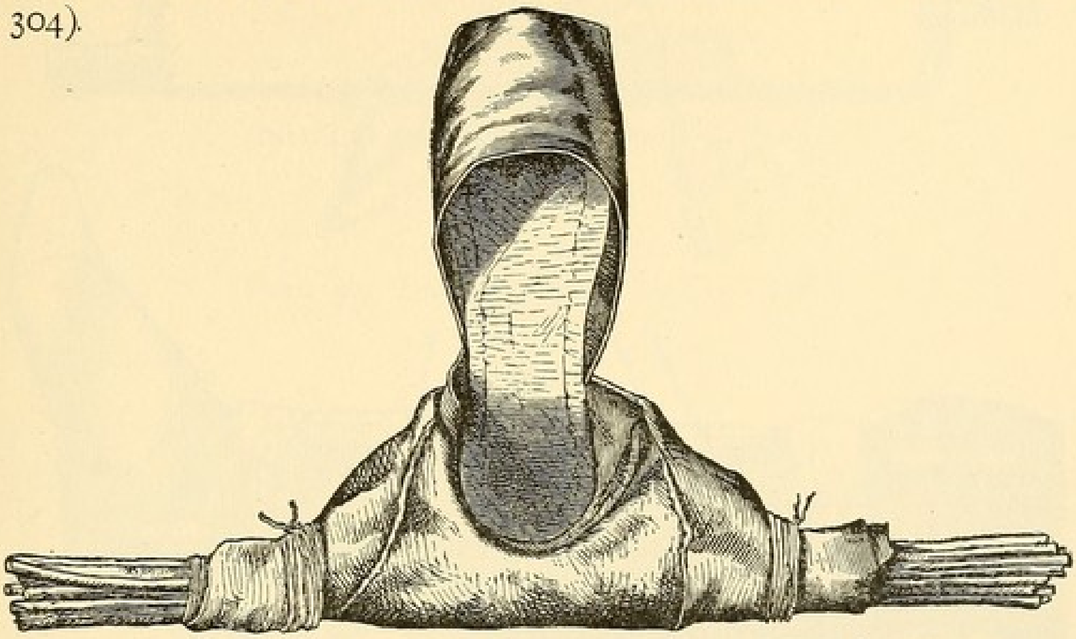


FIG. 304. BOOT CUT OPEN LENGTHWISE USED AS FOOT SPLINT

Weapons like swords, cutlasses, bayonets, sabres, scabbards, muskets, rammers, lances, leather, felt of the saddle, spokes of wheels, canes, umbrellas, and parasols may be used for splints without any further preparation (Figs. 305, 306, 307, 308).

(*g*) In cases of great emergency, when nothing at all is at hand, the healthy leg is used as a splint for the injured one, and the thorax for the diseased arm.

Often there are to be had neither *tables* nor practical position apparatus for applying the bandages. The *military model* is excellent as an operating and dressing table (Fig. 309). Upon this, by a kind of double music stand, two men can be dressed at the same time. By means of boards and pillows this arrangement can easily be fixed to any large common table. Position appliances and means of *suspension* for injured limbs may easily be made with wire and strips of cloth (Figs. 310, 311). A double inclined plane is made by two laths nailed together at an obtuse angle, a Heister's fracture box, by placing the leg upon a very low bench, the legs of which have been sawed off in a manner that accomplishes the object. A suspension apparatus for a fractured leg can be made by means of several triangular cloths, which as slings are carried across a transverse pole. It can be prepared in a still simpler manner if the stocking is cut open anteriorly and if two rods are fastened to its margins. These are hung up on a stronger rod or pole (Fig. 312). The position appliances in Figs. 243, 245, 246, 251, which can be made rapidly by any carpenter, are especially serviceable.

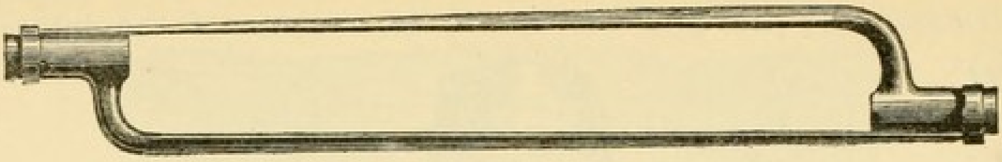


Fig. 305. Joined Bayonets used as Splint

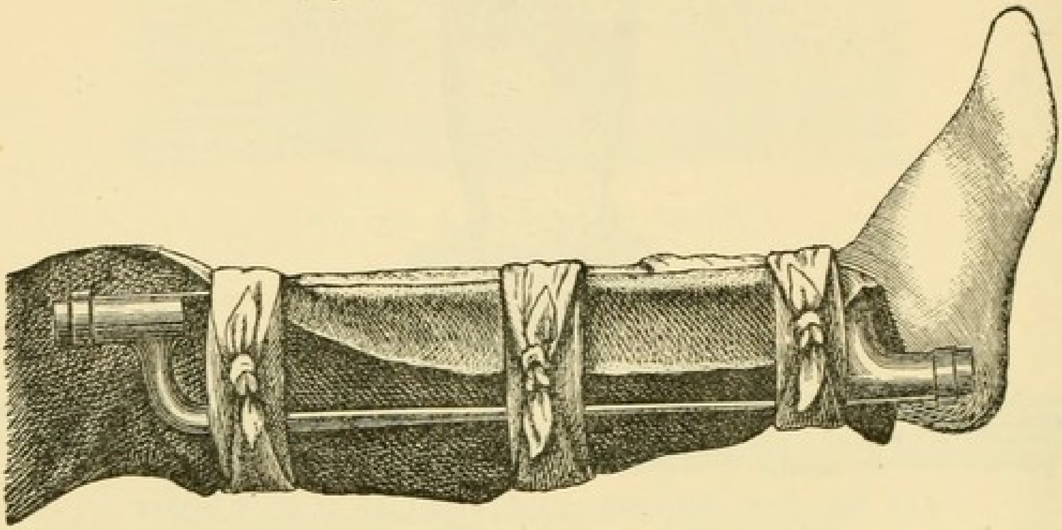


Fig. 306. Bayonet Splint

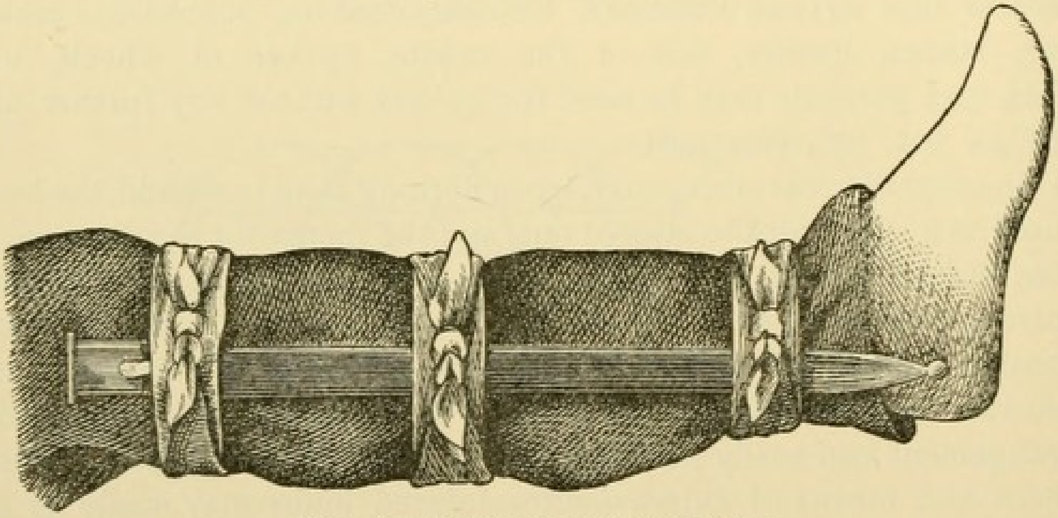


Fig. 307. Scabbard used as Splint

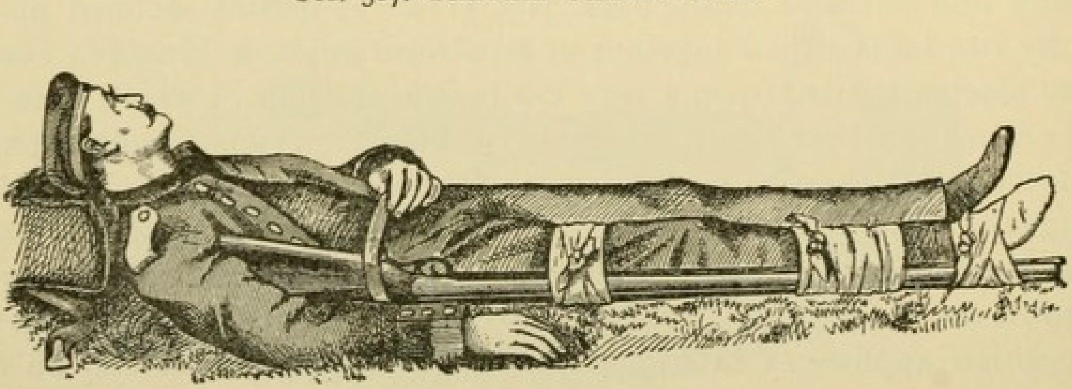


Fig. 308. Musket used as Splint

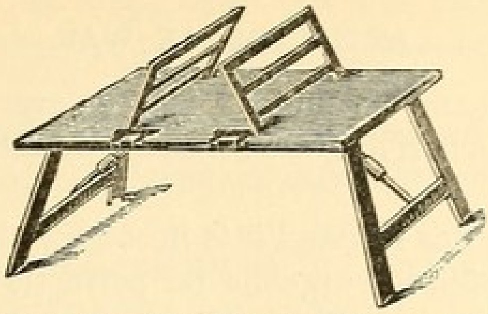


FIG. 309. DRESSING TABLE (Military Model)

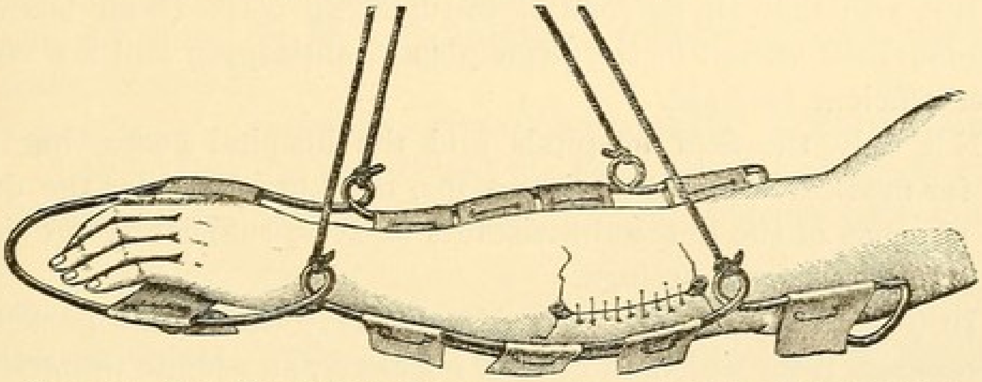


FIG. 310. VON VOLKMANN'S SUSPENSION APPARATUS FOR INJURED ARM

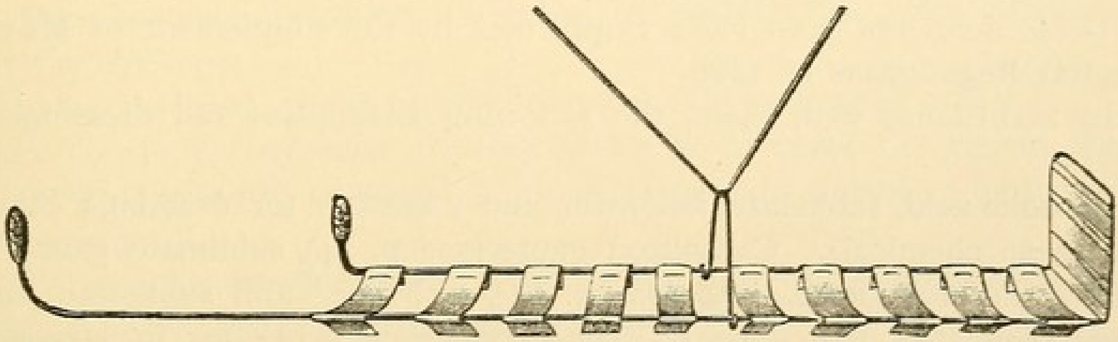


FIG. 311. VON BARDELEBEN'S WIRE SUSPENSION APPARATUS FOR FRACTURED LEG

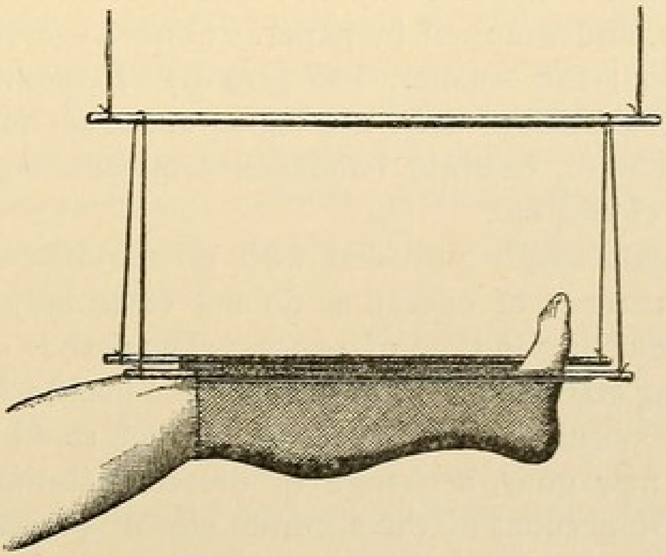


FIG. 312. CUBASCH'S SUSPENSION APPARATUS OF STOCKING CUT OPEN

ANTISEPSIS IN WAR

It is the urgent demand of humanity to have every wounded soldier, even in war, enjoy the protection and the blessings of the antiseptic treatment of wounds.

To be able to fulfil this demand it is necessary that:—

(*a*) Not only all military surgeons be perfectly familiar with the antiseptic treatment and the practical application of the same,

(*b*) But also that all persons of the hospital corps (litter bearers, Red Cross nurses) are versed in the principles of antisepsis, and are competent to render efficient first aid.

(*c*) Not only the field hospitals and the hospital corps, but also the wagons for medical supplies of the troops, the knapsacks for the dressings, and the pouches of the hospital assistants must be sufficiently provided with antiseptic material for dressings.

(*d*) In time of war, every soldier should carry with him a packet of antiseptic dressings from which, in case of necessity, an aseptic protective dressing can be temporarily supplied.

These demands have been amply met by the supplement of **Military Hospital Regulations of 1886.**

In accordance with them, the following antiseptics and dressings are used:—

Carbolic acid, sublimate, iodoform, and materials for dressings charged with these chemicals. Carbolized gauze (see p. 24), sublimate gauze (see p. 26), iodoform gauze, 25% (see p. 33), carbolized and sublimate wound cotton (prepared like gauze). These materials made up in larger and smaller packages are compressed by machinery into a very small space, are fastened together, and wrapped in paper. (The large packages contain 1 kilogram of cotton; the smaller, 100 grams.) In addition, they contain sublimate catgut, sublimate silk, antiseptic sponges and tampons, moss pasteboard, wood wool, cambric bandages 5 meters long, muslin flannel, gauze, triangular cloths, etc.

In **field hospitals** amply provided with all requisites, the treatment of wounds and the manner of operating do not essentially differ from those practised in large clinics in time of peace. The case is different, however, **at the first dressing station** and on the **battle-field** itself, where, on account of rapid changes of position, with the modern art of rapid warfare and with the far-reaching new guns, a change of dressing stations must very frequently occur. On account of the accurate aim of present weapons, moreover, the number of the wounded in a short time becomes so great that not only the surgeons but also the materials for dressing at hand soon become insufficient.

Here, where strict antisepsis cannot be performed, at least the first principle in the treatment of every wound should govern all action: **"Do no harm."**

Omit, therefore, *every* examination of the wound with fingers or instruments that are not *surgically* clean (aseptic).

Only in the case of dangerous hemorrhage is it justifiable to make an exception to this rule; for in such instances prompt action is the essential feature of the treatment.

In no case should *bullets be extracted* without the strictest aseptic precautions. A *bullet* that has penetrated the body produces in itself only little injury. Many bullets become encysted without causing any subsequent harm.

Experience teaches that even very serious internal injuries (of bones, joints, tendons, nerves, lungs, heart, brain, etc.) produced by the bullet in its course, can heal without any suppuration or fever and without any further complications, provided no germs of putrefaction have entered the wound at the time.

Hence, the work of the hospital corps should be limited solely: —

(1) To apply *temporary dressings;* that is, to cover the recent wound amply with antiseptic materials, in order to prevent germs of putrefaction from entering it.

(2) To secure for the injured parts of the body a condition of rest (*immobilization* by means of cloths, splints, etc.).

(3) To transport the injured thus treated as quickly as possible to the place where the wound can be treated in a strictly antiseptic manner.

If the wound of the soldier, provisionally dressed, presents after his arrival at the field hospital no symptoms necessitating a direct examination (fever, pain, hemorrhage, extravasation of the secretions), it is better to leave *the wound untouched* and not even to remove the first protective dressing; for many gunshot wounds heal thus under the scab without any disturbance of normal wound healing.

But if such symptoms appear as necessitate examination, the dressings must be removed immediately and the wound subjected to energetic antiseptic treatment. For this purpose (apart from major operations, amputations, resections, etc., which may be found necessary), it is above all things necessary to enlarge the wound and establish drainage followed by thorough disinfection with effective antiseptic preparations (such as sublimate, iodoform, chloride of zinc, etc.); after this, the antiseptic dressings should be applied (see secondary antisepsis, p. 66).

If a dressing station is near at hand, the stretcher bearers have no more important duty to perform than to transport the wounded as gently and as rapidly as possible to such a place.

Only in cases where medical assistance is not near at hand or where no materials for dressings can be had should the materials which the soldiers carry with them be used either by the wounded themselves or by the stretcher bearers (especially in smaller cavalry divisions).

THE SOLDIER'S ANTISEPTIC DRESSING PACKAGE

According to the Military Sanitary Regulations of 1886, each soldier in time of war is supplied with a dressing material consisting of two antiseptic muslin compresses, 40 centimeters long and 20 centimeters wide, a cambric bandage 3 meters long and 5 centimeters wide, a safety pin, and waterproof material 28 centimeters long and 18 centimeters wide, for covering.

Concerning the composition of this first aid dressing as well as concerning practical utility to supply the soldier with such a package for field service, very different opinions prevail among military surgeons. Some consider the same entirely unnecessary.

I have heard, however, from many experienced military surgeons, that, during campaigns in distant countries (in the war against the Boers, in the Ashantee war in Egypt, in the Caucasus), the surgeons in dressing the wounded often had to depend entirely on the first aid package which each soldier carried with him. In our last war, especially among the cavalry, very often no other material for dressing was at hand than that which could be found in the pockets of the soldiers; in my opinion, therefore, humane principles demand that each soldier shall carry with him in the time of war a practical first aid package of antiseptic dressings, with which his wound can be dressed antiseptically, if other material for dressing is not at hand.

For many years I have been occupied with the subject of what the first aid package of the soldier should contain and how the material should be packed to be of the greatest practical use. In the year 1869 I published a little pamphlet under the title "The First Dressings on the Battle-field," which contained, as a supplement, a triangular cloth with an engraving representing the application of *Major's* triangular cloth on the battle-field.

During the Franco-Prussian war, many antiseptic dressing packages were made in Kiel by the relief society, according to my directions, and were distributed among our soldiers. These contained, in addition to the triangular cloth with safety pin, two small packages each, filled with carbolized cotton, and a gauze bandage, all wrapped up in parchment paper.

When it was afterward found that carbolic acid evaporated rapidly, I used in its place salicylated cotton; and since the salicylic acid after carrying the package for some length of time fell out from the meshes of the cotton, I substituted a roll of jute of chloride of zinc and afterward packages of sublimated sawdust.

But since, on the part of the military authorities, the objection was made to me that it was not advisable to give to the soldier going to war a picture in which the "horrors of the battle-field" were represented, I had another triangular cloth made of the cheapest cotton material, on which only six different naked figures are printed, from which figures the various modes of applying the cloth for dressings can be seen. This cloth is now used universally as a means of instruction for first aid, not only in our Samaritan schools, but also by the large ambulance associations of England and America (Fig. 102).

In the composition of these packages, I have always endeavored to follow the progress of antisepsis; hence, my latest package, named "Temporary Dressing for the Battle-field," contains, in addition to this cloth, two compresses of sodium chloride sublimate gauze (10 centimeters wide, 100 centimeters long), each wrapped in glazed paper, and a sodium chloride sublimate cambric bandage (10 centimeters wide, 2 meters long), so that, with the antiseptic material contained in the package, even large wounds can be dressed.

The whole, greatly compressed and wrapped in very durable waterproof india-rubber material, presents a package 1.5 centimeters thick and 10 centimeters square, weighing exactly 100 grams. The following directions for use are printed on the same: —

"For simple gunshot wounds, apply on each opening of the wound one of the compresses, after the glazed paper has been removed. For larger wounds, unfold the compresses and endeavor to dress the whole surface of the wound with the antiseptic gauze. Hold the gauze in place by a circular bandage. The triangular cloth serves to protect this dressing still further, and at the same time it serves a useful purpose in supporting the injured limb, and in applying temporary splints, illustrated on the cloth."

By experiments, it was found that after prolonged storing even the sublimate evaporated from the materials for dressings; the materials themselves, however, were found aseptic, so that this temporary dressing serves to meet the indications of **primary aseptic occlusion.**

(The editor has devised a first aid package which is much more compact and which contains as the essential component parts a teaspoonful of boro-salicylic powder, compressed cotton, and a gauze handkerchief, to which are added two strips of adhesive plaster and safety pins. Without the adhesive plaster it is very difficult to hold the dressing in place.)

In what part of the uniform these packages should be carried, I do not wish to offer an opinion. This is a matter for the military authorities to decide. I would say, however, that the contents of the package may be folded together to make a package twice as large but half as thick, so that it could be sewed to one side of the breast of the uniform, thus serving for padding.

NOTE. — H. Beckmann, a surgical instrument maker in Kiel, furnishes these aseptic dressing packages for 12½ cents.

(A number of years ago the editor suggested that the first aid package should be worn on the inside of the belt, as the belt is about the last thing the soldier will part with on a forced march or in a pitched battle.)

NARCOSIS

During every major operation, and every prolonged and painful examination, especially when the relaxation of all the muscles is desirable or necessary, the patient should be rendered unconscious, that is, he should be placed under the influence of a general anæsthetic.

GENERAL ANÆSTHESIA

is produced by the inspiration of poisonous gases, of which chloroform and ether are the anæsthetics most generally used.

CHLOROFORM ANÆSTHESIA

Chloroform, $CHCl_3$ (discovered by Liebig, first used by *Simpson*, in 1847), a clear, colorless liquid, very volatile, non-combustible, and of a characteristic not unpleasant odor, is a poison, the inspired vapors of which produce a paralyzing effect upon the ganglionic cells of the brain and the spinal cord, sometimes causing cessation of breathing and of the heart's action. The paralysis seems to advance in the brain from before backward, so that first the frontal lobes (consciousness) become involved, and finally the function of the medulla oblongata (respiratory centre) becomes extinct. At *any stage* of anæsthesia death may occur suddenly from paralysis of the heart.

(The result of much experimentation and a large clinical experience appear to prove that the toxic effects of chloroform usually involve the respiratory centres.)

Pure chloroform should be free from ether or alcohol, and should contain no methylic compounds (turns black on the addition of concentrated nitric acid), no free chlorine (bleaches moistened litmus paper), no acids (reddens blue litmus paper). If a few drops of chloroform are allowed to evaporate on Swedish filtering paper, a rancid acrid odor of the residuum indicates that the chloroform is impure or decomposed (*Hepp's* odor test). Since chloroform easily decomposes on exposure to light and air, it should be kept in yellow or dark bottles (25–50 g.) and be changed from one bottle to another as little as possible, and then only in a dark room. Any part of chloroform left over from one anæsthesia should not be used for another anæsthesia, except, perhaps, on the same day. By the presence of illuminating gas vapors are formed from the chloroform, which strongly irritate and cause coughing (Chlorwasserstoffsäure?). By free admission of air and by saturating the room with steam (in a sterilizer), this inconvenience is partly removed.

In the **administration of chloroform** various **precautionary measures** must be observed: —

The stomach of the patient should be empty (no food during the last three or four hours); during the operation, the patient should lie upon his back or on one side with his head only slightly elevated, or best of all, perfectly horizontal with his limbs slightly elevated; he should not lie on the abdomen, because this position renders respiration more difficult; he should not be in a sitting position, because this renders syncope more likely to occur. All tight-fitting articles of clothing (collar, belt, corset), which impede the respiratory movements, should be removed or loosened; neck and breast should be free and the abdomen easily accessible. For all major operations it is best to place the patient perfectly naked upon the operating table. But since chloroform lowers the body temperature, the patient should be protected, especially in prolonged anæsthesias, from taking cold. Hence, cover his body with blankets, apply hot bottles or the "Wärmetuch." Artificial teeth, chewing tobacco, etc., must be removed from the mouth (danger of asphyxia from aspiration); the bladder, rectum, under some circumstances also the stomach, should be evacuated before the operation. If the *time* for an anæsthesia can be previously set the hours of the forenoon are decidedly preferable, because the stomach of the patient is then empty; hence vomiting occurs more rarely and the after effects of anæsthesia are less unpleasant. Weak patients may sometimes receive a small glass of strong wine about half an hour before anæsthesia to stimulate the heart's action. If the operation must be performed without these preparations (in case of accident) all precautionary measures on p. 182 must be especially observed, since vomiting nearly always occurs.

The *anæsthetizer* should attend only to the narcosis, and *should pay special attention* from the beginning of anæsthesia to the *pulse* and the respiration. He must keep within reach, in addition to the chloroform apparatus, a mouth-gag, tongue forceps, towel, sponge provided with a handle, and a pus basin. Care must be taken that perfect quietude prevails in the room. All talk should cease, and especially with the patient, likewise all running to and fro. Previous to every anæsthesia the anæsthetizer should carefully examine the heart and lungs of the patient in order that special precautionary measures may be taken in case the heart or lungs of the patient are diseased. Patients having a serious defective cardiac action or a severe affection of the lungs should *not* be anæsthetized with chloroform. During *every* narcosis, several persons in addition to the surgeon should be present, partly as assistants, in accidents which suddenly occur, partly as witnesses for the defence, to testify against the hallucinations sometimes represented by patients as facts.

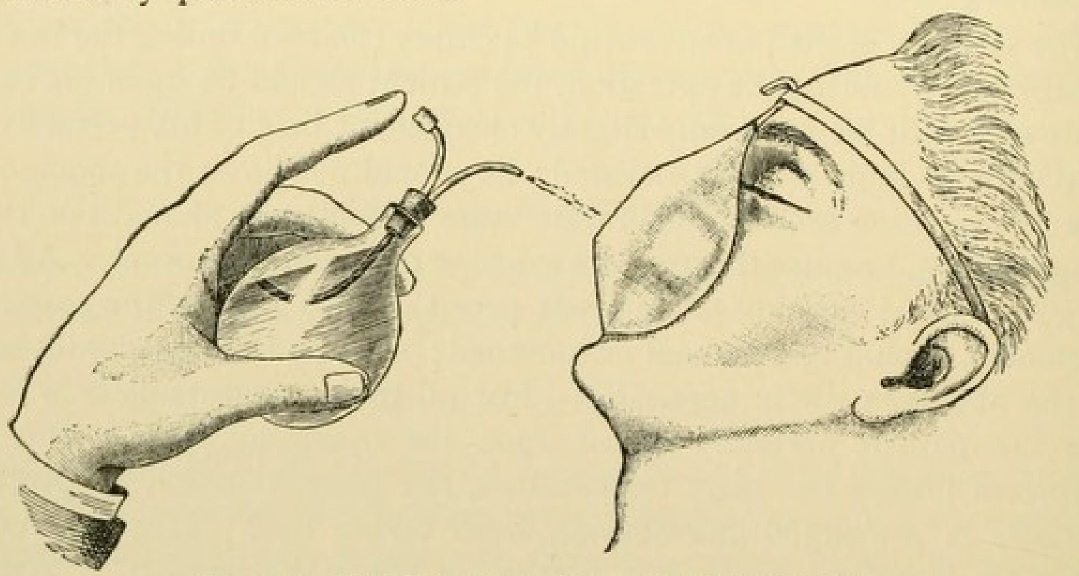


Fig. 313. Von Esmarch's Chloroform Apparatus

Concentrated chloroform vapors cause, after a very short time, cessation of respiration and of the heart's action. Hence, the administration of chloroform on a dense cloth or a saturated sponge, held in close contact with the mouth and the nostrils, is dangerous. Chloroform vapors used for inhalation should be *well diluted with air*. A very common method of inhalation is by means of *Skinner's* apparatus, simplified by the author, and consisting of a wire frame, covered with woollen tricot (mask), and a dropping bottle (Fig. 313). It can easily be carried in the pocket together with forceps for holding the tongue (Fig. 320), packed in a leather or a metal case (Fig. 314). Since the mask occasionally becomes soiled with blood, mucus, or vomited matter, it is well to renew the tricot cover before each anæsthesia; this can easily be done with *Schimmelbusch's* aseptic mask (Fig. 315). Likewise, during a prolonged anæsthesia it is well to change the tricot cover, whenever it has become moist from the expired air.

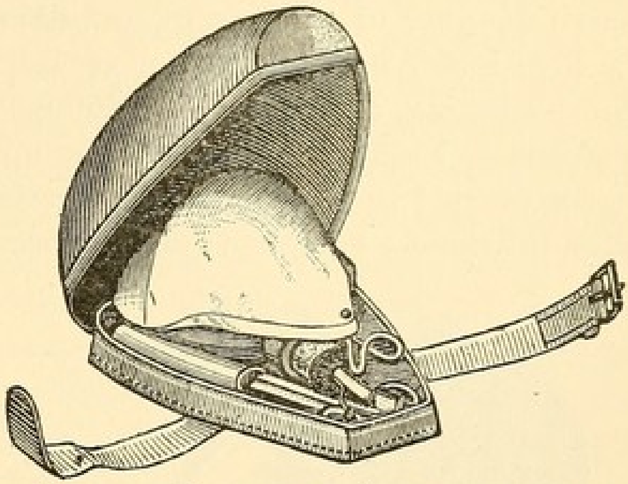


FIG. 314. CHLOROFORM APPARATUS PACKED IN CASE

Sufficient air is inspired with the chloroform vapors through the tricot cloth during each inspiration. Pour at first only a moderate quantity of the anæsthetic (10–20 drops) upon the mask, hold it lightly before the mouth and the nose, and instruct the patient to take full, deep inspirations, securing at the same time his confidence by assuring and encouraging remarks.

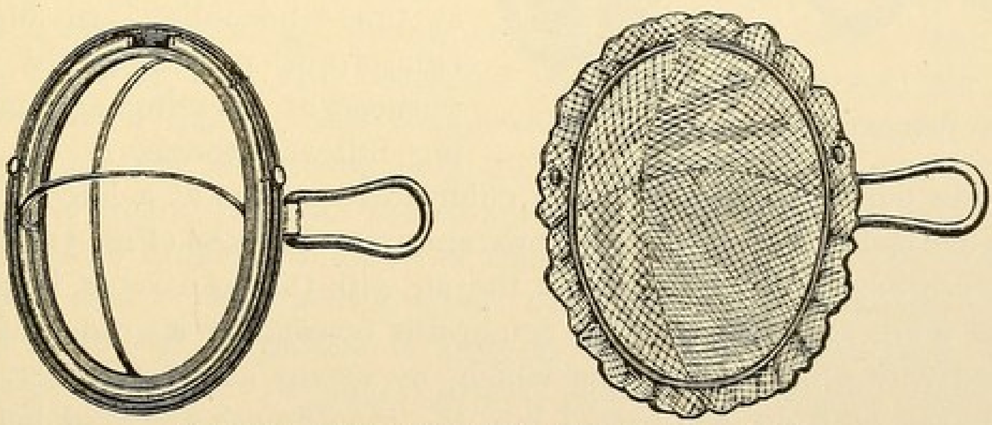


FIG. 315. SCHIMMELBUSCH'S CHLOROFORM MASK

It is altogether a great mistake to pour at once upon the mask so much of the anæsthetic that it trickles down from the inner surface. Aside from the violent irritation of the air passages, indicated by coughing, dyspnœa, and restlessness, inflammation of the skin of the face and especially of the eyelids is to be apprehended from this moistening with chloroform. The skin is protected from this inflammation by brushing it with vaseline or some similar demulcent. In the easiest manner, however, and with a very small quantity of chloroform, anæsthesia may be produced and the patient be kept under its influence for several hours without much danger, if, from the beginning, chloroform is administered only by the drop method (**drop narcosis**). From an ordinary dropping bottle, allow one drop to fall upon the mask every 5 to 10 seconds. Anæsthesia is often produced in 8 to 10 minutes, provided a complete quietude prevails in the room while the chloroform is administered and the patient is not touched, for instance, for the purpose of rendering aseptic the field of operation; nearly all unpleasant symptoms are absent when anæsthesia is thus gradually induced. After anæsthesia has been fully induced it will suffice to administer one drop of the anæsthetic upon the mask every ten seconds until the end of the operation. The quantity of chloroform used is about 25 to 30 grams an hour. In exceptional cases the anæsthetizer may at times be obliged to administer chloroform more rapidly for the purpose of effecting and maintaining full anæsthesia.

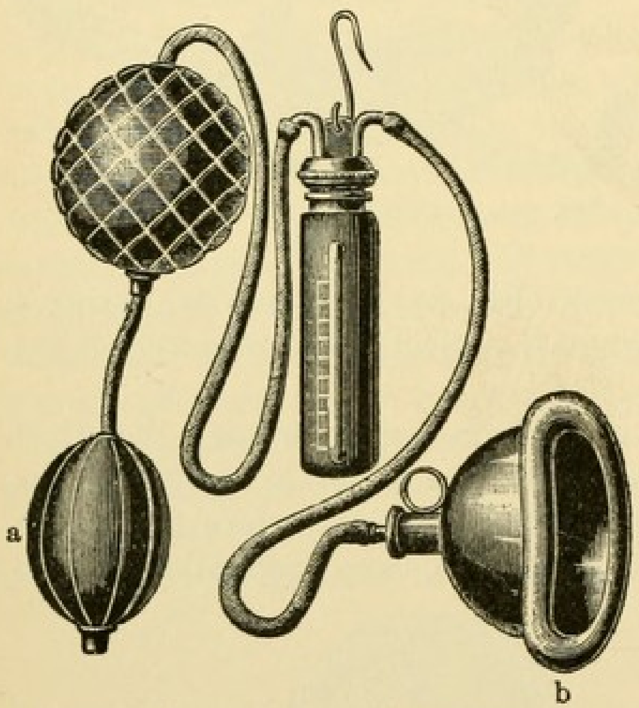


FIG. 316. JUNKER'S CHLOROFORM APPARATUS

For the purpose of diluting the chloroform vapors at a like proportion by the admixture of air, *Junker's* apparatus may be used (Fig. 316). Since the chloroform cannot evaporate in the air with this apparatus, its administration is more economical. The apparatus consists of a graduated bottle, half filled with chloroform, from which, by means of an atomizer, (*a*) the vapors mixed with air are forced into the mouthpiece, (*b*) held before the mouth and the nose of the patient. *Kappeler's* apparatus of a similar construction can also be recommended.

COURSE OF CHLOROFORM ANÆSTHESIA

After the *first* inspirations, patients have subjective sensations, mostly of a pleasant nature; respiration somewhat increases, the pulse becomes fuller and more rapid, and the eyes are filled with tears. An erythema resembling measles appears on a delicate skin on the neck and the upper portion of the thorax. The patients often cease breathing; the anæsthetizer should then request them to inspire. Sensibility may have been decreased to such a degree that certain minor momentary operations can be performed without any reflex movements. With many patients, this moment has been reached when the arm, held in a vertical position, slowly sinks down. With feeble patients, men of good habits, women, and children, full narcosis and complete relaxation of the muscles will at once set in. In most cases, however, it is preceded by a **stage of excitation.** Clonic and tonic contractions of the muscles occur; the patient screams, sings, fights, and makes attempts to run away. This state is especially well marked in vigorous patients and in intemperate persons. To control the excitement from the beginning, it is well, about 15 to 20 minutes before the anæsthesia, to administer an injection of morphine (0.01), whereby anæsthesia takes a considerably more tranquil course and is more rapidly completed.

If the anæsthesia is now continued uninterruptedly, by administering chloroform by the drop method, this state of excitation gradually decreases, and, under deep, often stertorous, respiration, complete anæsthesia — relaxation of all the muscles, arrest of all reflex movements (**period of tolerance**) — sets in. Last of all the cornea reflex disappears, as well as that of the mucous membrane of the nose and upon the inner side of the thigh. The pupil, which before relaxation was somewhat dilated, contracts, the eyeballs make asymmetric movements, the pulse becomes smaller and weaker, the body heat and the *blood pressure become lower*, the respiratory movements quicker and shallower, and metabolism is retarded. If still more chloroform is inspired, the paralyzing effect may extend to the medulla oblongata and the motor ganglia situated in the heart itself, and with a sudden *dilatation* of the pupil, cessation of the respiratory movements and of the heart's action may ensue. This dangerous stage can be avoided, if the patient is kept anæsthetized only to such a degree that the *cornea reflex is just extinct;* chloroform should then be administered by the drop method at greater intervals, and for some time not at all; only on the return of the reflex should a few more drops be administered. Hence, a frequent *test for the cornea reflex* is necessary. Raise the upper eyelid with the third finger, and touch the cornea gently with the forefinger. If the pupil becomes dilated — complete relaxation of the muscles not having set in — it is a premonitory stage of vomiting, which at times may be prevented by administering drops of chloroform more rapidly.

With this careful and gradual method of using chloroform, threatening symptoms only rarely occur during anæsthesia. They are most to be apprehended in very excitable patients (hysteria); in feeble and anæmic and in stout persons (fatty degeneration of the heart); and in patients subject to pulmonary or heart disease; in inveterate smokers and drinkers (alcohol, morphine, chloral); likewise, in patients having a diseased liver or kidneys, diabetes, diseases of the lymphatic glands, and thymic asthma (status thymicus). Whether an anæsthesia will take a normal course may be recognized after the first inspirations from the fact that the eyes close peacefully; if the upper eyelid does not close entirely, or if the eyes remain half open, the surgeon must be prepared for unpleasant accidents.

THE AWAKENING FROM ANÆSTHESIA VARIES

The patient should never be roused from it by calling, shaking, or by beating his chest, etc. After anæsthesias of short duration, in which, however, the stage of fullest tolerance had been reached, the patients often rise suddenly, are able to walk, and have no after pains. Still in most cases vomiting occurs sooner or later. If the patient must be put to bed, as it happens in by far the majority of cases, he should be placed comfortably, and continued quietude should prevail, in the slightly darkened room. Only one person may watch at his bedside. Sometimes anæsthesia is followed by a natural sleep of varied duration. The longer the sleep lasts the milder are the sequelæ of chloroform narcosis. In the majority of cases, however, the patient is disturbed in his slumber by vomiting or spasmodic efforts to vomit (nausea). At once turn the head well to one side and hold a folded napkin or a basin at the side of the mouth. Vomiting can become very obstinate and continue for days. The patient is relieved most rapidly, if not a drop of any fluid is given to him in spite of his most imploring entreaties. If his request is fulfilled vomiting will undoubtedly occur again. Should, however, circumstances make it justifiable to accede to his request, to quench his thirst, it is well to give him small pieces of cracked ice, to place a slice of lemon on his tongue, or to administer a few teaspoonfuls of champagne. Injections of caffeine are also recommended against nausea. *Lewin* warmly recommends covering the face of the patient with a cloth saturated with vinegar. This should be applied immediately at the end of anæsthesia over the mask, and the latter be removed from under it, so that no pure air is inspired. The cloth remains in position for several hours. As a rule this crapulence-like condition ("Katzenjammer"), similar to that resulting from the intoxication of alcoholic drinks, is over on the following morning, and after a day of fasting the first meal is greatly relished.

Unpleasant occurrences during the next few days are the following: Superficial inflammation of skin (eyes, chin) from chloroform having trickled down from the mask; contusion of the tongue if it has been held for a long time with forceps, pain and swelling in the region of the parotid gland, caused by an awkward and prolonged lifting of the lower maxilla; *lameness* of one arm from having been *raised forcibly in a lateral direction* during anæsthesia, — the clavicle, having been turned around its longitudinal axis, contused the brachial plexus against the first rib (*Erb's* paralysis), or the arm was carelessly pressed against the edge of the table or bed in taking the pulse (radial paralysis). Likewise similar symptoms may occur on the legs from pelvic high position.

Chloroform as well as ether anæsthesias cause a considerable decrease of urinary excretion and albuminuria, the degree of which seems to depend less on the duration of anæsthesia and the quantity of the anæsthetic than on the individual sensibility of the patient (*Drencke*).

Unpleasant accidents during anæsthesia are especially: —

1. *Disturbances of respiration.* Soon after the first few inspirations, many patients suddenly cease breathing, and must be urged to do so either by encouragement or command. With others, obstinate coughing occurs, which, however, generally ceases after a few very deep inspirations. Patients with bronchial catarrh or asthma are afflicted most frequently by distressing cough.

Long-continued expiration (*singing*) interrupted only by short superficial inspirations becomes especially unpleasant because it prolongs anæsthetization. By addressing the patient or by a light blow upon the chest he often resumes the natural mode of breathing.

2. *Vomiting* may occur during partial as well as complete anæsthesia; especially when the stomach is not empty, and when the mask for some time had been removed from the face and chloroform was again administered because the patient showed signs of reaction. Even when the stomach is empty, patients are sometimes forced to vomit during the beginning of anæsthesia, on account of swallowing the saliva, which flows profusely and is mixed with chloroform vapors. In such a case, turn the patient's head *at once well to one side*, in order that the vomited matter may not be aspirated into the air passages; next, the mucous membrane of the stomach must be rendered less sensitive by a more complete anæsthesia. Experiments have also been made to produce an immediate effect upon the pneumogastric and

the phrenic nerves by finger pressure directly behind the sternal end of the clavicle (*Joes*).

When vomiting has ceased, the buccal cavity must be carefully cleansed with a sponge provided with a handle, or with a cloth.

3. A *sudden cessation of the respiratory movements*, which in the beginning of anæsthesia can generally be restored by encouraging the patient, may later on produce symptoms dangerous to life (reflex inhibition of the pneumogastric nerves by irritation of the trigeminus branches upon the mucous membrane of the mouth and the Schneiderian membrane of the nose). After a few stertorous inspirations and after violent spasmodic movements of the muscles, the glottis is closed by the muscular spasms; the abdominal wall makes a few more inspiratory movements, then retracts and becomes as hard as a board; the jaws are firmly pressed together; the tongue is drawn backward and upward, so that the passage to the larynx is obstructed. The face becomes flushed; the lips bluish; the veins swell; the pulse at first becomes slow, then imperceptible. This state of asphyxia is caused by the spasms of the muscles of the larynx and the tongue (**spastic asphyxia**). Prompt action is now imperative to free the upper entrance to the larynx. The set jaws must be separated, the tongue must be drawn well out of the mouth; if this prove successful, respiration is often restored without further assistance, if not, artificial respiration should be made (see below). Relaxation of the rigid muscles is effected by administering more chloroform. In old people and children, during inspiration, the closed flaccid lips are sometimes drawn like valves toward the toothless jaws and the thin alæ of the nose against the septum, preventing the entrance of air. To prevent the injurious reflex from the trigeminus of the mucous membrane of the nose upon the heart's action, *Guérin* had the chloroform vapors inspired only by the mouth (the nostrils having been occluded with clamp forceps or cotton). More recently *Rosenberg* recommends — as a prevention of asphyxia — to anæsthetize the ramifications of the trigeminus of the mucous membrane of the nose. With a spray he atomizes into the nostrils at two different tempos 6 cg. of a 10% cocaine solution a few minutes previous to general anæsthesia.

4. In the *stage of the fullest tolerance*, during the complete *relaxation* of all the muscles, the tongue, following gravitation, not rarely falls back and comes to lie upon the posterior pharyngeal space, thereby obstructing the upper entrance to the larynx (**paralytic asphyxia**). These accidents are the more dangerous because the symptoms of asphyxia do not occur in so violent a manner; but, in a short time, the blood becomes subcharged with

carbonic acid. The respiration becomes heavy and stertorous; or even respiratory retractions ("Einziehung") set in, the face becomes blue, the blood dark, and the pulse irregular and weak. With sufficient attention, these symptoms can be easily removed, by raising the lower jaw and by drawing out the tongue.

5. *Disturbances of the circulation.* The most dangerous accident that can occur in all the stages of chloroform anæsthesia is the *sudden paralysis of the heart,* which can produce death (**syncope**). The face very suddenly turns as pale as death; the pupil becomes dilated and fixed; the cornea reflex disappears; the lower jaw falls as in a corpse; the pulse becomes rapidly imperceptible; the heart beats are no longer audible; the hemorrhage from the operating wound ceases. Respiratory movements may continue still for some time, although superficial and irregular, until, after a few short inspiratory efforts, they cease as in the dying. Fortunately, this distressing state very rarely occurs, and then mostly in anæmic persons and in those who are suffering from heart disease. Still, even robust persons in perfect health may become subject to it, especially when they have manifested great fear and excitement before the operation. If the cardiac function cannot be restored by artificial respiration and massage, death ensues. The **mortality from chloroform** is about one in every ten to twenty thousand persons anæsthetized, and undoubtedly death from this cause is becoming more and more infrequent. Many fatal cases from chloroform are of course kept secret or reported as resulting from other causes. The cases heretofore published occurred especially during minor operations, which were to be performed *rapidly* with imperfect precaution and insufficient preparation. Likewise, all those cases of fatal *shock* during operations, which were observed *before* the discovery of chloroform, must be considered here. Fatal accidents from anæsthesia may happen in the practice of any surgeon with any patient; and the blame should not be attached to the surgeon, provided he is familiar with and has followed all precautionary measures.

NOTE. — According to the statistics collected by *Gurlt* and communicated to the last Surgical Congress, of 327,593 persons anæsthetized 134 deaths occurred (1 : 2444). Of the several narcotics, chloroform was fatal at the ratio of 1 : 2039; chloroform with ether, at 1 : 5090; ethylene bromide, at 1 : 5228; pental, at 1 : 199. With pure ether, no death occurred in 14,506 anæsthesias, and the same freedom from danger was observed with the mixture of chloroform, ether, and alcohol recommended by *Billroth*, at 1 : 3870, ether and chloroform, at 1 : 7594.

(The statistics quoted by the author refer only to deaths resulting from the immediate effects of the anæsthetic. The mortality would be much greater if all the fatal cases were reported, and more especially if it would include deaths resulting from secondary complications caused by the anæsthetic; if this were done the dangers from ether anæsthesia would become more apparent.) Death from chloroform must be considered an accident for which every surgeon ought to be prepared if he uses chloroform. The statistics quoted show that this accident occurs rather frequently, even though some surgeons for years and tens of years had no fatal case during anæsthesia. Death from chloroform (poisoning) may even occur subsequently (after several days), especially after a very prolonged full and often repeated anæsthesia, from which the patient completely recovered. In such cases frequent vomiting, hæmaturia, icterus, albuminuria, weakness of the cardiac action, collapse, occur. Frequently these cases resulting from the after effects of chloroform are not rightly diagnosed as such.

The **action of the surgeon during serious accidents** is of the very greatest importance, since upon it often depends the life of the patient. He should see to it that the air can enter freely and that respiration not only does not cease, but, if necessary, is maintained artificially. The chloroform mask, of course, must be removed *immediately* whenever grave symptoms make their appearance.

Care for unobstructed respiration. *Displacement of the entrance of the larynx* occurs most frequently during full anæsthesia; in consequence of *relaxation of the muscles*, the tongue falls toward the posterior pharyngeal wall, and the epiglottis closes the upper entrance to the larynx. This condition can easily be corrected by: —

Lifting of the lower jaw. Standing behind the patient, apply both hands flat to the neck in such a manner that the forefingers come to lie behind the ascending rami of the lower maxilla; push the whole lower maxilla forward until the lower row of teeth projects beyond the upper (subluxation, Fig. 317). By means of this manipulation, the muscles at the root of the tongue attached to the lower maxilla, together with the epiglottis and the hyoid bone, are drawn forward in such a manner that the upper entrance to the larynx becomes free. The same effect is obtained also in the following manner: Stand before the

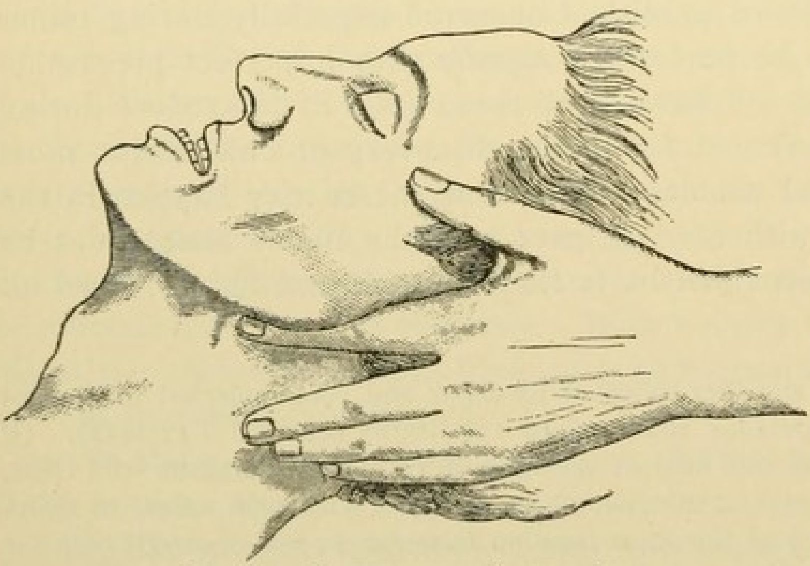


Fig. 317. Lifting the Lower Jaw

patient; place the forefingers of both hands, hook-like, behind the angle of the jaw and draw it forward (*Kappeler*). Do not open the mouth too far during these manipulations, else the base of the tongue is not lifted forward but only upward.

The operator should proceed very gently in lifting the lower maxilla, especially when the process must be continued for some time; else, during the following days, violent pains occur in the temporo-maxillary articulation, together with swelling of this region, especially of the parotid gland, which causes greater trouble to the patient than the operation itself. For this purpose, *Gutsch* has mentioned a **lower maxilla holder**, with which the lower maxilla can be drawn forward permanently and easily (Fig. 318). The rubber pad is placed behind the lower row of teeth, the wire ring under the chin; the clasp is closed, and then the lower jaw is drawn forward by means of the ring.

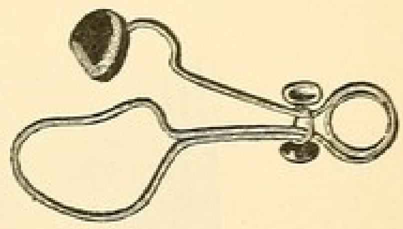


Fig. 318. Gutsch's Lower Maxilla Holder

If, however, an obstruction to the respiratory passage occurs in consequence of *spastic contraction* of the muscles of the larynx, whilst also the other muscles of the body are forcibly contracted, the operator will *not* succeed in pushing forward the lower maxilla in the manner indicated; in such a case the jaws must be *separated* (*Heister's* or *Roser's* gag—see Figs. 1135, 1136), the **tongue** must be grasped with the fingers or with

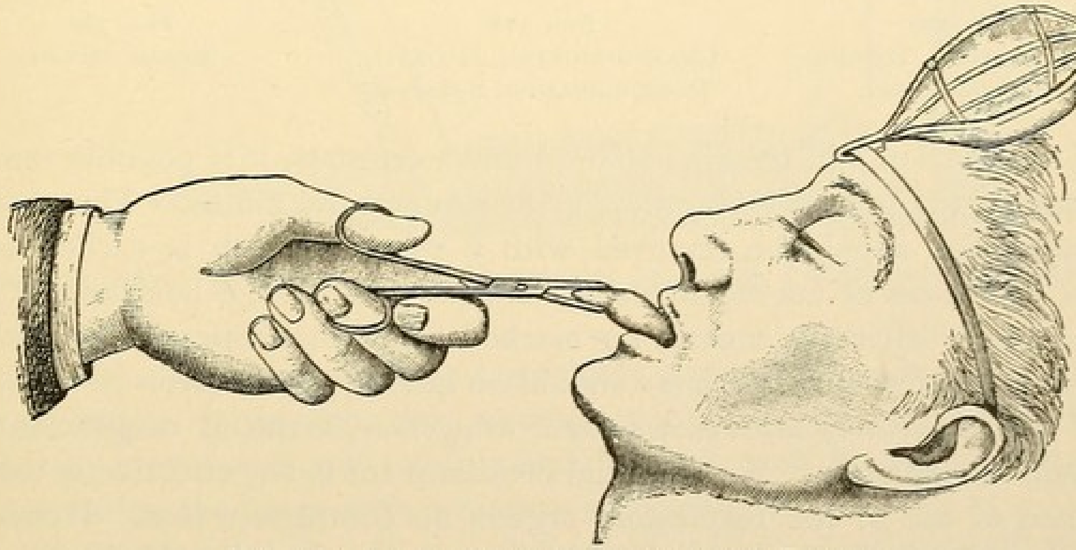


Fig. 319. Protraction of Tongue with Forceps

tongue-holding forceps (Fig. 320) and *drawn out of the mouth* as far as possible (Fig. 319). As after a long use of the forceps sometimes a considerable contusion of the tongue is produced, it is better to employ a tenaculum forceps (Fig. 321), as its use is attended by less injury to the tongue. In case of necessity, a strong thread may be drawn through the tongue with a large needle and used as a substitute for forceps. If the jaws are set very tightly, *Kappeler* recommends *to grasp* the *hyoid bone* with a little sharp hook from the outside and to draw it forward; by this means the base of the tongue and the epiglottis yield to the traction.

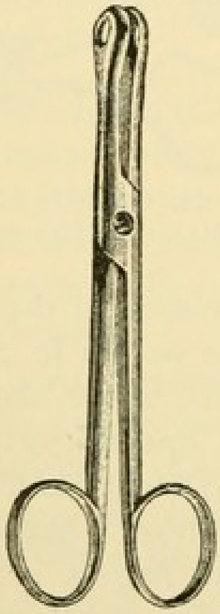


FIG. 320
VON ESMARCH'S TONGUE HOLDING FORCEPS

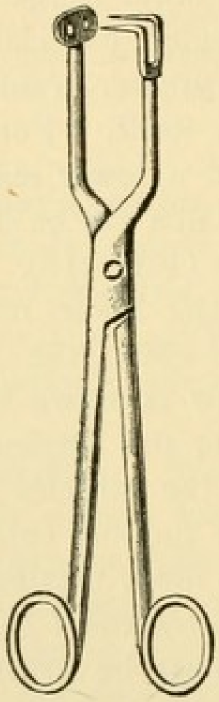


FIG. 321
CHAMPIONNIÈRE'S HOOKED TONGUE-HOLDING FORCEPS

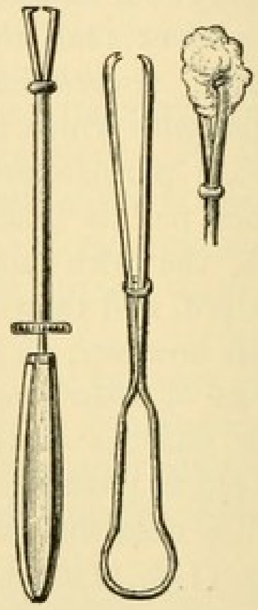


FIG. 322
SPONGE HOLDER

If respiration still remains labored and stertorous, it is possible that this depends on the presence of *mucus* or *blood* upon the glottis. The obstructing substance should be removed with a sponge, which is carried to the larynx by means of curved dressing forceps or a sponge holder (Fig. 322). If, in spite of all these means, no marked relief in respiration is effected, then as a last resort *tracheotomy* should be quickly performed.

If the *respiratory movements cease altogether*, **artificial respiration** must be made immediately. An essential condition for being effective is that the entrance of air to the respiratory organs be completely free. Hence the lower jaw should be pushed forward by an assistant and held in this position; or the tongue should be drawn forward as far as possible and held in this position (lower maxilla holder); or it should be fastened over the chin with a cloth, strip of linen, rubber band, etc., else tracheotomy should be performed. The most effective methods of artificial respiration are:—

1. **Silvester's method**. Stand at the head of the recumbent patient; take hold of both arms directly below the elbow; draw them slowly, but vigorously, upward and over the head of the patient; hold them extended in this position for about 2 seconds (Fig. 323); then bring them again downward, and press the bent elbows gently, but firmly, for 2 seconds in front of the thorax, the left one more toward the median line and the region of the heart (Fig. 324). Repeat these upward and downward movements of the arms about fifteen times (corresponding to the number of normal

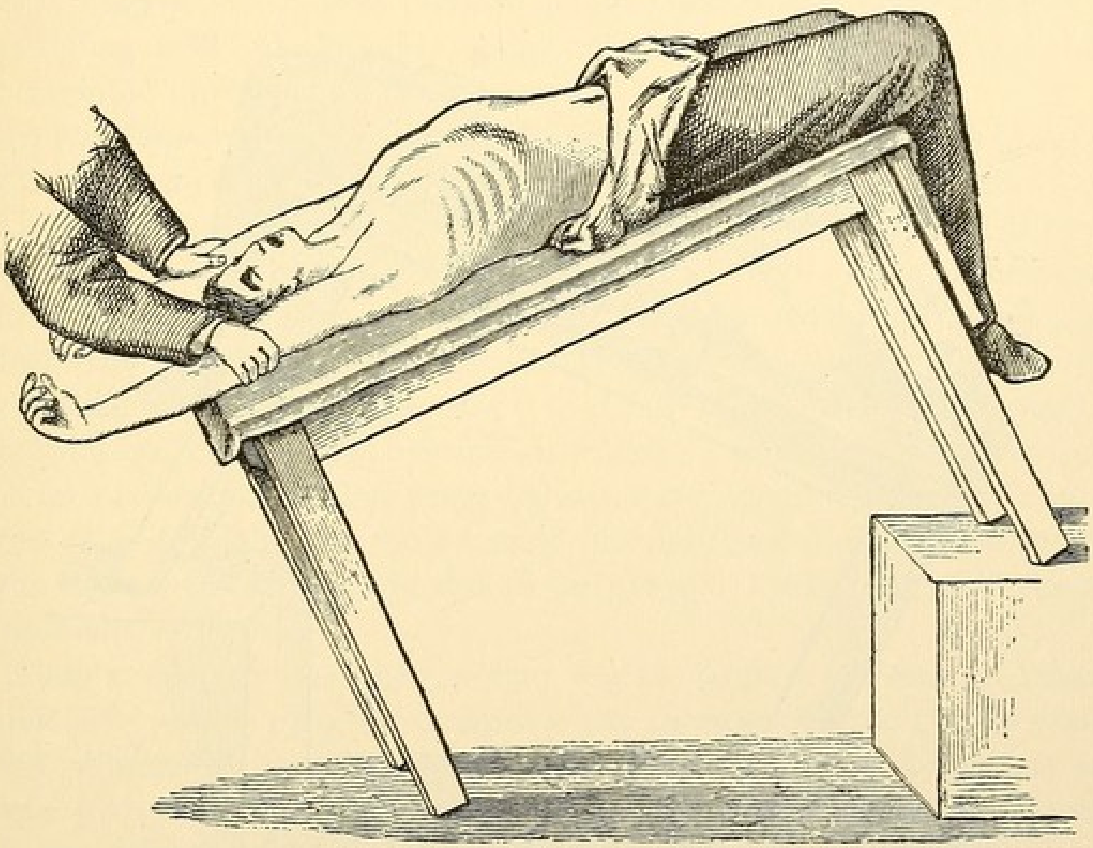


Fig. 323. Nélaton's Inversion and Silvester's Artificial Respiration (Inspiration)

respirations) a minute, quietly and regularly (counting 1 — 2 — 3 — 4) until the respiration is restored; this sometimes requires *several hours*. If the respiratory movements are made properly, with each inspiration the air is heard entering the lungs with a hissing or sipping sound.

2. **Schüller's method**. If the abdominal walls are completely relaxed and not too fat, stand at the patient's head, take hold of the costal arches with both hands, draw them vigorously outward, and compress them like a pair of bellows; by this means very powerful respiratory movements are produced.

Flashar compresses the thorax by means of two straps (towels, belt) carried around it, which are equally drawn upon at the same time on both sides; when the traction is discontinued the elastic thorax *expands again.*

3. **Laborde's method.** Seize the root of the tongue with the fingers or forceps, draw it forward as far as possible, and allow it to return. Continue this slowly and rhythmically fifteen or twenty times a minute, corresponding to the number of normal respirations. The excitation of the respiratory centre is affected in a *reflectory* manner by stretching rhythmically the superior laryngeal nerve.

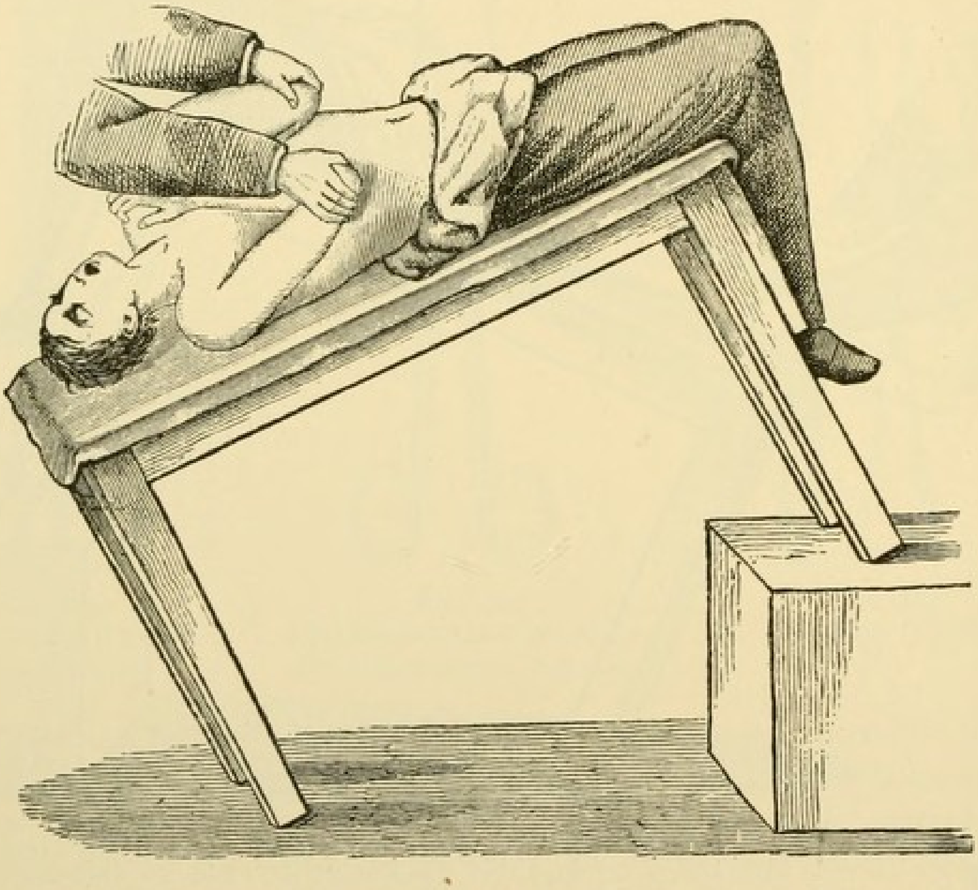


FIG. 324. NÉLATON'S INVERSION AND SILVESTER'S ARTIFICIAL RESPIRATION (Expiration)

The method of **Marshall Hall** (according to which the patient is rolled alternately from the abdominal position — expiration — to the lateral position — inspiration) and *Howard's* method (in which an assistant kneels upon the patient, seated as if on horseback, and presses with his whole weight upon the thorax — expiration) are of little value for the surgeon.

4. Rhythmic **faradization of the phrenic nerve** (*Duchenne, von Ziemssen*) can be made only when everything is within reach and in readiness, but then

most effectively. Apply the electrodes at both sides of the neck over the clavicle at the external margin of the sterno-cleido-mastoid muscle.

By means of certain **stimulants**, the failing respiratory movements by reflex action may be excited again, or restored after complete cessation. The most effective are: dashing cold water into the face, beating the breast (and back) with a towel dipped in cold or hot water, stimulation of the nasal membrane by an electric current, rubbing the region of the stomach or the neck with cold water, ice, snow, distention of the anus by introducing one or several fingers, a rectal injection of cognac and water (1 : 2); finally, vigorous rubbing with hot cloths, brushing the surfaces of the hand and the foot, inhalation of amyl nitrite.

In *sudden paralysis of the heart* (**syncope**), *Nélaton's* **inversion** (1861) must first be attempted as the chief remedy. Place the patient in such a position that his head lies lower than his body, by raising the foot end of the table (Fig. 323); or hold the patient by his knees and place him over the shoulders so that his body hangs down perpendicularly (see also Fig. 1416). In this position the blood supply to the heart, which has become anæmic during anæsthesia, is promptly increased; the flow of blood to the brain is also promoted, and the cerebral anæmia overcome. For the same reason, during artificial respiration, which must be made at once, the patient should be placed at least slightly in the inverted position, and during the compression of the thorax, the left elbow should be pressed forcibly against the region of the heart.

König's massage of the cardiac region is most effective. Stand at the left side of the patient; compress the thorax with the thenar eminence of the right hand between the place of the apex beat and the left sternal margin with considerable force and as rapidly as *possible* (120 a minute), until the effect of the movements is recognized by the artificial carotid pulse and the contraction of the pupils. In most serious cases, where even massaging the cardiac region did not effect the desired result, life was saved by intravenous *infusion of sodium chloride.*

Faradization of the heart by means of *electro puncture* (*Steiner*), formerly recommended, must be rejected as *injurious.* Rhythmic faradization of the exposed cardiac muscle has been suggested.

ETHER ANÆSTHESIA

Ethylic ether, sulphuric ether, $C_4H_{10}O$, is the oldest anæsthetic. It was first used for anæsthesia in 1846 by *Jackson* and *Morton*.

Only pure ether should be used for anæsthesia (æther purissimus pro narkosi, anhydrous ether, *Pictet*). If ether contains alcohol, it turns red by adding fuchsine; if it contains water, powdered tannin will be dissolved into a thick mass on addition. Ether to be used for anæsthesias is best kept in dark bottles of 100 to 200 grams each. It should be brought in contact with air and light as little as possible. Any portion of ether remaining over from one anæsthesia should not be used for a subsequent narcosis. Ether evaporates very easily, its vapors are heavier than air and combustible to a high degree. Hence, it renders operations dangerous for the surgeon as well as for the patient, especially when they are performed with artificial light or the use of the thermo-cautery.

Ether is much less poisonous than chloroform; its largest toxic dose is about five to seven times greater than that of chloroform. According to *Gurlt's* statistics death from anæsthesia occurred at the rate of 1 to 5000. Still, in some clinics a much higher ratio of anæsthesias has been obtained; for instance, *Ollier* at Lyons reports that since the introduction of ether no death occurred in 40,000 anæsthetized persons.

On account of its less toxic qualities, *much larger quantities* are required for a full anæsthesia. Ether does not act so rapidly and effectively as chloroform, but when *properly administered* most of the dreaded and dangerous symptoms are absent.

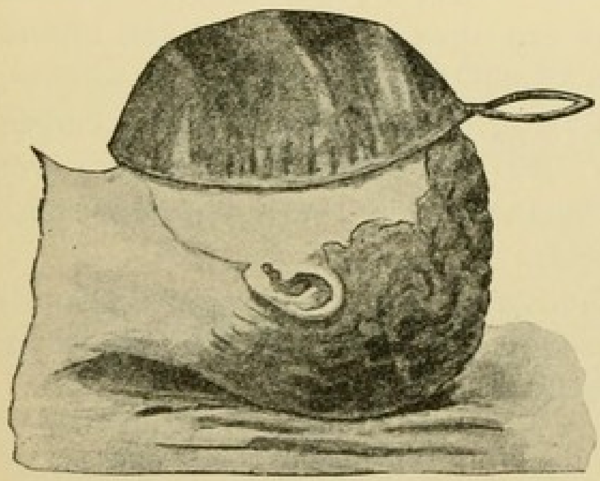


FIG. 325. JUILLARD'S ETHER MASK

Two methods of ether anæsthesia are used: —

First, the **asphyxiating form.** For this purpose a large mask is used, covering the whole face. On its inner side the mask has several layers of gauze, flannel, or cotton, on its outside it is covered with some impermeable air-tight material (Fig. 325). Into the mask about 20 grams of ether are poured at a time; the mask is then firmly pressed upon the face, so that very little, if any, air is admitted. For the purpose *of admitting still as little air as possible* a towel may be applied tightly around the margin of the mask. Anæsthesia comes on almost as rapidly as with chloroform; the apprehension that too much carbonic acid and too little oxygen is under the mask has no foundation (*Dreser*). When administering more ether the anæsthetizer should proceed *as rapidly as possible*, lest too much air is inspired by raising the mask.

This method is very convenient and simple. The amount of ether used is about 100 to 150 grams an hour. Sometimes even larger quantities can be administered without injury to the patient.

Second, the **intoxicating form.** Pour the ether in a *Wanscher's* mask, a large rubber bag whose opening can be applied almost air-tight to the mouth and nose (Figs. 326 and 327). Pour at first about 50 grams into the mask, hold it before the nose and mouth of the patient, and gradually apply it tight. By shaking the lower part of the mask more ether is caused to evaporate, hence *the dose of ether can be regulated* to some degree. Anæsthesia, of course, comes on much less rapidly, but it has less unpleasant symptoms and after effects.

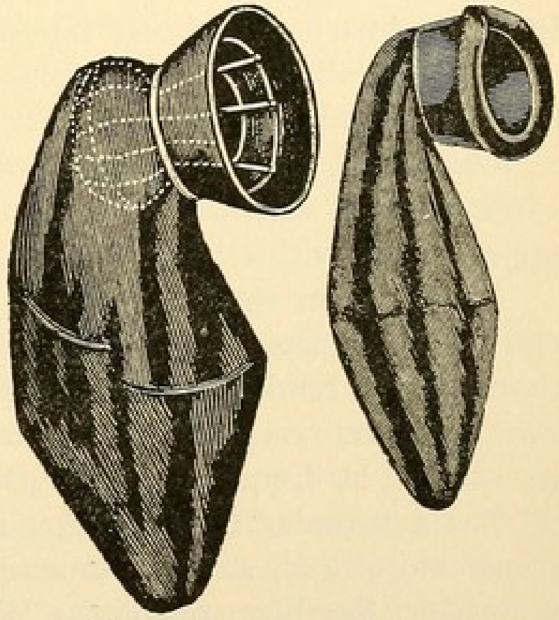


FIG. 326 Old Form — FIG. 327 Modern Form
WANSCHER-GROSSMANN'S ETHER MASK

The **course of ether anæsthesia** is essentially similar to that of chloroform. In the beginning of it the patient appears excited, often in a cheerful frame of mind. The face turns red, large maculated exanthem appears on the neck and chest, coughing, singultus (hiccough), salivation, perspiration, and lachrymation occur from its irritating effect. Cyanosis of the face in most cases is very pronounced, *the blood pressure* is often increased to twice or three times its normal, the beats of the pulse mostly remain normal. The condition of the pupils is with ether less important than with chloroform; in most cases they at first dilate and afterward contract, but not always. The occurrence of clonic contractions ("Aetherzittern") is often very annoying. When after more or less pronounced excitation the stage of tolerance occurs, inspiration is regular and stertorous.

Dangers from anæsthesia involve less the heart, as in chloroform, than the respiration. The very profuse secretions of saliva are aspirated; coarse crepitant râles are heard in breathing; the patient may die at the end of anæsthesia or several days afterward of broncho-pneumonia. Hence, it is the principal duty of the anæsthetizer to see to it that the mucous secretions from the mouth are cleared. Place the patient in a position with his head very dependent and *turned well to one side;* raise the angle of the lower jaw, place the forefinger hooklike behind the angle of the jaw, and draw it downward. Clear with a sponge the mucous secretions which have collected in the cavity of the mouth, this being the deepest point. With these precautions the *tracheal râle* (for a long time considered characteristic of ether anæsthesia) is avoided. For ether, aside from a slight increase of saliva, produces no excitation whatever upon the mucous membrane of the air passages (*Hölscher*).

In the stage of fullest tolerance, when too large a dose has been administered, primary *cessation of respiration* is to be apprehended. It should be treated according to the rules mentioned in chloroform asphyxia. Hence, it is even more important in ether anæsthesia than in chloroform anæsthesia to *observe carefully the respiration* of the patient. Any disturbance of the cardiac action which makes the use of chloroform so incalculable, is to be apprehended with ether only as a secondary cause.

Hence, ether should not be used: In diseases of the air passages (bronchitis, bronchiectasis, tuberculosis, and in the case of old patients with rigid thorax which renders expectoration difficult). Moreover, it is not preferably used in operations on the face, since the effects of ether anæsthesia become neutralized by frequently raising the mask.

The awakening from an ether anæsthesia takes place more rapidly than from chloroform; sometimes analgesia continues for some time after consciousness has been restored. With some patients subsequently great excitation occurs. *Vomiting* does not occur so regularly as with chloroform. For many patients the odor of ether (often lasting for days) of the expirated air is unpleasant; still, according to *Drescher*, the larger quantity of ether has been disassimilated one hour after anæsthesia.

As **after effects** should be mentioned, above all, bronchitis, pneumonia, œdema of the lungs ("we lose our patients anæsthetized with chloroform on the operating table, those anæsthetized with ether in their beds"); moreover, albuminuria and acetonuria (*Becker*); apoplexy observed in the case of aged patients after ether anæsthesia (but also after chloroform) may be explained from the considerably increased blood pressure.

Etherization per rectum (*Pirogoff*), which was abandoned, has been recommended again recently (*Starke*). It will hardly be adopted generally.

COMBINED ANÆSTHESIAS

Chloroform-ether anæsthesia. In prolonged anæsthesias chloroform and ether in succession have been used with the best results. The anæsthesia begins with chloroform, and when the stage of tolerance has occurred, it is kept up with ether, after the mask has been changed. The advantages of this method are: very little ether is required for keeping up anæsthesia; the same can be continued for several hours; no unpleasant consequences as in prolonged chloroform anæsthesia need be apprehended; according to statistics the mortality is very low.

Ether-chloroform anæsthesia (*Madelung*) is used much more rarely, mostly with patients who from ether inhalations become exceptionally excited, who have a pronounced tracheal râle, cyanosis, and hiccough (singultus), or with whom the occurrence of full anæsthesia is retarded in spite of large doses of ether. It has the advantage of avoiding primary syncope caused by the effects of chloroform. If chloroform is administered, after ether anæsthesia has occurred, the subsequent part of anæsthesia takes an especially favorable course (*König*).

Very frequently a subcutaneous injection of morphine is previously made (see p. 177) (with the addition of 0.03 grams oxyspartein (to regulate the action of the heart), or 0.001 gram atropin (to regulate respiration)). The stage of excitation is thereby shortened, and with a smaller quantity of the anæsthetic narcosis takes a more tranquil course. After an injection of 0.01–0.03 morphine 15 to 20 minutes previous to anæsthesia, the latter can be kept up with ether (**morphine-ether anæsthesia**, *Riedel*), or it can be brought on with a very small quantity of chloroform (**morphine-chloroform anæsthesia**).

This kind of anæsthesia is of especial advantage in the case of very excitable, frightened patients; with drunkards, who become considerably less excited from it; and in all operations on the face or on the neck during which blood is liable to enter the air passages, because the patient is not completely unconscious and when requested coughs out the blood which has been aspirated, and yet the pain inflicted is slight (for instance, in resection of the upper jaw, amputation of the tongue, etc.). Thus only analgesia with consciousness still partly preserved is produced. Instead of morphine 2 to 3 grams of chloral hydrate may be given.

Anæsthesias with chloroform mixtures have the advantage of less danger than those of pure chloroform, but they are not frequently used in Germany.

Billroth's mixture is known best of all (chloroform-ether-alcohol, 3 : 1 : 1) from which one death occurred in 3370 anæsthesias. The *English A. C. E. mixture* (1 : 2 : 3) brings on anæsthesia rapidly without causing any serious injury to the heart. *Tillmanns* prefers chloroform and ether mixed in equal parts.

For *anæsthesias of short duration* in operations which can be quickly performed, **ethylene bromide** has been used in modern times: 15 to 20 grams at a time, poured into an impermeable mask and inhaled with as complete an exclusion of air as possible produces, after one minute or less, anæsthesia which is complete for about 3 to 5 minutes. After this time analgesia can continue for some time. Sometimes, however, the desired relaxation of the muscles does not occur. During anæsthesia cyanosis, disturbance of respiration, nausea, and vomiting have been observed. On awakening the patient feels perfectly well, still the expirated air has for days an odor of garlic. If anæsthesia is to be prolonged, it is not advisable to administer again ethylene bromide; it is better to use ether (*ethylene-bromide-ether anæsthesia, Kocher*).

Ethylene chloride (*Kelen*), which is syringed upon a common tricot mask, can also be recommended according to *Soulier* and *Lotheisen* for anæsthesias of short duration. Likewise **bromoform** has been used successfully.

Pental, which has a pungent odor of oil of mustard, cannot be recommended for anæsthesia on account of its great dangerous qualities.

The other numerous anæsthetics, nitrogen monoxide, methylic pichloride, dimethyl acetal, diethylene acetal, and their combinations with one another or with chloroform, ether, oxygen, and others, are of little importance for surgical purposes.

LOCAL ANÆSTHESIA (ANALGESIA)

For rendering *only one certain part of the body* as *anæsthetic* as possible, and hence for alleviating or removing the pain of an operation, *strong* **pressure** was, even in olden times, exerted either upon the principal nerve or upon the whole circumference of the limb; by this means, aside from the partial interruption of the nerve transmission, the circulation of the blood becomes retarded, and thereby the hemorrhage diminished. In the same manner, the elastic bandage in the bloodless method, after some time, proves antalgic.

The fact that frozen limbs are always without sensation led to the use of **refrigeration** as an anæsthetic. The part involved was treated with a freezing mixture, covered with a piece of ice or with ice bags. *Richardson* used the **ether spray**, which quickly evaporates, for reducing the temperature in a very short time to the freezing point. The cold, thus produced in a few minutes, renders the skin insensible. After a momentary redness, the place of the surface of the skin subjected to the spray turns white; next, after prolonged spraying, the skin becomes wrinkled almost like parchment. Minor operations which have to be performed rapidly and which are confined mainly to the skin can then be performed in a painless manner. In consequence of the ether spray as well as of the thawing of the refrigerated part, very violent pricking pains generally occur, which often continue for a long time. Immersion of the part in warm water will somewhat mitigate the pain (*Kocher*).

In a similar manner *liquid carbonic acid* and *methyl chloride*, both in small siphons, have been used. Most convenient is **ethyl chloride**, a colorless liquid which boils at 11° C. It is sold in glass tubes with a capillary opening and an air-tight cover (Fig. 328). Likewise, mixtures of ethyl chloride and methyl chloride are used. On removing the cover the liquid

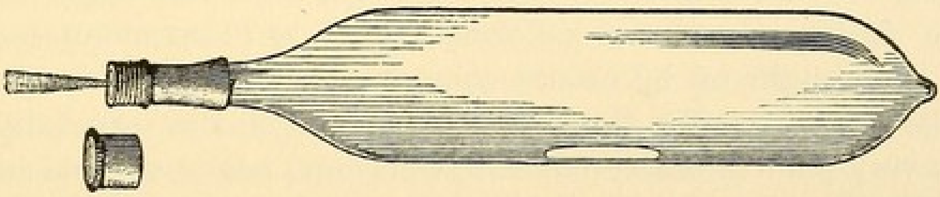


FIG. 328. FLASK CONTAINING ETHYL CHLORIDE

begins to boil from the ordinary temperature of the room, and still more from that of the hand. It squirts forth in a fine spray. If the glass tube is held 10 to 20 centimeters distant from the portion of skin to be refrigerated, the skin turns white almost instantly, and snow is formed on the cutaneous hair. This refrigeration is indeed painful, but it renders the skin antalgic for punctures or incisions. A disadvantage for handling the knife is the solid icy condition of the refrigerated part. After the thawing, which occurs rapidly, often a marked redness of the skin remains. This redness, as well as the pain, may be reduced during refrigeration by previously *lubricating* the portion of skin. By means of elastic constriction of the limb, and by ischæmia thus effected, refrigeration occurs more rapidly and continues for a long time.

Cocaine and its salts, especially cocainum muriaticum, however, is mostly used for producing local anæsthesia (*Koller*, 1884). It possesses the property of rendering antalgic mucous membranes and wounds, *but not the uninjured skin.* It paralyzes the sensory nerve fibres, while, at the same time, a *contraction* of the lumen of vessels occurs. The anæsthetic is used in solutions of 1% to 20%. Cocaine solution heated to 50° F. is still more effective (*Costa*). Since the solutions easily become mouldy, it is better to have them freshly prepared, or to use them when only a few days old. By sterilizing them in a temperature of 212° F. they lose in effectiveness.

Mucous membranes, surfaces of wounds, and ulcers are rendered antalgic when brushed with a solution of 5% to 10%. After a few minutes anæsthesia will occur and minor operations can be made. If any part with uninjured skin is to be rendered antalgic the anæsthetic is *administered* from a *Pravaz* syringe in and under the skin, and also into the deeper layers. For this purpose weaker solutions (1% to 5%) are sufficient, of which not more than 0.1 gram of cocaine as the maximum dose should be administered, else toxic symptoms can occur. The place of puncture made by the syringe can be rendered antalgic by ethyl chloride.

For **direct analgesia by means of cocaine** (*Réclus*) inject about 0.05 to 0.1 of cocaine, distributed in one or several syringes, into the field of operation and its immediate neighborhood. The operation can begin after a few minutes. Analgesia will not last longer than 15 to 20 minutes. If ischæmia can be brought on by elastic constriction (on the limbs), the effect of cocaine lasts longer. But the injection into tough, and especially inflamed, tissues is very painful before anæsthesia occurs, hence, a rapid incision, for instance, the division of a simple felon (panaritium), can be borne as easily as an injection. **Regionary analgesia** (*Oberst*) is quite especially adapted to such cases in which a portion of limb by means of *elastic constriction* can be rendered anæsthetic by injecting cocaine into the region of the *nerve trunks, centrally* from the field of operation. Originally recommended by Oberst for the fingers and toes, this method has been extended to the hand and foot (*Manz*). *Berndt* amputated even an arm and a thigh under regionary analgesia.

Analgesia for the fingers and toes is made as follows: First, encircle the *base* of the limb with a rubber tube or a small bandage, subsequently moistened, so firmly that complete ischæmia occurs. Next, under a spray of ether or ethyl chloride inject *immediately at the place of constriction* in the direction of the tip of the forefinger and at the four sides of the limb $\frac{1}{4}$ to $\frac{1}{2}$ a *Pravaz* syringe filled with a 1% solution of cocaine. *Wait* five to ten minutes until anæsthesia has occurred, when the operation can begin. In operations on the hand and foot apply the constrictor directly above the joint and wait at least ten to twenty minutes after the injection has been made into the afferent nerve trunks. In the thigh the desired analgesia does not occur until thirty minutes after the injection. For producing deep analgesia it is advisable to paralyze also the small cutaneous nerves by a circular œdematization with *Schleich's* solution. This should be made close to the constriction band.

Bier evidently went farthest centrally by **cocainizing the spinal cord**: Place the patient in a lateral position; next, with a very fine hollow needle make *Quincke's lumbar puncture* under infiltration anæsthesia. On removing the top which closes the needle, apply immediately the finger upon the opening to prevent the outflow of the cerebro-spinal fluid; next, inject the cocaine solution with a *Pravaz* syringe fitting exactly the orifice. The hollow needle and syringe remain in a position for two minutes to prevent the cocaine from oozing out of the punctured canal of the spinal membranes into the tissues. On removing the syringe the little puncture opening is closed with collodium. Half a syringe to a full syringe of a 1% cocaine solution is sufficient (0.005–0.01 cocaine). After about twenty minutes paralysis to a *high degree* of the sense of pain and of touch, extending over the whole body (trunk and limbs), occurs from the effect of cocaine upon the sheathless spinal nerves; perhaps also upon the ganglion cells. After about three-quarters of an hour sensibility is restored. This procedure might be adapted to become even a substitute for inhalation anæsthesia, if no unpleasant after effects occurred from it, such as nausea, vomiting, headache more prolonged than after chloroform anæsthesia.

Cocaine is a nerve poison. Even in small quantities (especially on mucous membranes) it can often cause *toxic symptoms* and even death. In such a case occur: Paleness of the face, dizziness, headache, fainting, convulsions, delirium, small pulse (anæmia of the brain). Immediate inspiration of amyl nitrite is considered as the best antidote; likewise morphine, potassium bromide, and antipyrine have been used. In addition the patient should be placed in a recumbent position.

Hence, attempts have been made to substitute for cocaine the less toxic and more rapidly effective *tropacocaine* and also eucaine, of which as much as two grams can be injected without injury. But in contradistinction to cocaine, it produces hyperæmia. Both remedies have not been able to supersede cocaine.

The dangerous qualities of cocaine injections can be removed and still a complete analgesia in the field of operation be effected by **Schleich's infiltration anæsthesia**. With *very weak* cocaine solutions all tissues involved are infiltrated (artificial *œdematization*). For this purpose a syringe holding 10 grams and provided with a very fine canula is used with the following three *Schleich's* solutions:—

I. Strong		II. Medium		III. Weak	
Cocain muriat.	0.2	Cocain mur.	0.1	Cocain mur.	0.02
Morph. mur.	0.025	Morph. mur.	0.025	Morph. mur.	0.025
Natr. chlorat.	0.2	Natr. chlorat.	0.2	Natr. chlorat.	0.2
Aq. sterilis.	100.0	Aq. sterilis.	100.0	Aq. sterilis.	100.0

Solution I is used for the epidermis, being the most sensitive tissue to pain; solution III for the deeper, less sensitive tissues. Generally for minor operations solution II is sufficient. With the exception of the first puncture with the hollow needle, which, if necessary, can be rendered antalgic by means of ethyl chloride, all subsequent injections are painless. Analgesia occurs at once. Elastic constriction is not required. Many surgeons mention as a disadvantage of this procedure the more difficult orientation in the œdematous tissues.

Procedure: Make the infiltration by layers. First render the field of operation œdematous. Insert the syringe obliquely, very superficially, and *intracutaneously*, so far that the opening of the syringe is in the *cutis*. Inject so much of the solution that a pale blotch of the size of a bean is raised. At the margin of this portion of skin, rendered instantaneously antalgic, insert the syringe again and raise a new blotch connected with the first. Continue in this manner until a field is infiltrated as long as the external incision is intended to be. From this field infiltrate the deeper layers and circumscribe, for instance, well-defined tumors, also in their depth (by means of a curved syringe (canula)). For tough tissues sometimes a very strong pressure upon the piston is required. The external incision can now be made *immediately*, the patient feeling no pain. Often the whole operation, after a previous infiltration, may be made as in general anæsthesia. In most cases, however, in advancing into the deep layers the knife must be changed for the syringe and a new infiltration be made, as soon as the patient feels any pain. The procedure is simple. Still, for a complete control of its technic, it is necessary to have seen it performed. If the surgeon is familiar with this procedure it is very convenient and adapted to make anæsthesia dispensable with in many cases, — for instance, in enucleation of benign tumors

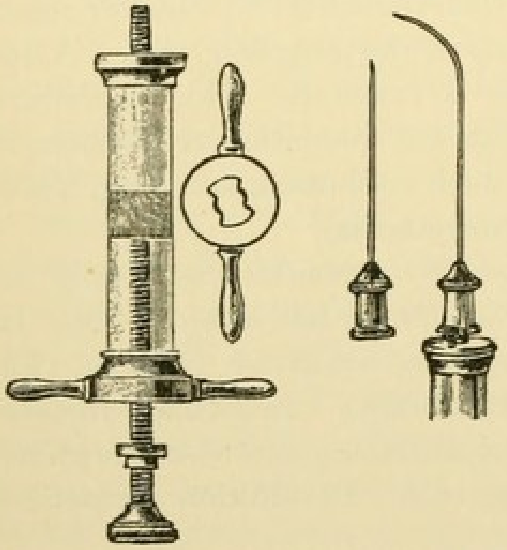


Fig. 329. Syringe and Canulæ for Infiltration Anæsthesia

in all parts of the body, in herniotomies, laparotomies, hemorrhoids, rectal fistulæ, etc.

In *inflamed* tissues pain is caused by increasing the pressure of the tissues, unless the surgeon cautiously approaches the focus of inflammation from the healthy surrounding tissue. Still, it is to be remembered that inflammatory stimulus may be pressed into the surrounding healthy tissue, and thus progressive inflammation (phlegmone) be caused.

Wherever elastic constriction can be used regionary analgesia is certainly preferable in such cases.

For anæsthetizing wound surfaces, burns, lacerations, and exposed nerve ends in general, recently, instead of toxic cocaine, the non-poisonous **orthoform** has become very popular. *Orthoform*, a yellowish powder, is dusted upon the wound. It has antiseptic properties and renders anæsthetic the parts involved almost for a day, but surely for several *hours*. Other local anæsthetics, such as guajacol (1 to 2 grams applied on the skin), solution of antipyrine (for mucous membranes), eucaine (10% salve), etc., are less generally used.

Only briefly may it be stated here that the surgeon can, by psychical influence (suggestion), also render an expected pain much less severe to the consciousness of the patient, when he has been perfectly assured that "it will not hurt." The efficiency of the "**suggestion**," especially in the hypnotic state, has been made manifest by many excellent examples. But even without a methodically induced hypnotic state, it is sometimes successful to anæsthetize a patient suitable for such treatment, by merely holding a dry mask or one moistened with a few drops of some ethereal fluid over the nose. In these experiments, which can sometimes be tried as an expedient, much, of course, depends on the personality of the physician as well as on that of the patient.

SIMPLE OPERATIONS

The **operation wound**, in the great majority of cases, is made by an **incision** with the surgeon's knife (scalpel). How this is to be held and manipulated depends on the personal practice and manual dexterity of the operator. Generally, however, we distinguish the following *methods of holding the knife*: —

If fine shallow incisions are to be made, or if the operator wishes to proceed by way of anatomical dissection, so to speak, the knife is held like a pen, the little finger resting on the surface of the body (Figs. 330, 331). If it is desirable to use more strength for making long, flat incisions, hold the knife like a violin bow (Fig. 332); by holding the knife in this manner, the entire blade rather than its point is made effective. In using still greater power, in dividing tougher tissues, hold the scalpel like a table knife, the

FIG. 330. (*a*) In anatomical dissection

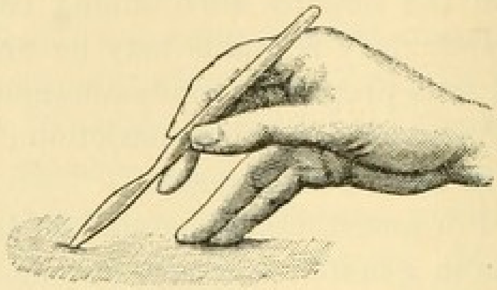


FIG. 331. (*b*) In cutting from within outward

HOLDING THE KNIFE LIKE A PEN

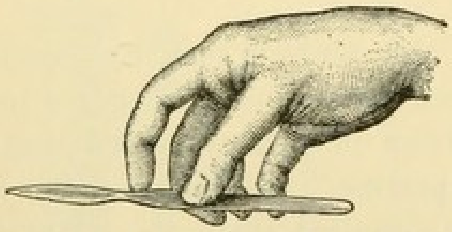


FIG. 332. HOLDING THE KNIFE LIKE A VIOLIN BOW

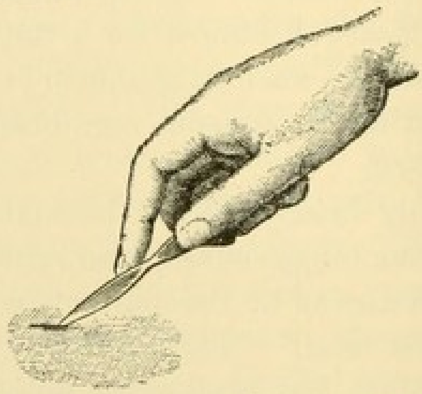


FIG. 333. HOLDING THE SCALPEL LIKE A TABLE KNIFE

forefinger resting on the back of the knife (Fig. 333). Finally, for dividing all soft parts with one firm stroke down to the bone, hold the knife with the whole hand like a sword.

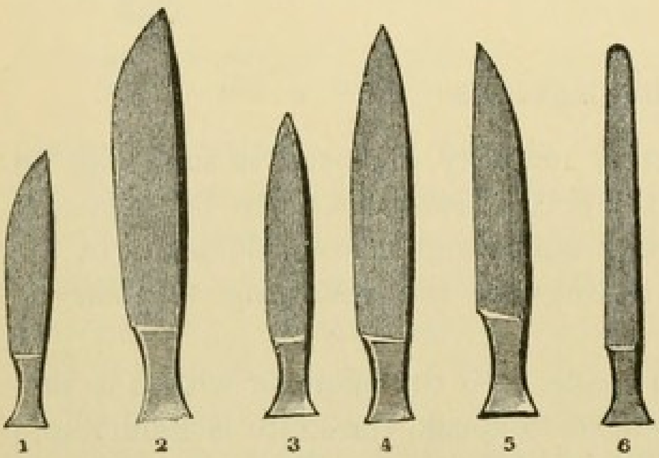


FIG. 334. SHAPE OF KNIFE BLADES. 1–2, curved; 3–4, pointed; 5, straight; 6, blunt-pointed

The shape or form of the blade (Fig. 334), whether curved or straight, and also the prescribed manner of holding it according to the rules of art, is a matter of little importance for one who knows how to handle a knife dexterously, gracefully, and easily, provided the wound made with it shows a smooth clean incision, which has everywhere uniform depth and no jagged, contused, and mangled margins. Especially uncomely are the "*tail ends*" in skin incision, — viz., when the angles of the wound are made only superficially into the skin. In order to make smooth uniform incisions, it is of the

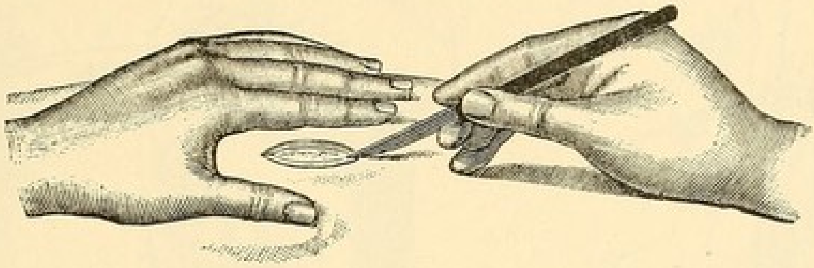


Fig. 335. Stretching Margin of Wound for External Incision

greatest importance to stretch the skin as tense as possible. In smaller incisions it is made tense by stretching the skin between two fingers applied near the margins of the wound (Fig. 335); in larger incisions, by applying both hands. In most cases the smooth incision of the knife is the most appropriate procedure in penetrating downward. If the operator reaches any muscular septa and other layers of connective tissue, he may advance

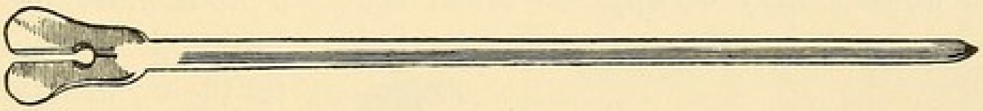


Fig. 336. Grooved Director

more rapidly in a *blunt manner* by tearing them apart with the handle of the knife or with the finger. If distinct layers are present, the *grooved director* (Fig. 336) may be used. Insert it under such a layer and conduct the knife along the groove (Fig. 337). The incision by *raising a fold of tissue* (Figs. 338, 339) is more conservative, and is especially to be recommended for the fine dissection of numerous thin layers. In incising the skin, raise it with two fingers at each side of the intended line of incision. Next, grasp with forceps a portion of the underlying layer of tissue. Let an assistant grasp another portion close by. The raised fold is superficially divided between the two forceps, and this is repeated layer after layer, until the desired depth has been reached. The operator proceeds in such a manner most frequently in exposing an artery or a hernial sac.

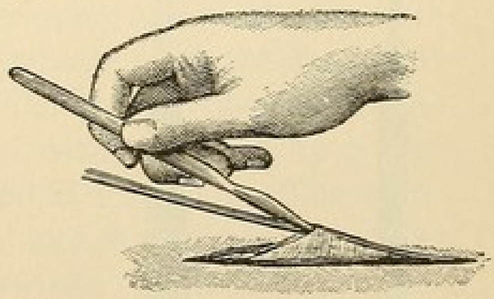
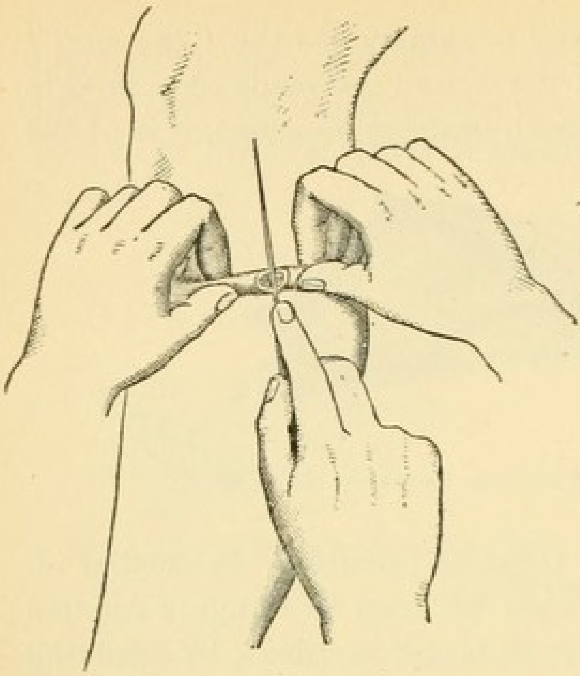


Fig. 337. Conducting the Knife along the Grooved Director



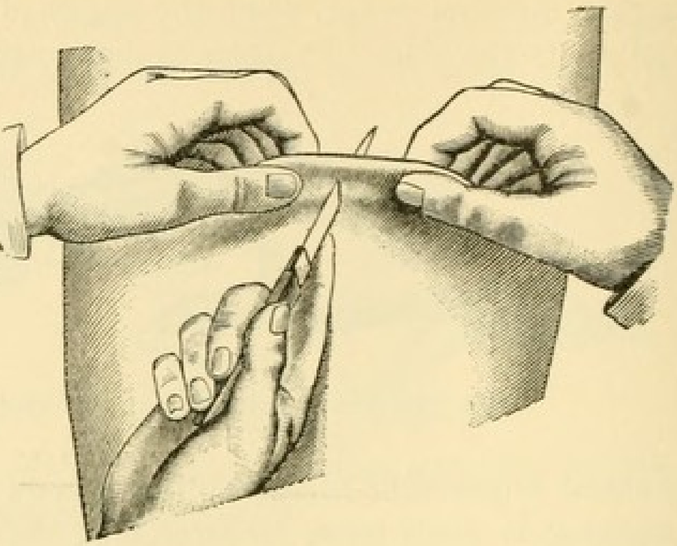


FIG. 338 FIG. 339

EXTERNAL INCISION BY RAISING A FOLD OF TISSUE

Retractors (Figs. 340–342) should always be applied with great care; if in smaller wounds they occupy too much space, light *ligature loops* may be practically substituted for them; with these, the margins of the wound are retracted. The ligatures are finally used in suturing the wound. In places where larger veins might be injured only blunt retractors should be used. Likewise, in resections, else from the large traction and the repeated insertion of the sharp prongs, the wound surface is unnecessarily irritated.

The wound can also be deepened rapidly and easily with the *scissors* (Figs. 343, 344, 345).

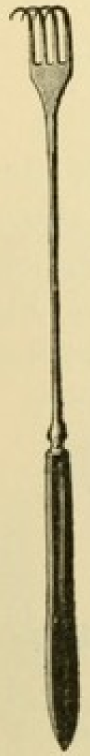
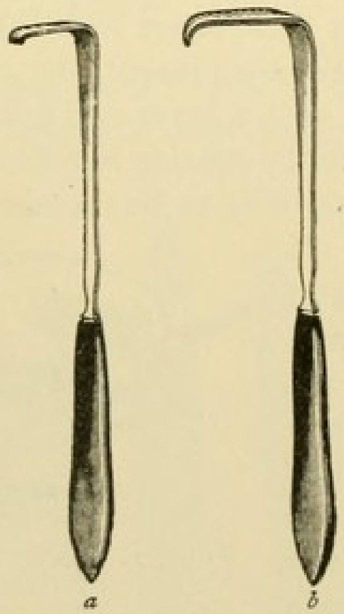


FIG. 340
VON VOLKMANN'S SHARP RETRACTOR



a *b*

FIG. 341. VON LANGENBECK'S BLUNT RETRACTORS. *a*, small; *b*, large

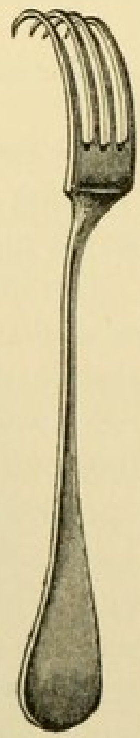


FIG. 342
IMPROVISED RETRACTOR

Scissors, however, cause contusion, and hence make rough incision margins; nevertheless, the operator can very conveniently and safely work with them; for instance, in the enucleation of some tumors. In addi-

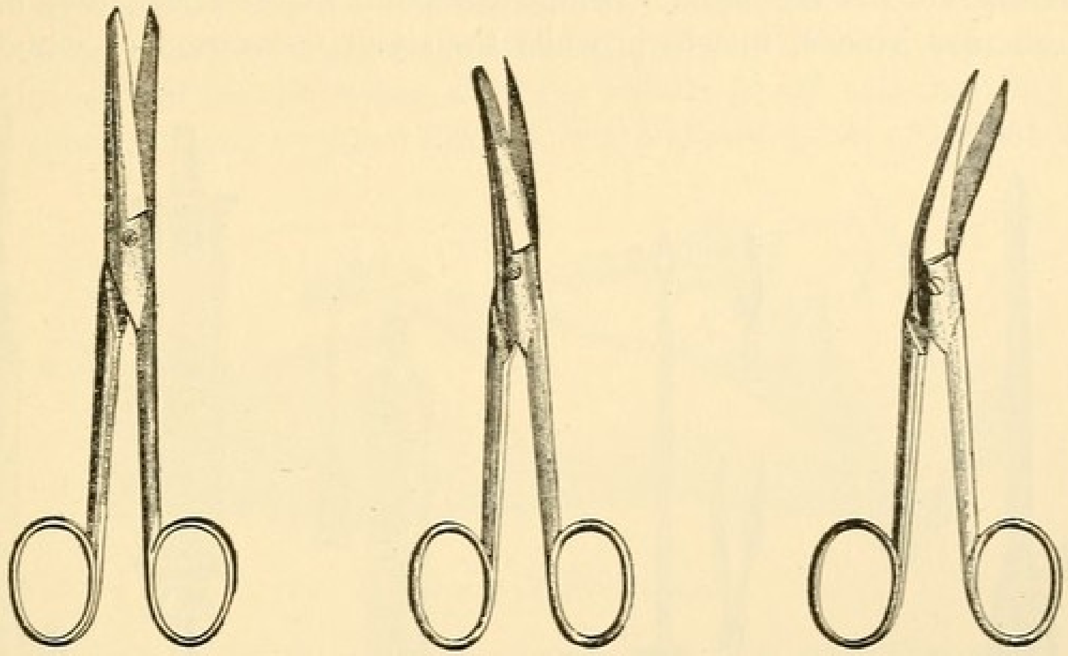


FIG. 343. STRAIGHT SCISSORS FIG. 344. COOPER'S SCISSORS FIG. 345. ANGULAR SCISSORS

tion to the *straight scissors*, the bent or *angular scissors* are also used for deepening and enlarging incisions. *Cooper's scissors*, which are slightly curved, are used especially for shallow or surface incisions.

PUNCTURE

This serves for evacuating fluids from the cavities of the body, for recognizing pathological transformations in the deeper layers, and finally for administering medicines in fluid form. Larger puncture openings may be made with a small pointed knife held perpendicularly and pushed into the skin. If it is desirable, however, to avoid hemorrhage from the larger vessels, use round tubes pointed at one end. The *trocar* (acus triquetra) (Fig. 346) consists of a metal tube, the lumen of which is filled by a stylet that can be withdrawn; the stylet is three-edged at its point. The instrument is inserted by one plunging movement, and the stylet withdrawn, when the fluid can be evacuated through the canula. If it is desirable to make the puncture very small, so that it closes of its own accord on withdrawing the instrument and heals without any further treatment, long, fine trocars, pointed like a writing pen, are used, with a closely fitting syringe with which the fluid is removed by suction, and with which fluids can be injected. For larger cavities use the various kinds of aspiration apparatus mentioned under Figs. 1248–1249.

For diagnostic purposes (**Akido-peirastik** — *Middeldorpf*, 1856), trocar-shaped instruments are used. Behind the point of the stylet, they have a small circular groove, in which, while the stylet is inserted or withdrawn

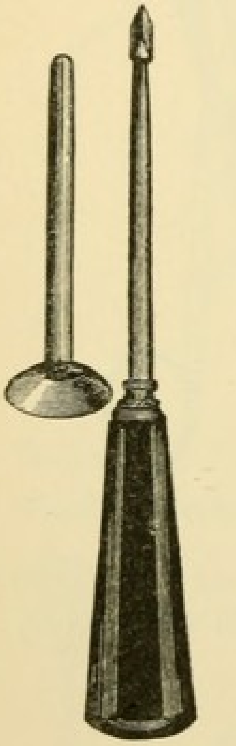


Fig. 346. Trocar

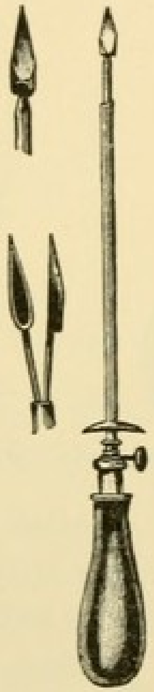


Fig. 347. Von Esmarch's Trocar for Akido-peirastik

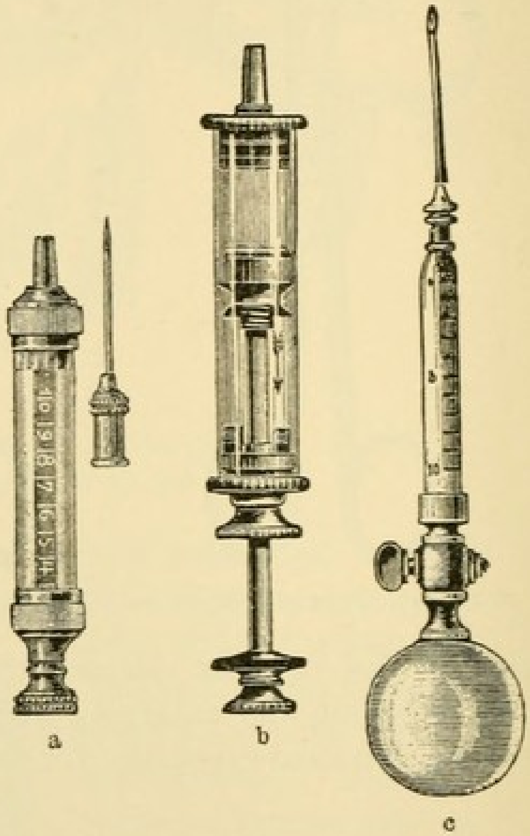


Fig. 348. Syringes for Subcutaneous Injection. *a*, Pravaz's syringe; *b*, Overlach's syringe; *c*, Koch's syringe

from the canula, small quantities of tissue sufficient for microscopic examination are caught. There are also instruments with a divided point, which opens of its own accord when the canula is withdrawn (harpoon) (Fig. 347).

For *injecting* medicines, syringes with a long fine hollow needle are used. *Pravaz's* well-known and largely used *syringe* (Fig. 348) contains exactly one gram of fluid; its cylinder is marked by a scale divided into ten equal parts, so that a definite quantity may be injected into the body by pushing forward the piston. The injection is made as follows:—

Fill the syringe by suction with the desired quantity of solution, and expel the air which may have entered by pushing forward the piston with the point raised. Raise a fold of skin at some portion of the body; insert the needle *quickly* through the base of the fold and into the superficial facia;

convince yourself by a few lateral movements that the point did not enter the corium merely, or perhaps even a vein; empty its contents by slowly pushing the piston forward (Fig. 349).

Next, withdraw the needle and place the forefinger for a few moments upon the puncture, to prevent the injected fluid from flowing out. A slight pressure exerted simultaneously with the middle finger and the ring finger and a gentle rubbing promote the diffusion and resorption of the solution.

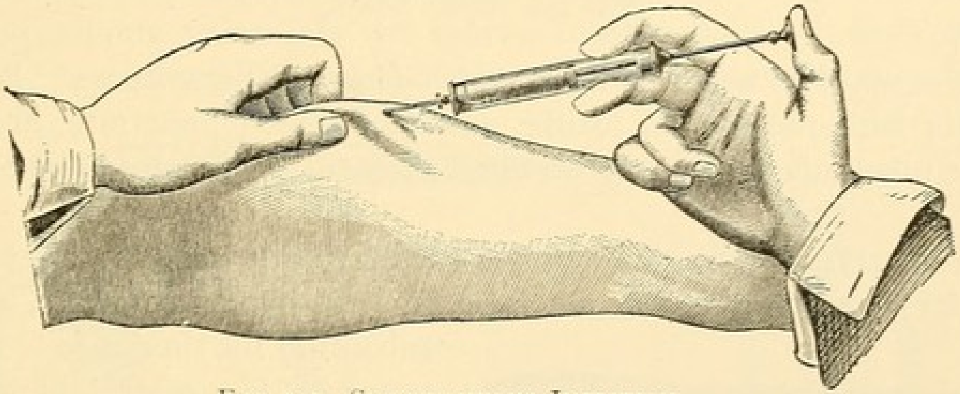


FIG. 349. SUBCUTANEOUS INJECTION

Preliminary even to this trifling operation, it is necessary carefully to cleanse and disinfect, not only the syringe and the fingers of the operator, but also the place on the skin selected for the injection. Otherwise, subcutaneous abscesses may be caused from it.

For some cases it is better to make the injection not merely subcutaneously, but deep into the muscles (intramuscularly), — for instance, in the case of quicksilver solutions, which, injected subcutaneously, can cause gangrene. Insert with a quick movement the fine hollow needle perpendicularly to the surface of the skin down to its hilt. The skin is drawn somewhat laterally in order that the puncture of the skin does not form a straight line with the punctured canal in the deep layers. The same procedure is observed in injections of arsenic into malignant tumors and in injections of iodine into struma (parenchymatous injections).

TISSUE DESTRUCTION

This can be made *mechanically*, by *thermo-cautery* or by *cauterization* with chemical substances.

Soft tissues can be scraped away with the **sharp spoon** (*von Volkmann*, Fig. 350), especially lupus, fungous granulations, soft tumors, and caries. If the instrument is properly manipulated with firm repeated strokes over the whole diseased portion, it serves at the same time for diagnostic purposes, since only diseased tissues can be scraped away, while healthy tissues resist the action of the spoon. This operation is valuable and frequently resorted to in the treatment of lupus. During the operation, some portions of lupus

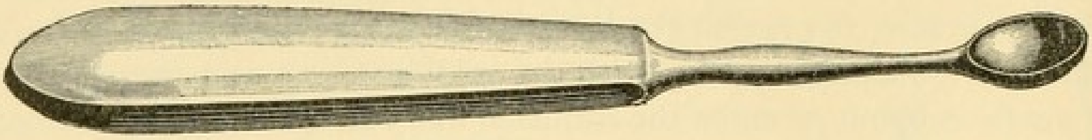


Fig. 350. Sharp Spoon

can be recognized as new foci from their characteristic softness. By boring movements with the spoon, fistulæ and foci which penetrate downward, especially tubercular softening of the bone, can be followed, exposed, and removed.

The *cautery iron* (cauterium actuale) was formerly used most extensively, not only for destroying tissues but also in arresting hemorrhage, and as a substitute for the knife. The cautery iron has a straight handle or one bent at an angle. The ends are variously shaped. It is heated on a coal basin, hearth fire, etc., until it is red hot or white hot. In many cases, the old *cautery iron* (Fig. 351) is often the best agent in effecting tissue destruction; country physicians especially cannot do without it. Moreover, it can be easily improvised, — for instance, from a piece of iron shaped suitably for the purpose. Roll up a piece of thick wire (telegraph wire in time of war) at one end in the shape of a cone or disk; fasten the other pointed end (by means of a file) into a wooden handle (*Brandis*, Fig. 352). On the whole, however, the cautery iron is not so much used since *Paquelin* invented the **thermo-cautery** (Fig. 353), which can be handled more conveniently but which unfortunately is rather expensive. Its effect consists in a hollow cauterizing point made of platinum, containing a platinum sponge. It is brought to a bright red heat by benzole

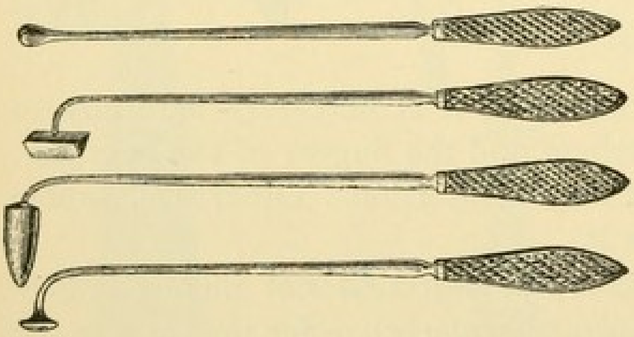


Fig. 351. Cautery Iron

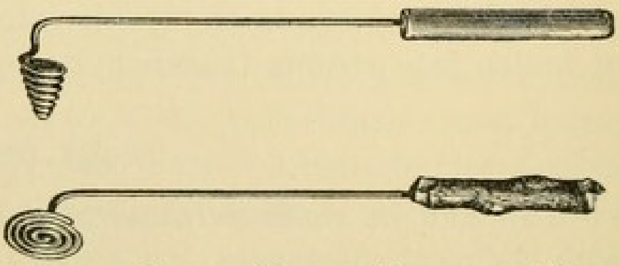


Fig. 352. Cautery Iron of Telegraph Wire (according to Brandis)

or benzine vapors forced into the point from a bottle by a double rubber bulb.

Heat the platinum point (*a*) over a spirit flame for a few minutes (Fig. 353); next, work the bulb (*b*), first slowly, then gradually more rapidly, until the platinum point becomes a bright red heat. By means of the bulbs the desired heat can be maintained for any length of time. Care must be taken to hold the bottle, containing the benzine, always perpendicularly and lower than the red-hot point, else an explosion may occur from benzine entering into the platinum point. If the thermo-cautery does not work, heat it for some time in a strong flame without forcing any vapors into it. After using

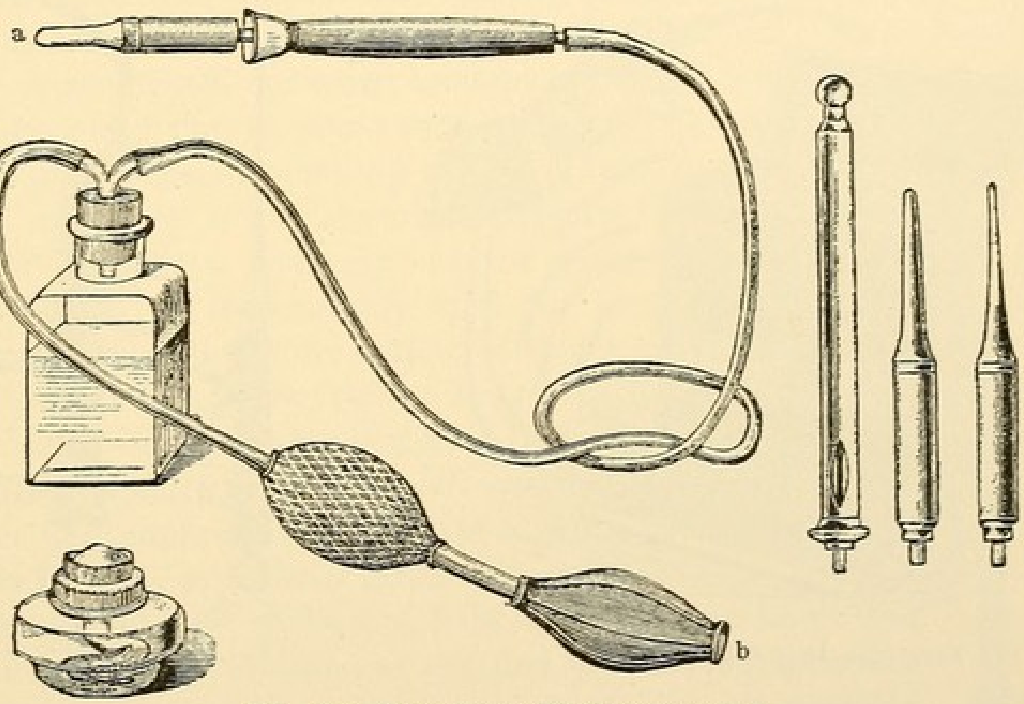


Fig. 353. Paquelin's Thermo-cautery

it, do not dip it into cold water to cool it more rapidly. Since the introduction of thermo-cautery, which appears comely and can be manipulated so easily, the actual cautery has lost its terror in surgery, and its application has vastly increased. Accordingly, as the operator selects ball-shaped, knife-shaped, or needle-shaped points, he may destroy surfaces with the instrument or make bloodless incisions, and hence, whenever it seems necessary, substitute it for the knife or make the finest punctures (with the so-called micro burner, to the platinum point of which a fine copper needle has been welded). *White heat*, to be sure, destroys the tissues more rapidly, but it cannot be relied upon in preventing or arresting hemorrhage. *Red heat* chars the tissues more slowly and thus becomes a potent hemostatic. If the points remain too long in the wound, the charred tissue fragments adhering to the red-hot metal often lessen its effect. Outside of the wound, the coating must be removed by increasing the heat. The eschars produced by the thermo-cautery do not necessarily interfere with the primary healing of the wound, especially when they are superficial; for this reason, even in the abdominal cavity, the dull red-hot thermo-cautery is used for dividing adhesions, arresting hemorrhages of stumps, etc.

Galvano-cautery (*Middeldorpf*) purposes making a piece of platinum wire red hot by an electric battery. If the operator possesses the necessary

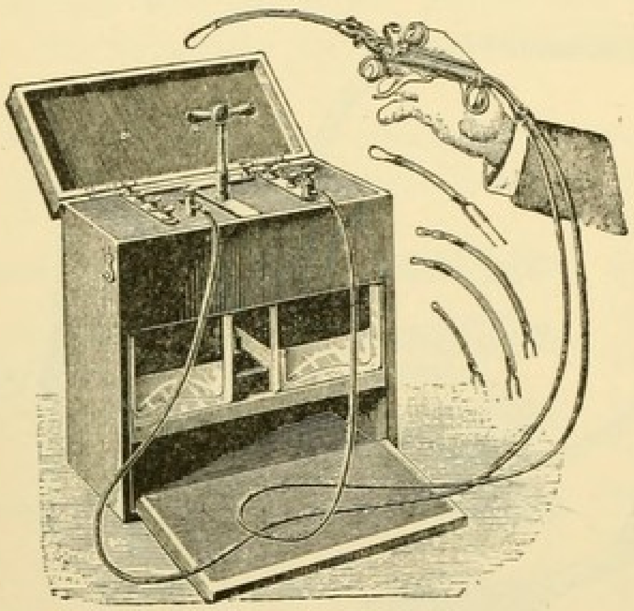


Fig. 354. Immersion Battery

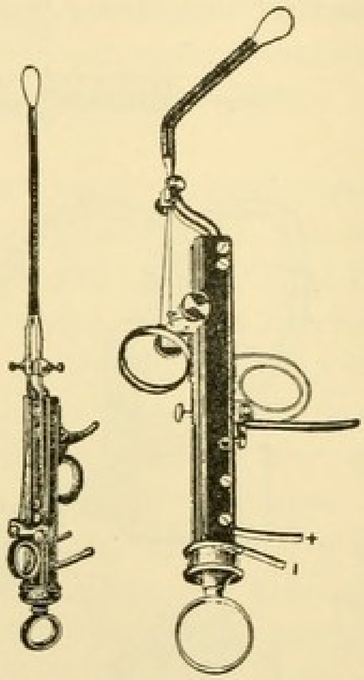


Fig. 355. Galvano-caustic Wire Loop

apparatus, its application is comparatively simple. Since this battery, however, is rather expensive, it will probably be used more in hospitals and by specialists than by the practising physician. At the present time, *immersion batteries* are especially used, for instance *Voltolini's*, and the *handle* recommended by *Bruns* and *Böcker* (Fig. 354), in which the various attachments are inserted. While, however, for surgical purposes, thermo-cautery can be substituted almost everywhere, the galvano-caustic *wire loop* (Fig. 355) has this great advantage over it: the wire can be introduced into the tissues while cold (for instance, in a fistula, or around a pedicle or a cord ("Strang") in the depth of the wound), and after the operator has convinced himself of its correct position, it is instantly brought to a red heat by closing the current. In this manner tissues can be divided bloodlessly by a fine incision. Galvano-cautery is probably most frequently employed for the delicate operations in the nares, the larynx, and the ear.

Galvano-puncture causes a slow destruction of tissues by introducing two platinum needles into the diseased portion; the needles are connected with the electric battery. The galvanic current passes through the tissue from one needle to the other, causing a circumscribed linear destruction of the tissue. In this manner, small warts, hair follicles, etc., may be destroyed; but even larger tumors, at least partly, may be caused to disappear **(electrolysis).**

For the destruction of tissue, moreover, chemicals that form an eschar, or cauterize, are used (**escharotics,** caustics, *cauterium potentiale*).

Kali causticum *potassa*, caustic potassa in white sticks about as thick as a pencil, very deliquescent when brought in contact with the tissues, cauterizes deeply, and if the necessary care is not exercised in preventing its diffusion also attacks the surrounding tissues. The eschar is white.

Solid nitrate of silver, **argentum nitricum** fusum, *lapis infernalis*, *lunar caustic*, of like shape and color as the preceding, affects only the place touched with it; it is especially used for touching profuse granulations, which it covers with a white eschar of silver albuminate. The mixture of lunar caustic and saltpetre (1 : 1 or 1 : 2) is harder and produces a milder effect than pure lunar caustic (*lapis mitigatus*).

Cuprum sulphuricum (*copper sulphate*) in sticks (blue stick) cauterizes only superficially. **Alumen** *ustum*, *dried alum*, can be used only for very superficial cauterizations.

Either the caustic sticks are held with the bare hand (the sticks are previously wrapped at one end with a little gauze or cotton) or instruments like penholders or pincers are used for holding them (**porte-caustiques,** Fig. 356).

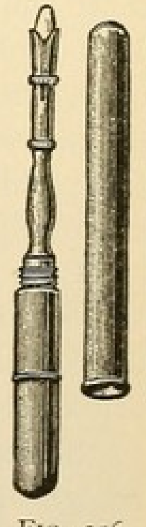


Fig. 356
Porte-caustique

Care should be taken that the caustic stick is lodged firmly in the holder so that it cannot fall into the wound during application. Simple and very convenient are the quills and wooden sockets into which the caustic sticks have been inserted. They can be purchased anywhere. The application of the stick causes only moderate pains, especially if care is taken not to touch the tender white epithelial margin of a healing wound.

Large ulcerating surfaces, tumors that cannot be removed with the knife, can be destroyed with the soft **caustic pastes.**

Vienna caustic (*pasta Viennensis*). Stir 6 parts of quicklime and 5 parts of caustic potassa with alcohol into a paste; apply it about 5 millimeters thick with a chip of wood; after 6 to 10 minutes, the very deliquescent paste has produced a firm gray eschar, which in its circumference appears as a gray line. Next, remove the paste and neutralize the cauterized part with acidulated water. The eschar is cast off in about 8 days after a severe inflammation.

Paste of zinc chloride (*Canquoin*). Powdered chloride of zinc and rye flour are kneaded with a little water into a dough in various proportions (according to the intended strength of the mixture, 1 : 2, 1 : 3, 1 : 4). It is applied in layers of $\frac{1}{2}$: 1 centimeters thick, which are not removed until after 12 to 24 hours. At the place to be cauterized, the epidermis must be previously removed by means of a hot hammer, since chloride of zinc does not cauterize the intact epidermis. The cauterization is well defined and produces a leathery tough eschar; but it causes violent pain, which may be mitigated by the addition of opium or morphine. After 8 to 10 days, the eschar is cast off and the wound presents good granulations. If necessary, the cauterization must be repeated by the application of freshly prepared paste.

Arsenic paste (*pasta arsenicalis Frère Côsme*), Côsme powder (originally arsenici albi, 3.5; sanguinis draconis, 0.7; cinnabaris, 8; cineris solearum antiquarum combustarum, 0.5), is mixed with a little water into a paste, or more simply 1 part of arsenic is mixed with 15 parts of starch and water. It is applied only as thick as the blade of a knife and not on a large surface (poisoning). Amidst the most violent pains, it produces a leatherlike eschar, which is cast off after 10–20 days, leaving a good granulating surface which soon becomes cicatrized. Poisoning by rapid absorption is especially to be apprehended in parts which are not covered with epidermis.

Less poisonous and less painful, especially for destroying vascular tumors, is the application of **arsenic caustic powder,** consisting of: acid. arsenicos. morph. muriat. aa. 0.25; calomel, 2; gummi arab., 12. (*von Esmarch*).

Ointment of tartrate antimony (1 part tartarus stibiat., 4 parts adeps) is sometimes still used for superficial cauterization and revulsion.

Sulphuric acid cauterizes the tissues so that they show a gray or brown eschar. Fuming **nitric acid** and **chromic acid** produce a yellowish green eschar (xanthoproteine). Chromic acid, however, even with careful application, can cause general poisoning and death. Pure **carbolic acid** cauterizes without causing pain, leaving a whitish eschar. **Sublimate** (1 : 10 collodion) is applicable only for very small lesions (warts) on account of its poisonous tendencies. **Lactic acid** cauterizes tumors until they form a blackish mass;

but it leaves normal tissues uninjured (*von Mosetig*). *Lactic acid paste*, consisting of equal parts of the remedy and of silicic acid, is spread as thick as the blade of the knife on india-rubber paper, and applied to the diseased part; it remains in position 12 hours.

In the application of all fluid and soft cauterizing agents, it is necessary to protect the surrounding parts from unintentional injuries by placing strips of adhesive plaster upon them, or by applying a thick layer of fat, collodion, etc.

Union of the margins of the wounds is effected in clean, fresh wounds, and in such operation wounds as are not intended to close by granulation, by the

SUTURE

The suture is applied with straight **needles** or such as are curved on the surface, smooth at the point, with two cutting edges (Fig. 357). Large needles are managed with the free hand; smaller ones are held with the **needle holder,** which affords a more safe and convenient guidance. *Dieffenbach's* forceps-like *needle holder* is most simple and useful for all purposes (Fig. 358). *Hegar's* (Fig. 359) and *Küster's "swan"* needle holders (Fig. 360) are especially suitable for suturing deep wounds and in cavities. *Roux's* needle holder (Fig. 361), the ends of which can be drawn apart and are closed by a sliding tube, is now less generally used; but it is very practical.

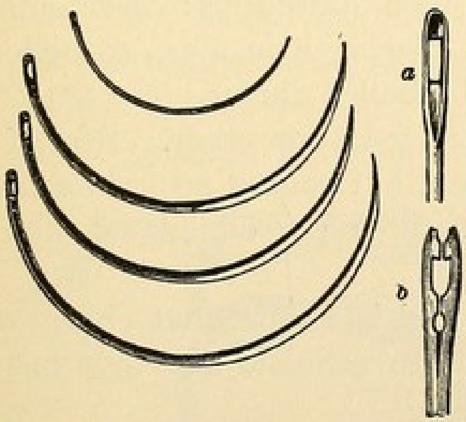


FIG. 357. SURGICAL NEEDLES. *a*, ordinary eye; *b*, springy eye

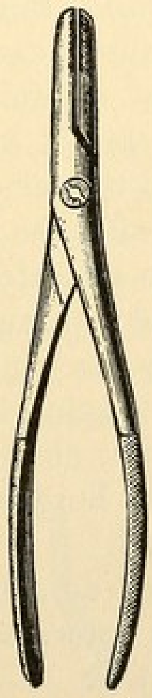


FIG. 358 Dieffenbach's

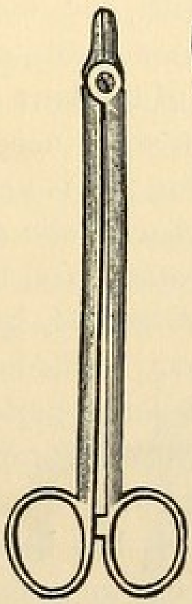


FIG. 359 Hegar's

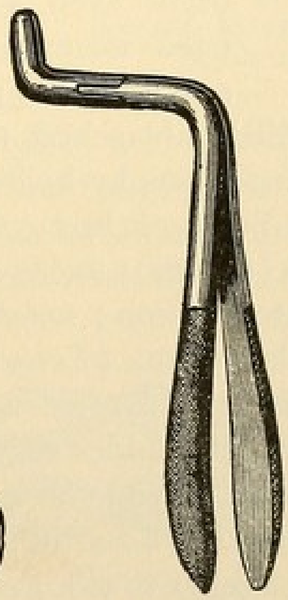


FIG. 360 Küster's Swan

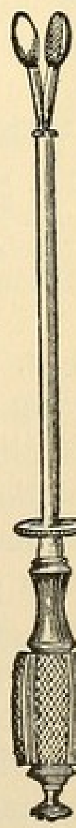


FIG. 361 Roux's

NEEDLE HOLDERS

Hagedorn recommended, in place of needles curved on the surface, needles bent *on the edge* and bevelled (like curved sabres — Fig. 363); this shape produces punctured canals, which do not gape when the suture is drawn tight, but remain in the form of a slit; the operator can sew with them very easily and conveniently, if he uses the needle holder specially adapted for them (Fig. 362); the holder can be taken apart and sterilized.

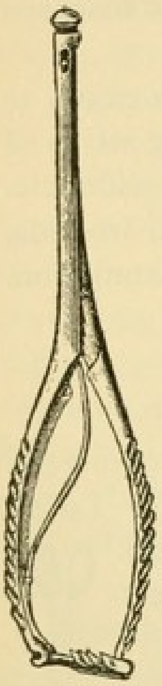


FIG. 362 HAGEDORN'S NEEDLE HOLDER

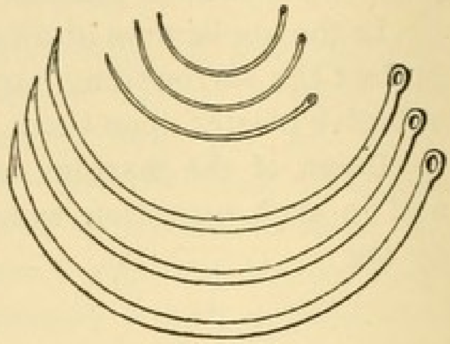


FIG. 363. HAGEDORN'S NEEDLES

The following materials are used for suturing:

1. **Catgut.** *Catgut cords* of varying thickness (violin strings) are prepared in factories. They swell in the tissues of the body and are gradually absorbed. The catgut is rendered free from living germs and made aseptic according to the rules laid down on page 10. If the catgut sutures are not sterilized, this animal material will cause suppuration in the punctured canals. Since suppuration may occur even with the most careful sterilization, attempts have been made to substitute for it less septic materials, such as, sutures made of tendons of the reindeer, kangaroo, and whale.

2. **Silk** unbleached, raw Chinese silk, can easily be rendered free from living organisms by boiling; it is also saturated with antiseptics: *carbolized silk*, by boiling it in a 5% carbolic solution and placing it in a 3% carbolic solution (*Czerny*); *sublimated silk*, by placing the boiled threads into a 1% sublimate solution; *iodoform silk*, by placing it in iodoform ether. Best of all is plaited silk (*Turner*). Silk is not absorbed, but causes no irritation. Still, sometimes after a long period buried sutures are eliminated like foreign bodies under slight suppuration.

3. **Flax thread** can be used as well as silk, and is a somewhat cheaper material. More recently it has been saturated with celluloid and thus has become similar to silk gut (*Pagenstecher*).

4. **Seegras, silk-worm gut,** *Fil de Florence* (obtained from the silk-worm), long, smooth, white, shining threads about ½ meter long, furnish a most excellent (and also not too expensive) suture material, since they can be left for a long time in the tissues of the body without causing any irritation and *without being absorbed;* they can be easily tied; moreover, they very rarely tear; hence, are of especial use in closing wounds in which after tying

the sutures much tension remains, and for relaxation sutures. They are sterilized in a 3% carbolic solution and are kept in a dry state, or boiled shortly before being used. Repeated boiling makes them brittle.

Horsehair is a cheap substitute for these materials, especially in military and country practice.

(The horsehair suture is almost indispensable in coaptating the margins of the skin and more particularly in plastic operations. They are somewhat elastic and can remain in the tissues indefinitely without causing irritation.)

5. **Metal wire.** *Silver wire and iron wire* can easily be rendered free from living organisms by boiling them or heating them in a spirit flame; they serve a useful purpose especially for relaxation sutures and for the union of wounds which are subsequently exposed to tension (laparotomies, neck of hernial sac), and for bone sutures.

The suturing is done in various ways:—

1. The **interrupted suture** (Fig. 364) is the one most commonly used and the most practical because it effects a very exact union of the edges of the wound. After the thread has been passed through both sides, it is tied and cut off about 1 centimeter in front of the knot. Always apply the knot laterally from the line of the wound, for if applied directly over the wound it causes slight pressure and thus impairs exact adhesion. It is also important to tie the suture with a safe double knot, which does not become loose. The "**reef knot**" (Fig. 365) serves for this purpose; in this, the two ends of the thread are passed through both loops in the same direction, whilst in the *false* or **granny's knot** (Fig. 366), which does not hold securely, the ends are passed through the loops in opposite directions.

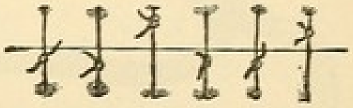


FIG. 364. INTERRUPTED SUTURE

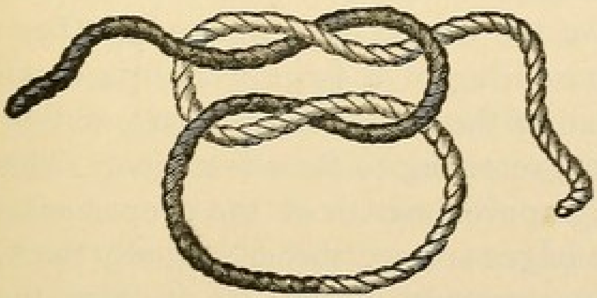


FIG. 365. REEF KNOT

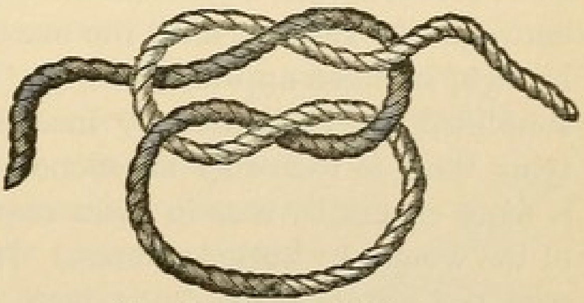


FIG. 366. GRANNY'S KNOT

The "*reef knot*" is made in such a manner that in tying the first and the second knot *the same end* is placed uppermost, or lowermost. This is done in the simplest way as follows:—

Draw the right end from below over the left end and over the point of the left forefinger in such a manner that, after the first knot has been tied, the right hand comes to lie upwards to the left, and the left hand downwards to the right (position "over the hand"). Next, bring the right hand back in the same way into the position first occupied, — that is to say, pass the right end over the left, and, below it, draw it out in a right upward direction. In another manner the knot can be tied with the hands by *changing the ends of the sutures.* Of the ends of the loop hanging down, pass the left with the right hand over the right, held with the left hand, and draw it out to the right; next, by changing hands, carry it over the right and toward the left, so that each hand now holds the end it first held.

When the margins of the wound are very tense, it is necessary, for the first knot, to pass the threads twice around each other (**surgeon's knot** — Fig. 367), and to tie the second knot upon it as in a "reef knot." The first knot already holds the margins of the wound firmly together, whilst in the "reef" and "granny's" knots, the ends must be held tense when the second knot is tied; else, they become loosened.

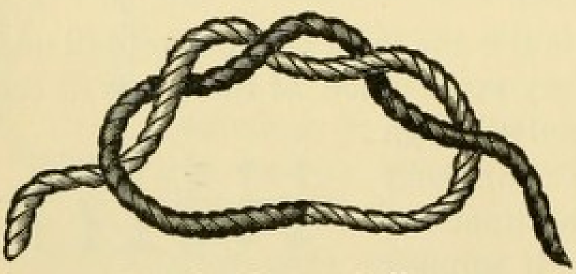


FIG. 367. SURGEON'S KNOT

If a large wound is to be closed with the interrupted suture, the procedure is as follows: —

First, approximate the margins of the wound and hold them as closely together as possible in the manner in which they are to be sutured; next, apply the first suture in the middle; the two subsequent sutures at the middle of both sides between the first suture and the angles of the wound; and all subsequent sutures, according to requirements, always at the middle between two sutures, until the margins of the wound everywhere have been brought in close approximation. (The suturing of a large wound is much simplified and facilitated by inserting all of the deep sutures first; and by tying them in the order mentioned above, referring to their insertion. This is more especially true in cases requiring approximation of the deeper parts of the wound by buried sutures.) If the edges are everywhere equally thick, pass the needle through on both sides at an even depth. If, in tying the knot, you find that one margin of the wound lies deeper than the other, raise it somewhat with forceps or a fine hook; or else, depress the other sufficiently (Fig. 368). If the margins of the wound are of unequal height, carry the needle superficially through the thicker margin, but more deeply through the thinner and nearer to its edge (Fig. 369); if the thin edges of the wound turn up inwardly, introduce the needle close at their margin (Fig. 370), and in tying the knot, raise the edges of the wound with fine hooks; or, if possible, press together with two fingers both margins of the wound into a

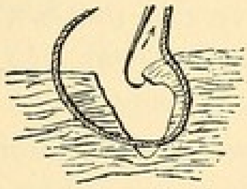


Fig. 368

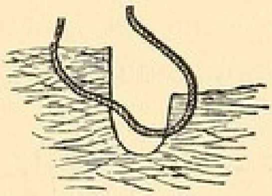


Fig. 369

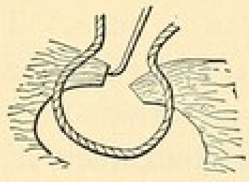


Fig. 370

small fold, and unite them in this position. If one margin of the wound is a little longer than the other, make the interspaces on the longer one somewhat larger than on the shorter, the number of stitch openings being equal. In tying the sutures, compress somewhat the longer margin, and unite it with the other ("*verhalten nähen*"). If it is desirable to obtain a very exact union, carry the needle through near the edge of the wound and only superficially; for farther away from the margin of the wound and introduced more deeply, the suture *relaxes* rather *the tension* of the superficial line of suture and unites the deeper parts of the wound. Usually both kinds of sutures, in closing a deep wound, are used in such a manner that a few deep interrupted sutures are first applied; the approximated edges are next exactly united with superficial sutures; the necessary relaxation sutures, according to requirement, are finally added (Fig. 371).

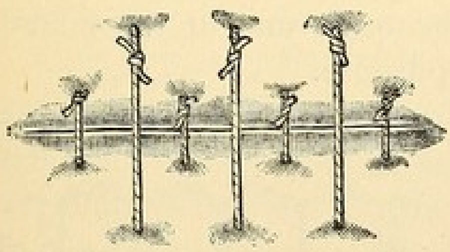


Fig. 371. Superficial and Deep Interrupted Sutures

After the healing of the wound, it is easy *to remove the sutures*, if the operator has used good catgut for suturing; the portion of the loop of the suture which lies in the wound has been absorbed; the other portion with the knot lying on the skin is adhering to the dry dressing, and is removed with the same. If no absorption has occurred, or if other materials have been used for suturing, grasp one end of the knot with forceps, raise it gently and divide the suture with a pair of scissors between the knot and the skin, and extract it laterally *toward the side which has been cut off* (Fig. 372). The fresh adherent margins of the wound are not drawn apart in doing this, but pressed one against the

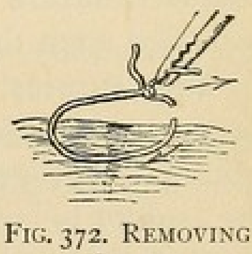


Fig. 372. Removing a Suture

other. Sometimes silk sutures do not heal in without reaction in spite of careful asepsis, and very unpleasant suppuration may be caused by them in the punctured canal. The suture methods with extractable (buried) sutures try to remedy this disadvantage. The sutures are applied in such a manner that from some places externally of the wound a whole row of sutures can be removed at once. These experiments, however, have not met with such a success that they can be recommended for general use (*Tonnasko*, *Link*, *Stapler*, and others).

2. **The continued or glover's suture** (Fig. 373) can be applied much more rapidly than the interrupted suture, and it unites the margins of the wound very accurately. Commence at one angle of the wound with an interrupted suture; do not cut off the thread after it has been tied; at a little distance, introduce the needle again, and pass it vertically to the line of the wound through both edges. Make tense to some extent the thread taking then an oblique direction to the wound, and continue applying the sutures to the other angle of the wound in the manner already described. Finally, for tying the knot, do not draw the last suture tight, but tie its loop with the end of the thread carried through the other edge of the wound (Fig. 374); or apply the continued suture across the line of sutures just applied, returning thus to the beginning (in this way, the stitches are placed in the form of a cross); finally, tie the end of the suture with the other end of the interrupted suture first applied and kept long for this purpose.

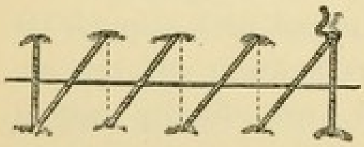


Fig. 373. Continued or Glover's Suture

Fig. 374. Tying a Continued Suture

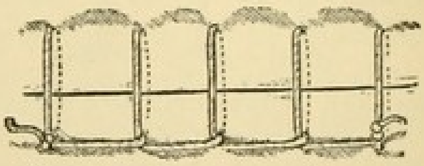


Fig. 375. Languette Suture

3. A modification of the continued suture, often very useful, is the **languette suture** (Fig. 375); the point of the needle before it is drawn out is passed each time under the thread loop of the preceding suture.

Deep sutures, which approximate and hold in contact the surfaces of deep wounds, are applied in order to obviate dead spaces at the base of the wound. If these spaces are of a very irregular form, and if the depth of the wound is considerable, **buried or subcutaneous sutures** (with catgut) are applied; these unite the different layers of tissue separately, and are applied in successive rows (**étage suture**). They can be applied as continued or as interrupted sutures. At the same time, however, the deeper layers in simple wounds can be united with the overlying skin by deep interrupted sutures, provided the needle is carried properly and at a sufficient distance from the edge of the wound, and provided all layers, one after another, are pierced separately with the needle. They are firmly pressed together by tying the knot.

4. The lace suture was especially used by *Dieffenbach* for closing smaller openings, fistulæ, etc. He applied it as a subcutaneous suture by allowing the thread to take a circular course under the skin of the opening to be closed. He stitched about the circumference of the circle in three or four sections, when, by continuing the suture, the needle was carried back to the first suture ("Ausstichöffnung"). Finally, the ends were tied loosely and thus the opening closed, or at least contracted. Similar is the **tobacco pouch suture** which is again used by *Doyen* and *De Quervain*, especially for closing peritoneal wounds (stomach, intestines, vermiform

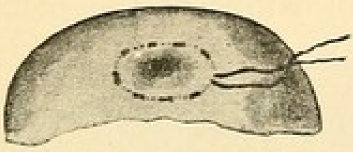


Fig. 376. Laced Suture with Margins of Wound turned inward

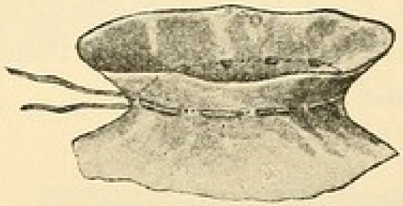


Fig. 377. Laced Suture with Margins of Wound turned outward

appendix, gall bladder, peritoneum of the laparotomy incision). The *inversion* suture (Fig. 376) serves for closing a hollow organ covered exteriorly with serous membrane; the *eversion* suture (Fig. 377) is especially adapted to close the lower portion of the abdominal cavity covered with displaceable serous membrane. As a rule the wound should not be longer than 8 to 10 centimeters. The part of the sutures lying toward the abdominal cavity should be as short as possible to effect a more extensive approximation of the peritoneal surfaces. When the first suture opening has been reached again, traction is made slowly and steadily on the ends, but not too firmly, to prevent necrosis.

The following sutures are especially used as deep subcutaneous sutures: —

(In uniting deep wounds without buried sutures, dead spaces can often be avoided by including in the deep sutures the floor of the wound. A large curved needle must be used for this purpose.)

5. The **folding suture, "Faltennaht"** (Fig. 378) serves especially for uniting very thin and flaccid edges of skin (for instance, on the eyelid).

The edges are raised to form a fold, and thus the surfaces of contact are made larger.

6. The **quilt suture** (Fig. 379) is like the preceding, only the needle is carried through much more deeply. It is sometimes used as a relaxation suture.

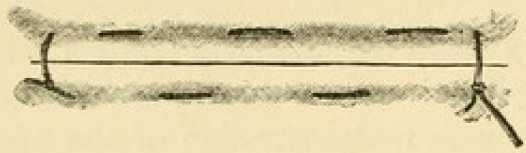


Fig. 378. Folding Suture

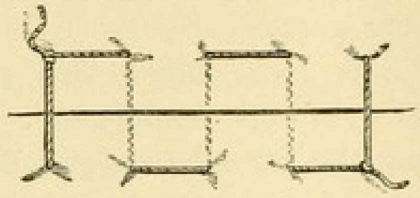


Fig. 379. Quilt Suture

7. The **quilled suture** (Fig. 380) is made with small, round rods (quills, portions of probes, catheters), which are firmly drawn together with silk or metal threads.

8. The **button suture** (*Lister*—Fig. 381) is made with silver wires. The ends of each wire are attached to lead buttons perforated in the centre. They are fastened across the upturned ends or wings of the buttons by figure-of-8 turns.

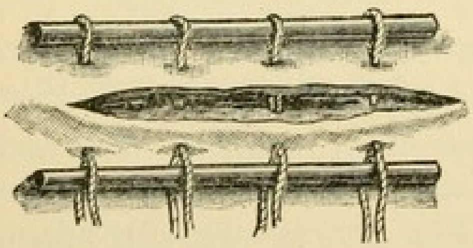


Fig. 380. Quilled Suture

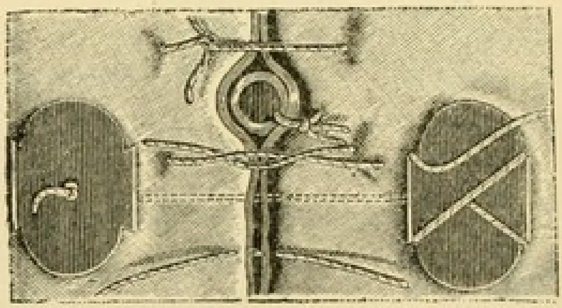


Fig. 381. Button Suture

9. In the **pearl suture** (*Thiersch*—Fig. 382) the silver wire is carried first through the lead buttons and next through glass pearls. It is fastened by winding around a little rod.

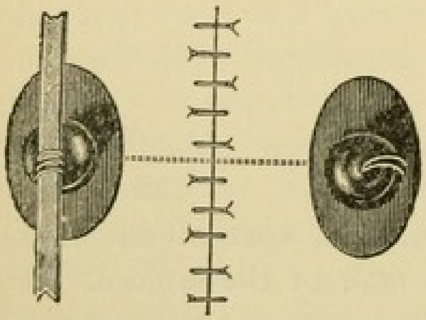


Fig. 382. Pearl Suture

10. The **shot suture, "Schrotkugel,"** is similar but simpler. The ends of the thread (silk, silver wire) are passed through perforated shot, and with a pair of clamping forceps the latter are compressed with the wound margins in proper position upon the thread over the skin.

These last sutures, as can be seen already from their appurtenances, can be made only after the necessary preparations; they served for certain purposes, especially as sutures in the perineum, rectum, vagina, and are probably used very rarely now. Likewise: —

11. The **twisted suture** (Fig. 383). It is applied with insect needles, the points of which are shaped like the head of a lance. After they have been passed through the skin, at some distance from the edges of the wound, sterilized thick cotton threads are wound around them in alternating circle and figure-of-8 tours in such a manner that the edges of the skin are evenly and uniformly drawn in apposition. Likewise little rubber bands

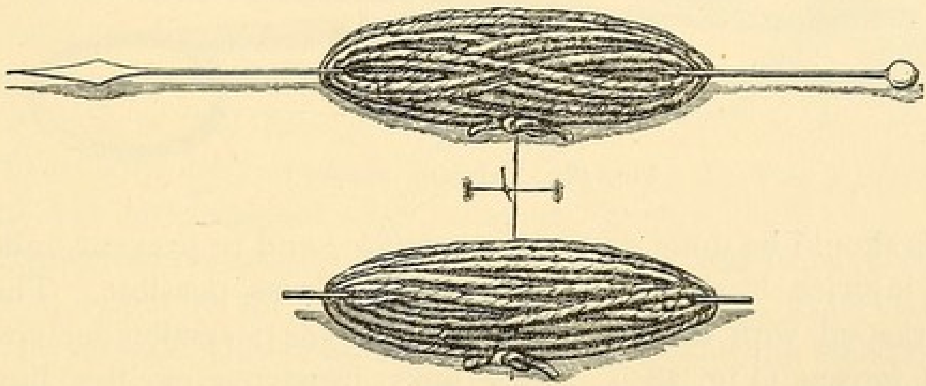


FIG. 383. TWISTED SUTURE

may be stretched over the needles. The ends of the needles are then cut off with a pair of nippers. For a more uniform union of the margins of the wound, apply a few fine interrupted sutures in the interspaces between the needles. The stumps of the needles may be extracted on the second day by twisting movements with forceps. The roll of threads, which are mostly agglutinated with the skin by the dried wound secretions, remains in position several days longer.

Very *small superficial wounds*, the edges of which do not gape, may also be united without suture by means of small compresses of absorbent cotton, or small pieces of gauze, which are saturated with **iodoform collodion** or zinc paste (see also p. 37). Very convenient is also the greatly adhesive zinc oxide plaster. **English plaster** and ordinary **adhesive plaster** can be used for only very small wounds, provided the hemorrhage has been arrested completely and the wound is not infected; for by occlusion with adhesive plaster the drainage becomes obstructed for the escape of the secretions, and inflammation, suppuration, etc., may set in.

"A physician who closes up a fresh wound with adhesive plaster, without any antiseptic precautions, exposes himself to the risk of prosecution for damages" (*von Nussbaum*).

REMOVAL OF FOREIGN BODIES

If a foreign body has entered from without and is lodged only superficially in a cavity of the body or in a wound, so that it can be easily reached and grasped, it is not difficult to remove it. To prevent symptoms of inflam-

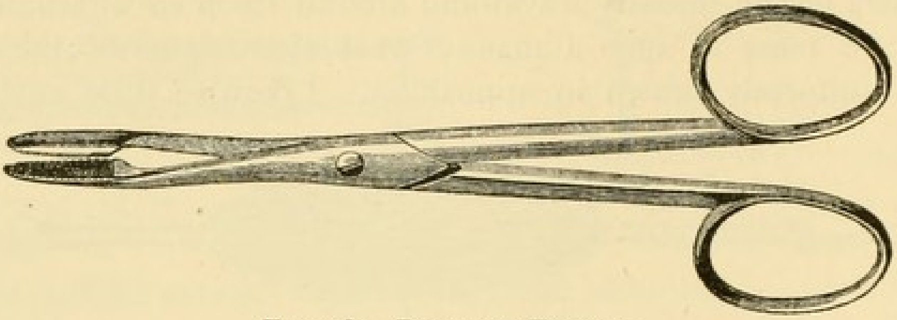


FIG. 384. DRESSING FORCEPS

mation, this should be done *as soon as possible*; and to prevent unintentional secondary injuries, it should be done as *gently* as possible. The foreign body is grasped with **dressing forceps** (Fig. 384); smaller ones with good **anatomical forceps** (Fig. 385). Sometimes, in narrow cavities, the operator

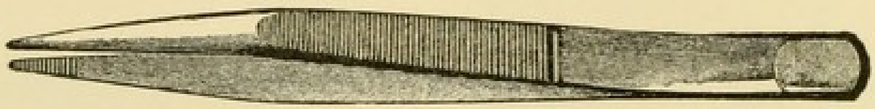


FIG. 385. ANATOMICAL FORCEPS

succeeds better in passing around the body a wire loop (for instance, made of a hairpin) and extracting it by pressure *from behind*. Concerning foreign bodies in the cavities and canals of the body, see details, under the various headings.

Sharp-pointed objects which have penetrated under the skin often cause difficulty and sometimes render an enlargement of the generally small skin wound necessary; this is especially the case with fragments of glass, which lacerate the wound with their sharp edges. Splinters of decayed wood, frequently entering beneath the nail, in most cases cannot be well grasped, since their projecting part generally has been broken off by attempts at removing them. Hence, either a small wedge must be excised from the margin of the nail, or else the portion of the nail over the splinter must be removed with the knife. It is simpler to grasp the foreign body with the pointed splinter forceps (Fig. 386). For the extraction of broken-off *blades of knives*, etc., which cannot be grasped very well on account of their smoothness, wind around the end of the dressing or other forceps a few strips of adhesive plaster; else, use a needle holder with jaws lined with soft lead. *Needles*, provided they can be felt through the skin, can be pressed between two fingers against the skin in such a way that they pierce it from the inside. (The Röntgen ray has become almost indispensable in ascertaining the presence and exact location of metallic substances in the body, and hence it is a very valuable aid to the surgeon in finding and extracting them.) Crochet needles may be extracted without any difficulty by a vigorous pull. Fishhooks, arrow heads, and other similar foreign bodies with strong barbed hooks must be pushed forward in the direction of the point of entrance, or must be exposed by an incision. If small objects, splinters, needles, etc., are to be removed from the tissues by an incision, a *resort to the bloodless method* is of very great advantage; otherwise, the foreign body is either very hard to find in the bleeding wound, or is overlooked altogether. The exposure to the Röntgen rays furnishes the safest diagnosis concerning the presence and position of the foreign body.

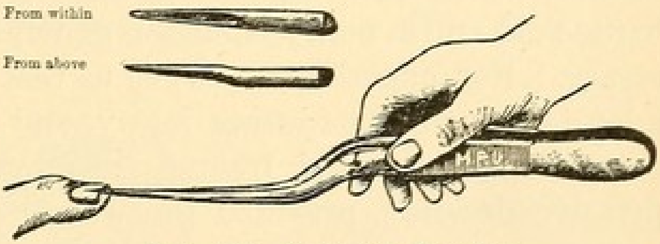


FIG. 386. SPLINTER FORCEPS

The *removal of metal rings* (finger rings, keys, etc.), which have been stripped over a finger or the penis, may sometimes cause a great deal of trouble, since the parts on the distal side of the circular compression begin to swell to such a degree that the strangulating ring is often not visible. In very easy cases, the operator will succeed, after the strangulated part has been lubricated with soap or fat, in removing the ring by turning movements; the œdema, which prevents the removal of the ring, is reduced in the quickest and most efficient manner by bandaging it with a small rubber bandage. In the absence of such an elastic bandage, a thread or narrow tape is applied closely and firmly from the tip to the ring; the end of the thread is passed below the ring and is now wound in a downward direction, whereby the ring is gradually drawn down (Fig. 387). If it is not possible to remove the ring in this manner, it must be divided with a pair of nippers or with a fine saw, and bent apart.

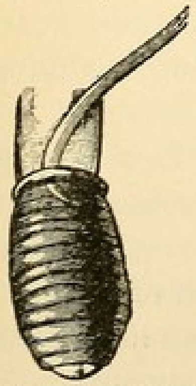


FIG. 387. REMOVING A RING BY MEANS OF A NARROW TAPE WOUND IN A DOWNWARD DIRECTION

In war, the **removal of bullets from wounds** is of special importance.

Of course, with the great penetrating power of modern firearms, bullets will remain lodged in the body more rarely than formerly.

If a bullet has not completely pierced the portion of the body, but has remained lodged in it, the wounded person desires most urgently to be freed from it, considers himself saved when this has been successfully done, and shows the greatest gratitude and due recognition to the surgeon. As simple as this operation is in most cases, as much as the young surgeon rejoices over its success and the gratitude of the wounded, it is, nevertheless, unpardonable unless the surgeon is able to perform it aseptically, which on the battle-field and in field hospitals is generally difficult and in most cases unnecessary. For experience teaches us that bullets can remain in the body for a long time without causing injury, and that gunshot wounds, even with an extensive comminuted fracture can heal under a simple antiseptic compressive dressing, provided the wound has not previously been examined with unclean or only seemingly disinfected fingers, probes, or forceps. The great difference between wounds which have been touched with the fingers and those which have been left untouched, the sad consequences which such a rash examination can have for their healing or even for the life of the wounded person, should always call to the mind of every surgeon (and most especially in war), the first principle of all medical action, "*Do no harm!*" For the experience gained during the wars of the last fifteen years shows that even severe splintered fractures of joints healed smoothly under an aseptic occlusion dressing and immobilization of the limb, although the bullet was still in the body. For, according to Langenbuch, a gunshot wound is to be considered as aseptic.

To extract a bullet which can be felt *under the skin*, is by no means a difficult operation.

With a sharp knife, a bold cut is made down to the bullet, kept steady with the fingers of the left hand until it becomes visible in the wound, when it is extracted with dressing forceps or bullet forceps.

If a soft lead bullet has become very deformed by meeting with resistance, or is very distended and jagged, the cellular tissue and the fascia must often be divided in several directions, in order to extract it without using force.

The *extraction of deep-seated bullets* does not cause any especial difficulties under the protection of asepsis, since the operator need not hesitate to divide the soft parts to such an extent as may be required for finding the foreign body. (The Spanish-American, Philippine, and Boer wars have demonstrated the wisdom of abstaining from examining recent gunshot wounds and of pursuing a conservative course of treatment. There are very few cases, indeed, in which it is justifiable to search for and make attempts to remove the bullet. The modern bullet becomes more readily encapsulated than the old leaden missiles. The best results are obtained by healing the wound with the first aid antiseptic dressing and immobilization of the injured limb or part.)

In evacuating the blood clots from fresh wounds, the bullets which may have entered are removed at the same time, and no other instruments are needed for this purpose except the common dressing forceps or the American bullet forceps (Fig. 391); with these, the bullets can be readily grasped, since the sharp hooks of the same firmly penetrate the lead.

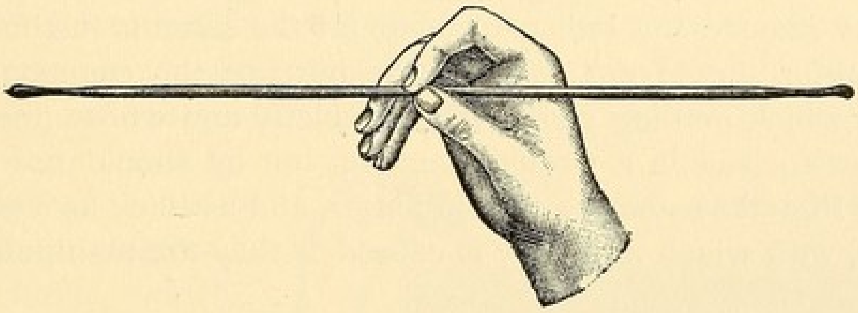


FIG. 388. FLEXIBLE ZINC PROBE

But if it becomes necessary to remove bullets that are in the depth of *granulating wounds* and that prevent the definite cicatrization of the same, that cause fistulæ of long duration, or that cause trouble by pressing on the nerve trunks or other important organs, the extraction can, after all, become very difficult, especially when the bullets are very much deformed, are lodged at dangerous places, or firmly impacted in the bone.

Sometimes the question must be first decided whether a foreign body is at all in the depth of the wound and of what quality it is. The safest information gives the exposure to the Röntgen rays, radioscopy and radiography, which already, in very many clinics, are used extensively to establish the presence of foreign bodies. Likewise in the last wars the procedure has rendered good service. If a bullet or a fragment of the same is present, it can be recognized at once in the skiagraph. The presence of small bullets healed in without causing any symptoms of inflammation etc., has established a new principle, namely, to disturb these foreign bodies as little as possible, but rather to promote their incapsulation. Shot and pistol bullets up to a calibre of 9 millimeters can remain in the body, even in the brain or the lungs, without causing any injury (*von Bergmann*). Hence, the surgeon should well consider whether probing in the last two organs would not cause greater injury than the bullet itself. The removal of the foreign body, however, is necessary when great injury has been caused; for instance, when the bullet is lodged in a nerve or upon an articular surface, when serious symptoms have occurred in the organ involved.

It is often very difficult to see from the skiagraph at what depth the bullet is lodged, hence, by means of pictures taken from various positions the exact location of the bullet must be established. Else a probe must be introduced, if the canal caused by the gunshot is still open, or if any fistulous opening exists. The shadow of the probe will lead to the exact location of the bullet.

But if the exposure to the Röntgen rays cannot be made, and if it is imperative to remove the bullet, probing for the same is justifiable.

The operator should not use for this purpose the common thin silver probes, with which nothing can be felt distinctly and whose fine points are especially apt to lead in a wrong direction, but he should use the flexible zinc probes (Fig. 388), about 1 foot in length and as thick as a goosequill or a lead pencil, with which no injury is caused, if they are manipulated gently.

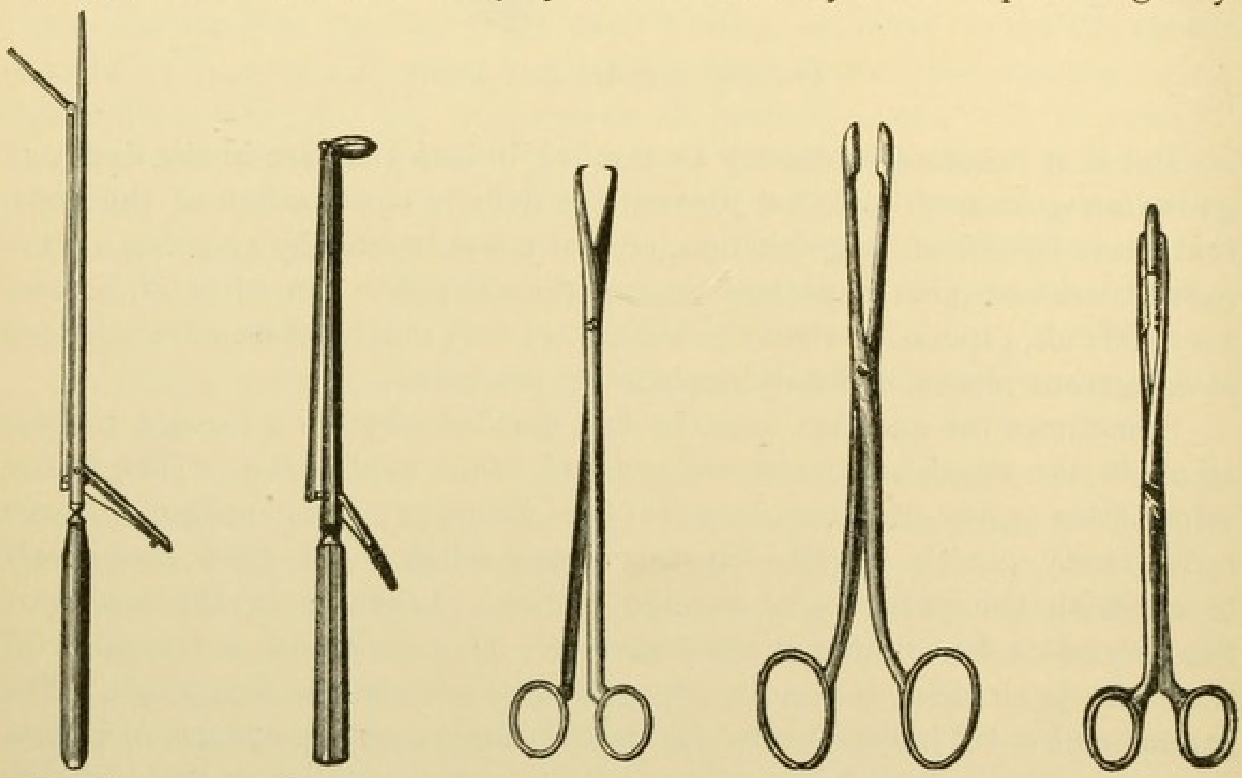


FIG. 389 FIG. 390
VON LANGENBECK'S BULLET FORCEPS

FIG. 391
AMERICAN FORCEPS FOR SOFT LEAD BULLETS

FIG. 392 FIG. 393
FORCEPS FOR JACKETED BULLETS

If the bullet is felt, the operator should try to grasp it with one of the various **bullet forceps** (Figs. 389–393) and extract it carefully.

If the bullet is lodged in a bone, it can be bored into with a **bullet screw** and thus be extracted. But if it is found to be very firmly lodged in the bone, not too much force should be used, since dangerous inflammations of the bone may be caused thereby. It is better either to wait until the bullet of its own accord is liberated by inflammatory absorption of the bone tissue, or, after an adequate incision of the soft parts, to remove with chisel and hammer enough of the surrounding bone to enable the bullet to be extracted with forceps without force.

(In all future wars the Röntgen ray will be largely relied upon in ascertaining the presence and exact location of bullets lodged in the body. It proved to be of inestimable value during the Spanish-American war.)

If the operator is in doubt whether the hard body felt in the depth is the bullet or not, with the soft lead bullets of former wars, he could obtain assurance of it either by using *Nélaton's probe*, tipped with an unglazed porcelain bulb, which, when rubbed against the bullet, is stained by the lead; or by means of *Lecomte-Lüer's exploring instrument for bullets* with which a small particle of lead may be nipped off from the bullet; or finally by the use of *Liebreich's electric bullet probe* (Fig. 394), which sets the magnetic needle of a galvanometer in motion as soon as the isolated points of the probe or of the forceps touch a metallic body.

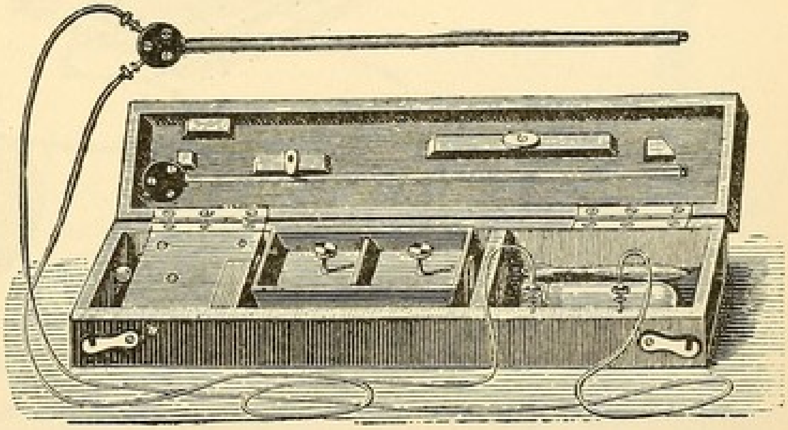


FIG. 394. LIEBREICH'S ELECTRIC BULLET PROBE

(*Nélaton's* probe has lost much of its diagnostic value in searching for modern jacketed bullets, as the lead test no longer can be elicited since the lead part of the bullet has been encased by firmer metals. The changes in the construction of the modern bullets have rendered also the use of the old bullet forceps obsolete. The editor has devised a bullet forceps which grasps with certainty jacketed bullets of any size.)

If the bullet cannot be felt in the wound, but can be felt at some other place *under the skin*, and if the operator is in doubt whether he feels a bullet or a piece of bone, he can assure himself by inserting two steel needles with handles (acupuncture needles), which are placed in connection with *Liebreich's* electric bullet probe. More recently electric microphonic bullet probes have been mentioned, for instance, by *Fowler* and *Klein*, by means of which a small sound is produced in a little telephone as soon as a needle touches the bullet. Of a similar construction is Wells's telephonic bullet probe and forceps.

If an electric bullet probe is not at hand, it can be *improvised* (according to *Longmore*) from a copper coin and a bent piece of zinc, which are kept apart by a piece of flannel dipped into diluted acid. One of the two insulated copper wires which end in acupuncture needles is wound several times around a pocket compass, the needle of which moves as soon as the current is closed by coming in contact with the bullet (Fig. 395).

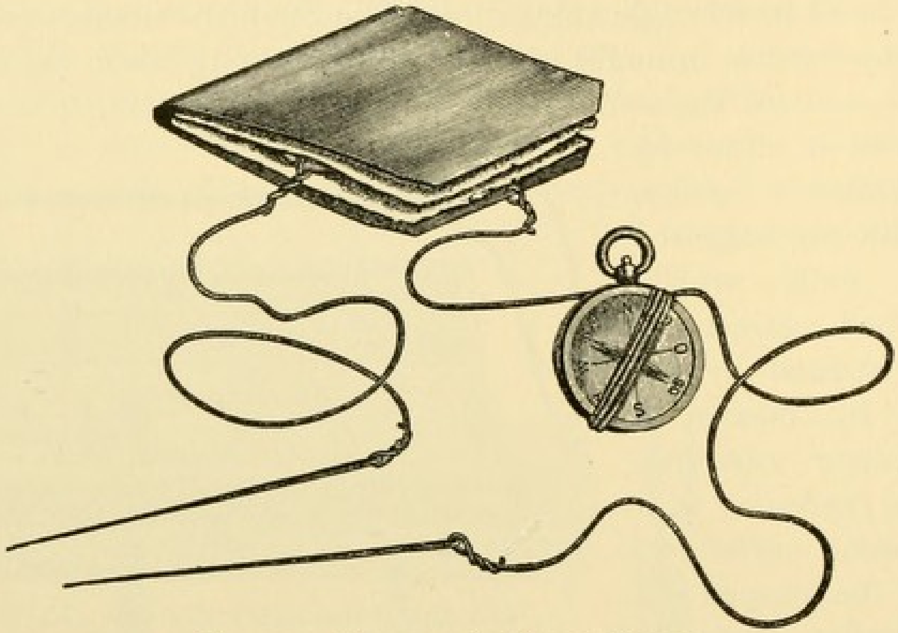


FIG. 395. LONGMORE'S BULLET PROBE

If bullets which have been imbedded in the bone for years or which in necrotic portions of bone lie in so-called "coffins" (involucra) are to be removed (after osteomyelitis, a very frequent occurrence in consequence of contusion of the bone by gunshot), then the broad *opening in the bone* (**necrotomy**) must be performed.

OPERATIONS FOR THE PREVENTION AND ARREST OF HEMORRHAGES AND THEIR CONSEQUENCES

SAVING OF BLOOD

From all times, surgeons have endeavored in operations and injuries to limit the loss of blood to a minimum. In olden times, before amputations, the limb was encircled with cords, the cautery iron was next used for arresting the hemorrhage, or the stumps were dipped into boiling pitch. Until about twenty-five years ago, surgeons confined themselves to reducing the loss of blood in **amputations** by preventing the arterial flow of blood to the wound. This was effected by compressing the trunk of the artery, either with the finger or with the pad of the tourniquet. With the same agencies they tried to combat arterial hemorrhage *in accidental injuries*. The attempts to remove a large portion of the body in a bloodless way by ligature (*von Gräfe*) and by crushing them with a chain (*écrasement — Chassaignac*, Fig. 396) have met only with temporary success. Not until the bloodless method was invented were surgeons enabled to avoid the loss of blood **in all operations** on the extremities, to keep off during the operation the disturbing flow of blood, and thus to operate on the living body with the same ease as on a cadaver.

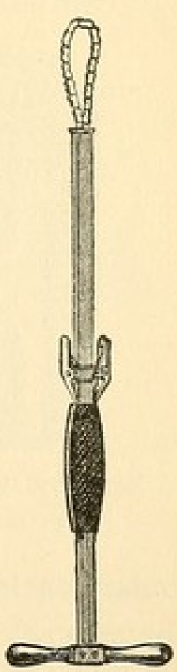


FIG. 396
CHASSAIGNAC'S ÉCRASEUR

The bloodless method, *temporary ischæmia* (*von Esmarch*, 1873), purposes two things: —

(*a*) To expel the blood present in the vessels from the portion of the body to be operated upon.

(*b*) To prevent the afferent flow of blood through the arteries.

The procedure is as follows: —

1. The limb from the points of the fingers or toes upward and beyond the field of operation is firmly bandaged with an **elastic band**, preferably of pure india-rubber. The several tours of the bandage overlap each other about one-half. Crossed and reversed turns are not made; it is unnecessary to bandage the several fingers and the heel according to the rules of bandaging. The compression bandage is carried up as far as the place where the elastic constrictor is to be applied, and here it is fastened by placing the head of the bandage under the last tour. For practical reasons, it is advisable to carry the bandaging always as far as the upper part of the arm or the thigh (Figs. 399, 400). Such parts as contain *pus*, *sanious matter*, or soft tumor tissue, must *not* be bandaged, because thereby infectious matter might be pressed into the cellular tissue and the lymph channels.

In such cases, the operator must be satisfied *to hold* the limb *up perpendicularly* for a few minutes until it has become visibly pale. Light superficial stroking with the hand promotes the return of blood from the veins.

(Very few surgeons now make an attempt to render the limb bloodless by elastic compression as a preliminary step to elastic constriction, as the limb is rendered practically bloodless by holding it for five minutes in a vertical position.)

2. At the place where the bandaging ends the **constrictor** is applied. For this purpose, it is best to use an **elastic band** 5 centimeters wide and about 140 centimeters long with inwoven rubber threads (rubber bandage), which

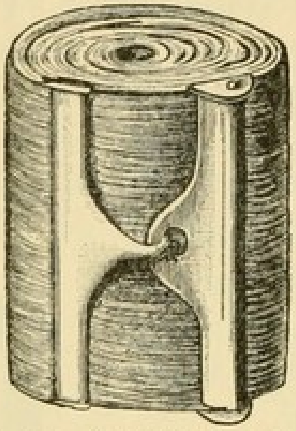


FIG. 397. ELASTIC CONSTRICTOR (according to von Esmarch)

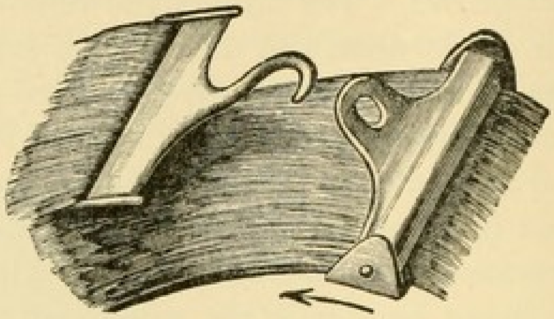


FIG. 398. CLAMP BUCKLE

under continued tension is carried around the limb in **circular turns** so that the several turns cover each other. *In this manner, each turn strengthens the effect of the preceding turn;* it is, therefore, not always necessary, espe-

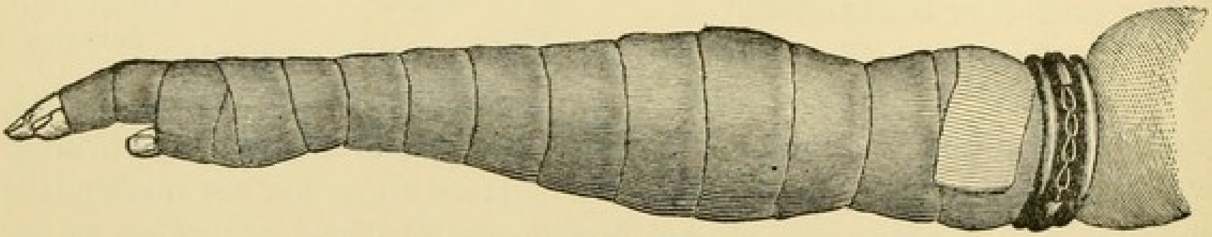


FIG. 399. ELASTIC BANDAGE AND CONSTRICTOR

cially with new elastic bandages, to stretch them to the limit of their elasticity, because, especially in the arm, considerable pain is caused, sometimes even paralysis. The right measure of force to be used is learned by practice.

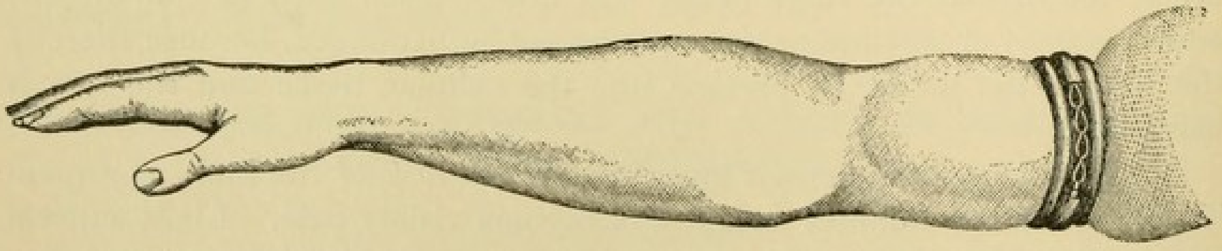


FIG. 400. LIMB RENDERED BLOODLESS ON REMOVING ELASTIC BANDAGE

In *applying the elastic band*, its starting end is pressed firmly with the thumb against the limb and held in position by the next turn, which passes over it. The rolled-up head of the band does *not* descend *closely* upon the turns of the limb as in the application of a common bandage; but, in order to secure the requisite tension, it is carried around the limb at a distance of 6 to 8 inches. The end is *fastened* by a **clamp buckle**, which is pushed toward the

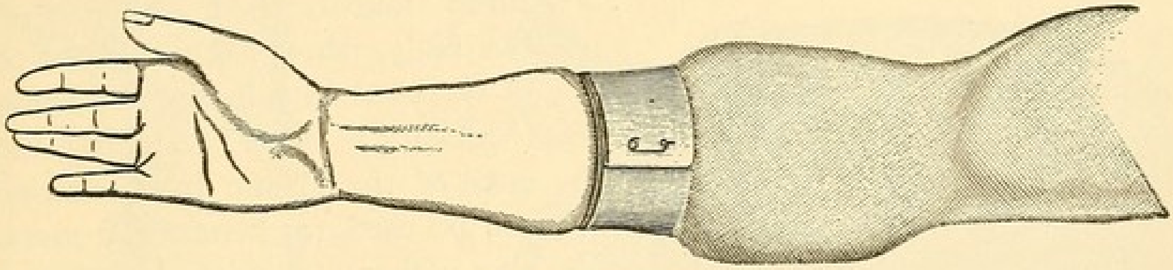


FIG. 401. RUBBER CONSTRICTOR

hook fastened to the upper end of the band (Figs. 401, 402), or else the end of the band is pushed under the last turn, best of all over the main trunk of the artery, and fastened thus (Fig. 398).

Nicaise's elastic band is also practical. It consists of a *hook* and a number of rings sewed in a row at one end of the band (Figs. 401, 402). In case of necessity, the end of the constrictor can be fastened with a safety pin (Fig. 401).

3. When the elastic bandage below the constricting band is removed, the limb presents a **perfect post mortem pallor.** *Any* operation can be performed upon it *without the loss of blood.* The operator is not hindered by the flow of blood from seeing or from recognizing the diseased tissues, and is not obliged to do much wiping or sponging; hence, he operates with less assistance, and with the same facilities *as on the cadaver*, even if the operation should be a prolonged one. Experience has taught that the flow of blood can be interrupted in this manner for **several hours** without causing any essential injury or fear of gangrene. Cases are even known in which the constrictor remained in position from 7 to 10 or 12 hours without resulting in gangrene or paralysis.

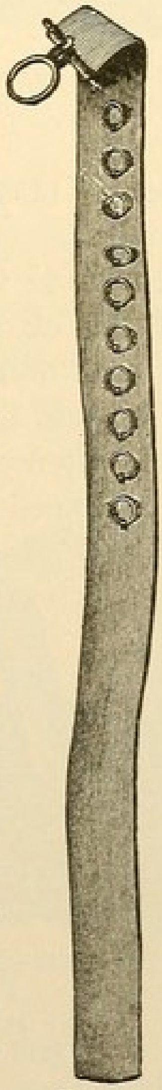


FIG. 402

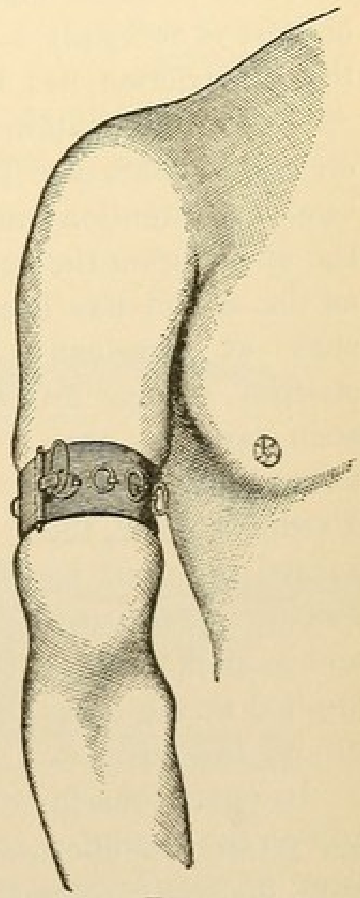


FIG. 403

NICAISE'S ELASTIC BAND

4. At places where the application of a

broad *constrictor* is difficult, as in the iliac region and the axilla, it is advisable to use the **thick elastic tube** which was *originally* used for constricting the limb, and which, under strong tension, is carried in circular turns two or three times around the part of the body, when its ends are tied or fastened with hooks and chain (Fig. 403). For fastening the ends of the elastic tube, a *clamp* can be used, for instance, a metal ring with an opening lengthwise from the diameter of the tube (Fig. 404); in the cleft of this ring, both *stretched* ends can easily be pressed. But if the tension is relaxed, they become fixed by pressing upon each other from opposite directions (Fig. 405).

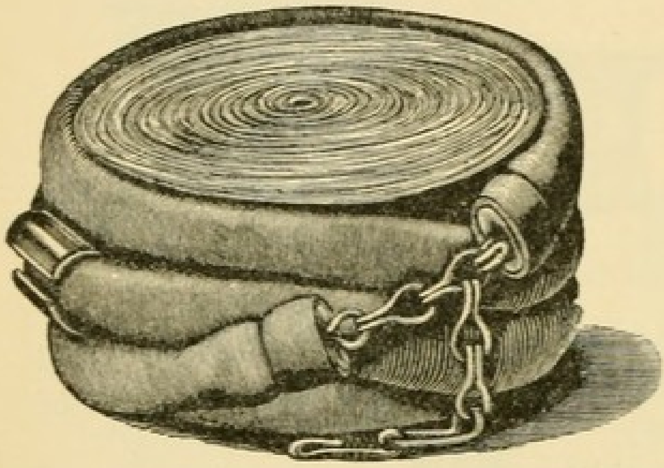


Fig. 404. Von Esmarch's Apparatus for Bloodless Method

(The simplest manner to fasten the ends of an elastic constrictor band or tube is to apply a strong forceps over the crossing of the two ends after the constriction has been made in a satisfactory manner.)

In the application of the elastic constrictor on limbs which are the seat of an **œdematous** swelling, attention must be paid to the fact that the effect upon the vessels often ceases as soon as the serum has been displaced from the tissues at the constricted place. In such cases, as soon as the limb assumes a reddish color, the constrictor must be quickly removed and immediately reapplied at the deep groove caused by it.

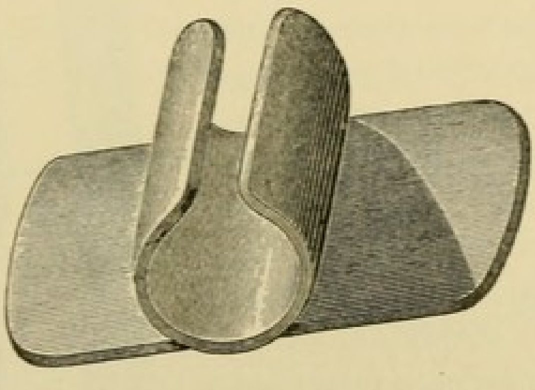


Fig. 405

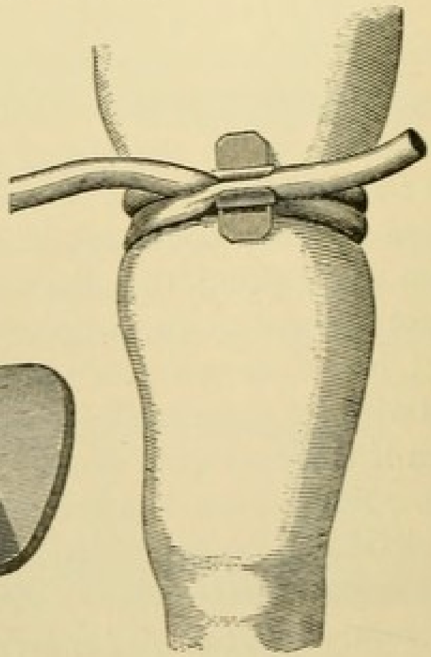


Fig. 406

Clamp for Fastening Elastic Tube (von Esmarch)

In operations in and on the **shoulder joint**, an elastic tube as thick as a finger, after it has been carried through below the axilla under strong tension, must be kept in position on the shoulder by a strong hand or by a tube clamp (Figs. 407, 408). By drawing the ends toward the neck, they are prevented from slipping off. Care

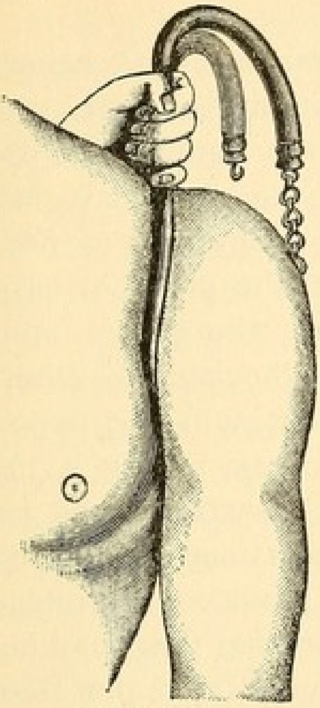


FIG. 407

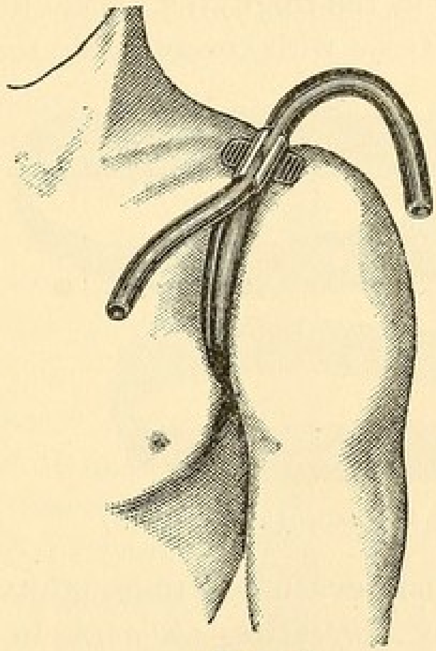


FIG. 408

BLOODLESS METHOD FOR DISARTICULATION OF SHOULDER

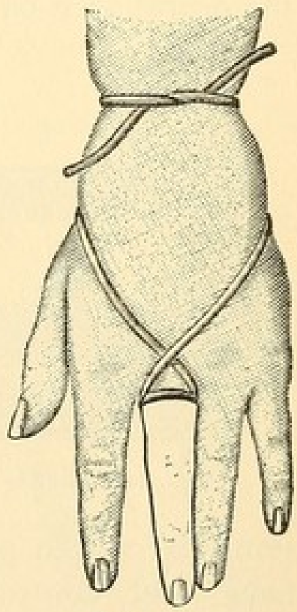


FIG. 409

FINGER RENDERED BLOODLESS

must also be taken not to divide the elastic tube and to guard against its slipping over the wound (after a very high amputation or disarticulation of the humerus).

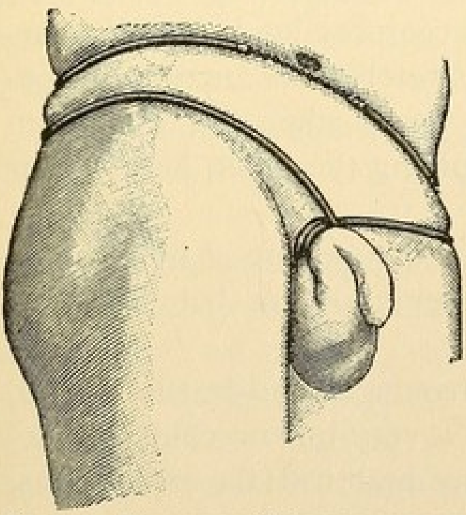


FIG. 410. BLOODLESS METHOD USED IN OPERATION ON PENIS AND SCROTUM

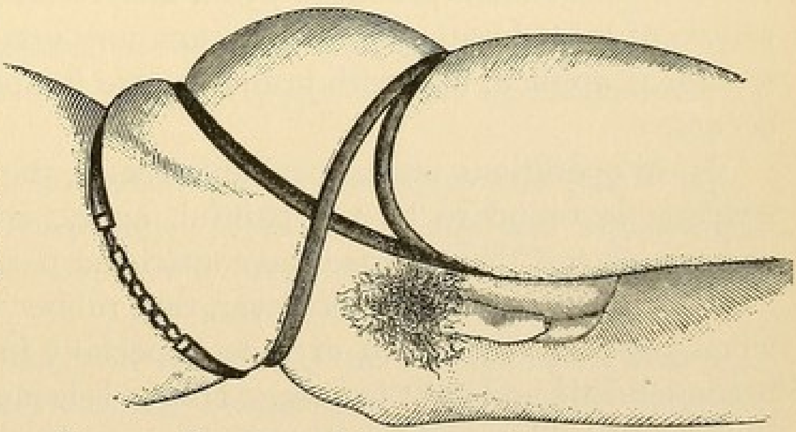


FIG. 411. BLOODLESS METHOD IN HIGH AMPUTATION OF THIGH

For tying off the circulation from a **finger,** a rubber tube as thick as a goosequill is sufficient; this is applied as represented in Fig. 409.

With a similar elastic tube, the root of the *penis* and the *scrotum* can be tied off, if the operator desires to perform operations on the external **male organs of generation** without any loss of blood (Fig. 410).

In **high amputations of the thigh,** the elastic tube is carried closely below the crural arch once or twice with considerable force around the thigh; the ends are made to cross over the inguinal region, and are then carried around the posterior surface of the pelvis and finally hooked together by a chain in the hypogastric region (Fig. 411).

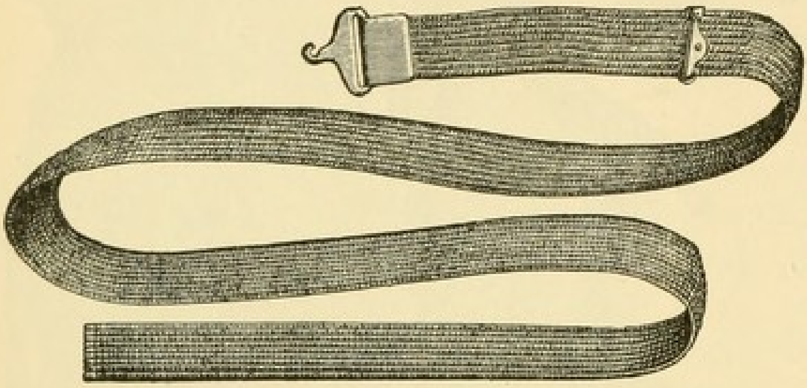


Fig. 412. Brass Spiral Bandage (von Esmarch)

In **disarticulations** at and **resections** of the **hip joint**, provided the intestines have been previously evacuated thoroughly, the arterial flow may be most safely controlled by *compressing the aorta* in the umbilical region (see p. 236).

Of course, elastic constriction with a rubber tube may also be applied in any other place, instead of the regular constrictor. Still, the latter is preferable, since its elasticity is more limited, and hence its effect never so powerful as that of the tube applied under the greatest tension. Moreover, the pressure of a *broad* bandage is more agreeable and can be borne without any dangerous consequences, since the circle of compression is a wider one. In fact, constriction produced by an *excessively* stretched *tube* may cause paralysis of long duration, which occurs only very rarely when the broad constrictor is applied, and with ordinary care in applying the same hardly ever occurs.

If, in operations under local anæsthesia, the pressure caused by the constriction is found to be too painful, apply, either above or below, a new constrictor and then release the constricted part.

It is a deplorable fact, however, that rubber bandages and textile fabrics, when kept for any length of time, especially in a very hot or cold climate, become brittle and unfit for use. Hence it is more practical (for expeditions, voyages on shipboard, in the tropics, and in the polar regions, for preservation in military arsenals, etc.) to have the constrictors made of fine **brass spirals**, laid side by side, covered with glove leather and provided with a clamp buckle (Fig. 412). This constrictor is not liable to deteriorate, and its elasticity answers every purpose in substituting it for the ordinary rubber elastic constrictor.

It is to be hoped that, just as in the various armies of foreign countries, so also in Germany, the constrictor of this simple and durable form will be introduced and that it will displace the old-fashioned tourniquet, which is not by any means as safe and effective. For the advantages of elastic constriction are apparent. They consist chiefly in the fact that it is unnecessary, even injurious, to place a *pad* upon the main trunk of the artery as is done in the use of the tourniquet. *Such a pad is altogether foreign to the bloodless method.* In making use of elastic constriction, the surgeon desires to produce an effect *not only upon the artery* but *uniformly upon all vessels;* it interrupts the entire circulation in the constricted part, and, for this reason, can be used in major operations as well as in arresting serious arterial and venous hemorrhage from accidental wounds; in fact, it serves a useful purpose in the treatment of poisoned wounds by preventing absorption of the poison, without presupposing an exact anatomical knowledge.

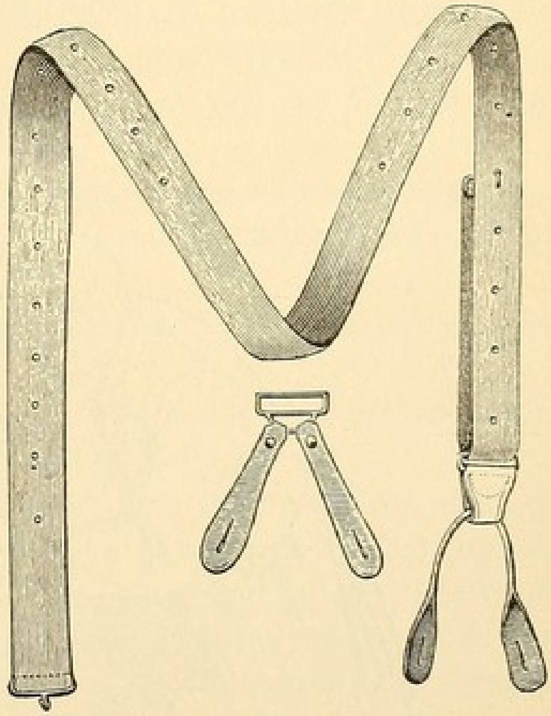


Fig. 413. Tourniquet Suspenders (von Esmarch)

These considerations suggested the idea of supplying laymen with an elastic constrictor in the form of a pair of suspenders as an aid in sudden accidents.

The **tourniquet suspender** (*von Esmarch*, 1881) consists of an elastic band 150 centimeters long, 4 centimeters wide, provided at each end with hooks and eyelets; by untying three loops it is transformed into a very light and comfortable band (Fig. 413). Its elasticity is sufficient to constrict successfully the thigh of a powerful man. If this inexpensive wearing apparel were worn by every workman and soldier, then, with proper instruction, many accidents could be mitigated by a proper application of the bandage; and especially death from hemorrhage might be prevented. Indeed, a very large number of such cases have been reported already, both by physicians and by laymen.

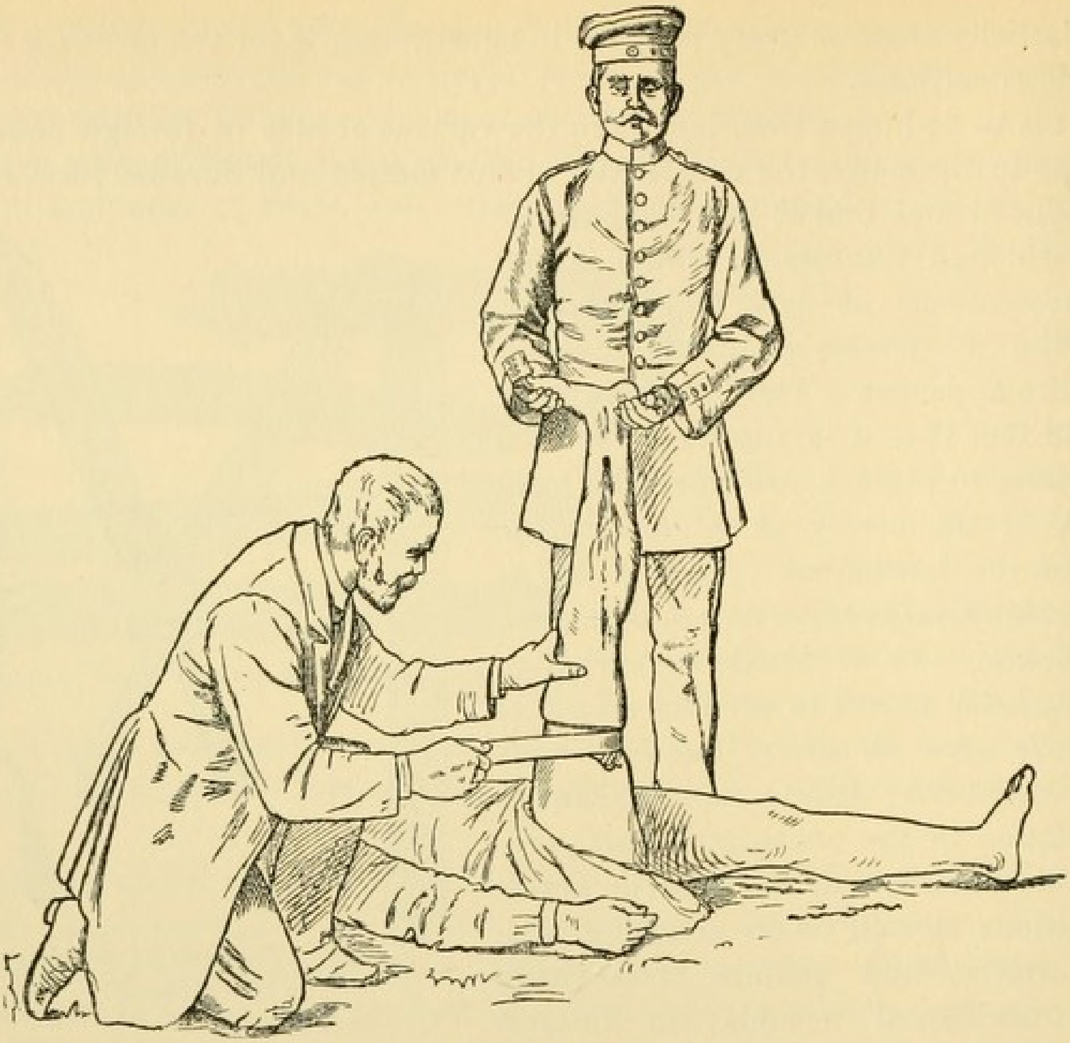


Fig. 414. Applying a Tourniquet Suspender

In emergency cases, when an elastic bandage is not at hand, apply a *linen bandage* in circular turns as firmly as possible around the limb, and then *moisten* it with water; the swelling of the bandage caused by the moisture increases the constriction. The ascending bandaging of the limb may also be made more effective with a cloth bandage subsequently moistened. Likewise, the *Spanish windlass*, represented in Fig. 425, can be made use of for circular constriction *without any pad*.

When the *constriction bandage is removed* at the end of the operation, the limb, which until then presented a deadly pallor, turns as red as a boiled lobster, and a **very considerable hemorrhage** occurs in the wound, because the walls of the blood vessels were in a state of paresis and had become flaccid from the continued pressure upon the vasomotor nerves; hence, they allow more blood to pass through them than in their normal condition. The consequence is that the blood gushes forth from the operating wound as from a sponge. The arteries spirt forcibly, and even the finest capillary vessels bleed almost twice as much as without the use of elastic constriction. The hemorrhage is, of course, most violent if the constrictor is removed *slowly*, because the blood immediately enters the arteries of the part which was constricted; but since it cannot return immediately through the veins, which are still compressed by the last turns of the bandage, as in the operation of bloodletting, venous congestion is likely to occur in addition to the paralysis of the vasomotor system. Hence, it is necessary to remove *the constrictor not slowly, but* **quickly**.

The profuse parenchymatous **secondary hemorrhage**, which is the greatest disadvantage of elastic constriction, can be **avoided, before** *removing the constricture*: —

1. If all visible vessels that have been divided are *most carefully ligated;* next,

2. If the wound in its depth and at its margins is *sutured* so that no *dead spaces* remain anywhere; and finally,

3. If a uniform *compressive bandage,* everywhere *firmly applied,* is placed upon the sutured wound. Cavities of the wound which must heal by granulation, or which are intended to be closed by secondary sutures, are firmly tamponed. The constriction band is not removed until the dressing has been completely applied; hence, it is advisable to apply the constrictor from the beginning as high above the field of operation as possible, in order not to cause any difficulty in removing it rapidly.

4. If, after the removal of the constrictor, the *limb is raised and placed in a vertical position* for several hours; in suitable cases, also, the compressive bandage can be strengthened by an *elastic bandage* under moderate tension.

If these rules are observed, a secondary hemorrhage need not be apprehended.

If the surgeon, however, from excessive fear of secondary hemorrhage, or because he thinks himself not sufficiently skilled in finding smaller divided vessels, does *not venture* to suture the wound and to bandage it before the constriction is removed, then, after removal of the bandage, with the limb held in a vertical position, a large compressive bandage or a sponge must be firmly pressed *for several minutes* upon the surface of the wound, and the vessels which are still bleeding or spirting must next be sought for and tied. If the parenchymatous hemorrhage, however, continues, it is arrested by *irrigating* the wound with a sterile or antiseptic fluid as cold as ice. For this purpose, an *ice douche* is used, — that is, a glass irrigator in the middle of which a glass tube filled with a cold mixture (pounded ice and salt) is inserted. Digital compression of the principal artery is also useful in arresting parenchymatous hemorrhage.

The **advantages of elastic constriction** over former methods, — especially the advantages of the application of the *tourniquet*, — are generally known; they consist chiefly in the fact: —

1. That the blood interruption is *safe* and can be maintained conveniently for a long time.

2. A *displacement* during transportation, as is the case with the pad of the tourniquet, need not be apprehended.

3. The constrictor can be applied *on any desirable* part of the limb.

4. For applying the constrictor band, *no anatomical knowledge* is necessary.

In contradistinction to these advantages, it is hardly necessary to refute the assertions again and again made by some persons that the procedure had the following **disadvantages**: —

1. More profuse parenchymatous hemorrhage.

2. Gangrene of the margins of the wound, or even of the whole constricted limb.

3. Paralysis of the nerves from the pressure of the constrictor.

4. The danger of infection from pus or tumor cells from compression of the limb.

None of these disadvantages exist, if the above simple rules are observed in applying the bandages.

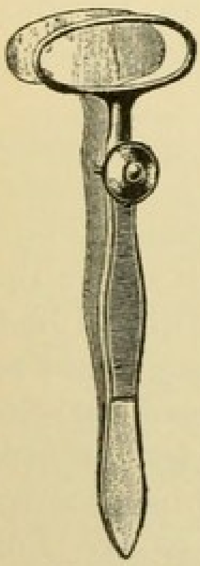


Fig. 415
Desmarres's Clamp

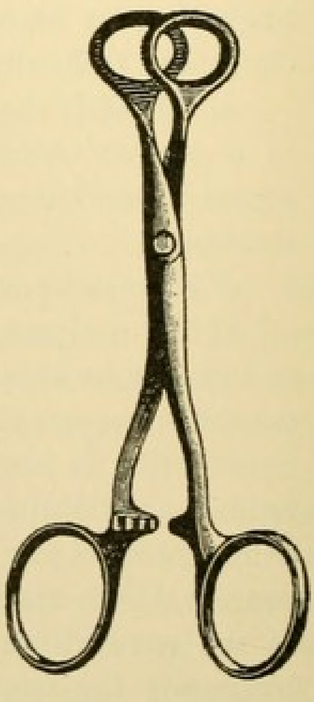


Fig. 416
Dieffenbach's Ring Forceps

Only briefly may it be mentioned here that formerly a successful attempt was made to *interrupt* the *flow of blood* by *pressure* limited to the field of operation. *Desmarres* invented his *clamp* for operations on the eyelids; these are clamped upon the plate by means of the ring (Fig. 415). *Dieffenbach* used *forceps* ending in two rings, between which he clamped the cheek, the tongue, or the lip, in order to remove bloodlessly angiomata, etc. (Fig. 416). In the operation for harelip or the cutting out of a wedge-like portion in cancer of the lips, the flow of blood from the coronary arteries can be arrested on both sides of the field of operation with two long hemostatic forceps. In the same manner operates the constriction of the root of the tongue in amputations of the tongue, and the stitching about of the neighborhood of the wound in tumors of the tongue and cheek, and in tracheotomy. We may mention here also *Ricord's* forceps for phimosis operation. The transverse and parallel forceps for compressing the pedunculated base of many tumors and as an aid in circular gastrorrhaphy and enterorrhaphy, etc. Finally, may be mentioned the application of the rubber tube in most recent times, in amputation of the rectum, in supra-vaginal amputation of the uterus, and in the Cæsarean operation.

Compared with the bloodless method, the other blood-saving methods of former times are used only in exceptional cases, since they are performed with difficulty and are uncertain in their results. They all have for their object

THE COMPRESSION OF THE MAIN TRUNK OF THE ARTERY

above the wound.

1. **By pressure of the finger (digital compression)**, the artery can be compressed effectually only in places where a hard base is furnished by the bone and where the vessel lies not too deeply concealed in the soft parts.

The most suitable places for digital compression are: —

For the **common carotid artery**, the anterior lateral region of the neck between the larynx and the median margin of the sterno-cleidomastoid, where the finger presses the artery against the cervical column (Fig. 417).

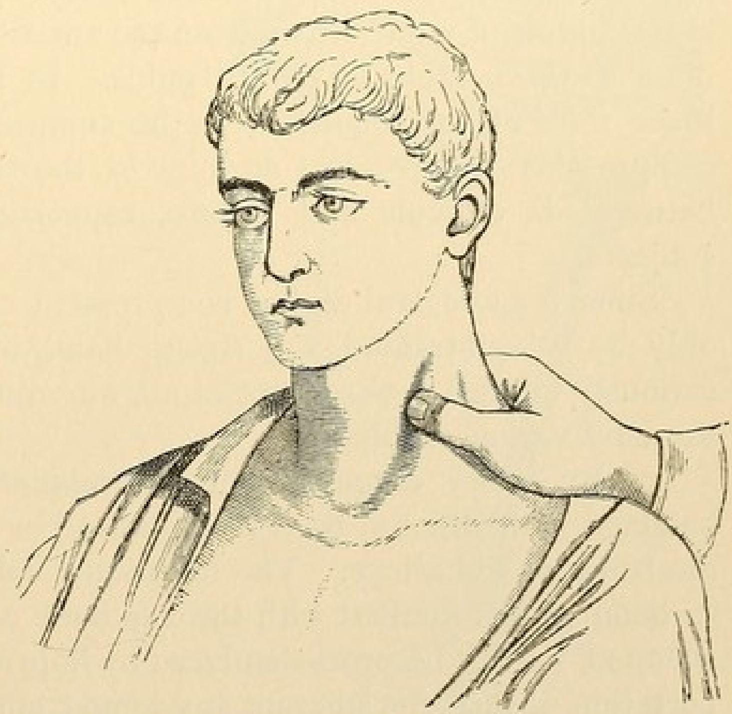


Fig. 417. Compression of the Carotid Artery by Finger Pressure

For the **subclavian artery,** the supraclavicular fossa on the lateral margin of the sterno-cleidomastoid, where the artery is behind the scalenus anticus muscle and is pressed against the first rib. The access of the finger is facilitated by pressing forward the shoulder and the clavicle (Fig. 418). The subclavian artery also can be compressed by strong retraction of the shoulder in a posterior direction and with the aid of the other arm, between the clavicle and the first rib (like a compression stopcock). The hand is made to grasp from behind the bend of the elbow of the healthy arm; the latter is pressed forward and both arms are tied together in this position by cloths or bandages (Fig. 419).

For the **axillary artery**, the anterior margin of the axillary space (the anterior border of the axillary hair) where the artery can be compressed against the head of the humerus when the arm is raised.

For the **brachial artery**, the internal side of the humerus in its whole length, where the artery can be everywhere compressed easily against the humerus along the internal margin of the biceps muscle (Fig. 420).

The **abdominal aorta** with flaccid abdominal walls and empty intestines can be compressed at the level of the umbilicus against the vertical column. In most cases, however, the pressure cannot be tolerated long without anæsthesia.

The same is to be said of the **external iliac artery** in its upper part, where it can be compressed against the lateral margin of the inlet of the pelvis. It can be compressed more easily and for a longer time a little in front of its exit from the pelvis above the middle of *Poupart's* ligament against the superior border of the horizontal ramus of the pubis.

The **femoral artery** is most easily compressed directly below Poupart's ligament against the iliopectineal eminence (Fig. 421). The vessel is found in the middle of a line drawn from the anterior superior spinous process of the ilium to the symphysis of the pubis. In its further course as far as the lower third of the femur, it can be compressed against the femur; digital compression, however, on account of the thickness of the soft parts lying between, is difficult and unsafe, especially in stout and very muscular subjects.

Since a successful digital compression can be performed for some time only by a well-trained and strong hand, but during the transportation of seriously injured persons, not at all, attempts have been made to supply the same by various appliances.

2. By **artery compressors** or **tourniquets**; they consist essentially of a bandage with which a hard pad (*pelotte*) or a roller is firmly pressed against the trunk of the artery. The tourniquet can be applied correctly only by a surgeon who is familiar with the anatomic conditions. It must be constantly watched, for if it becomes displaced by imprudent movements or during transportation, it does not operate any longer and can even become injurious by causing stasis by pressure on large veins, which always accompany the artery.

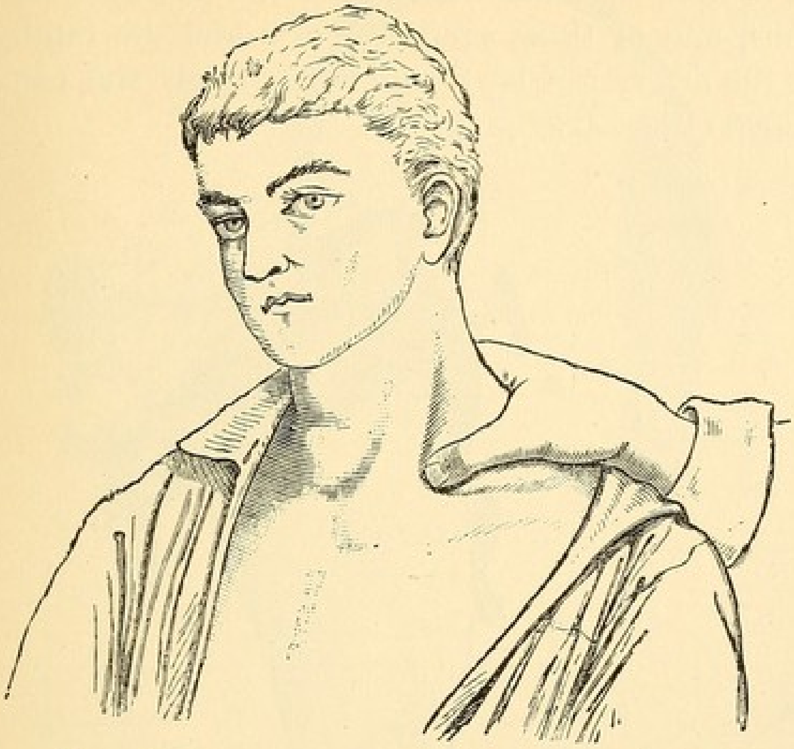


FIG. 418. COMPRESSION OF THE SUBCLAVIAN ARTERY BY FINGER PRESSURE

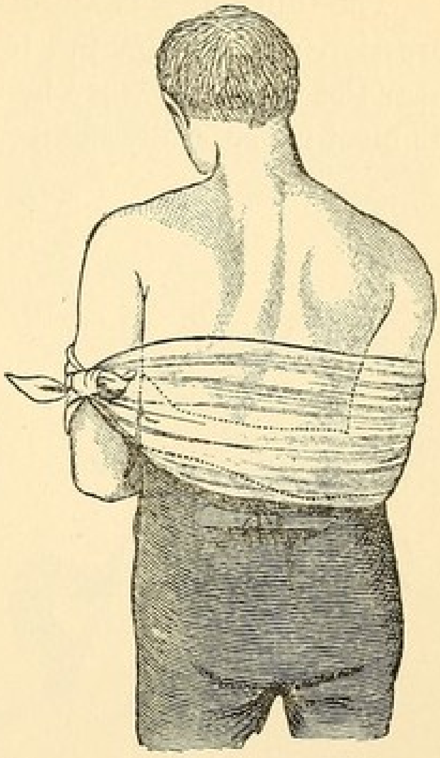


FIG. 419. COMPRESSION OF RIGHT SUBCLAVIAN ARTERY

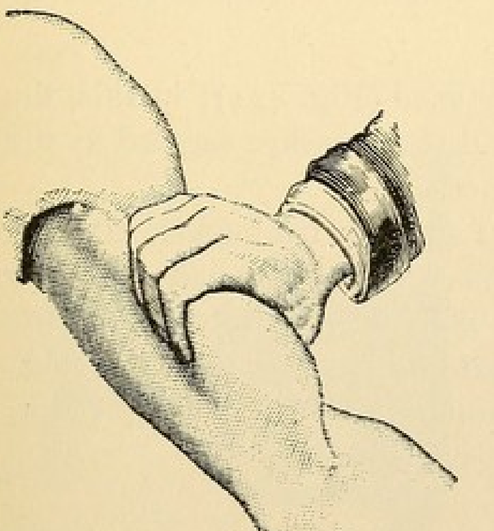


FIG. 420. COMPRESSION OF BRACHIAL ARTERY

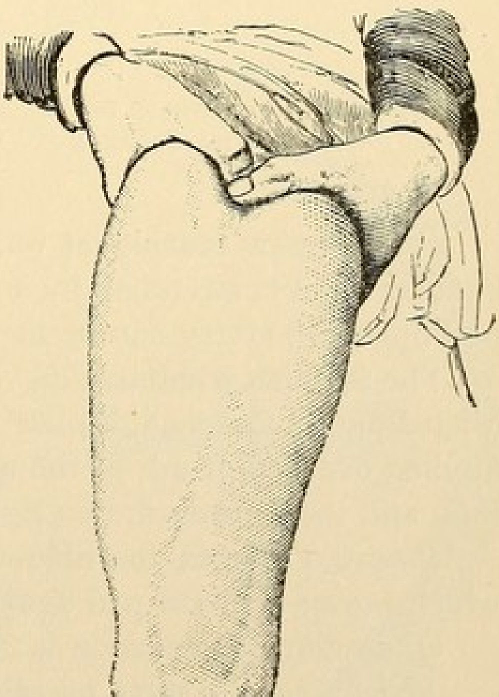


FIG. 421. COMPRESSION OF FEMORAL ARTERY

The tourniquet is applied in the places mentioned above for digital compression selected on the limbs, and of these again, the arm and the thigh near the trunk, because here the artery can be found rather easily and can be most successfully compressed (Figs. 422, 423).

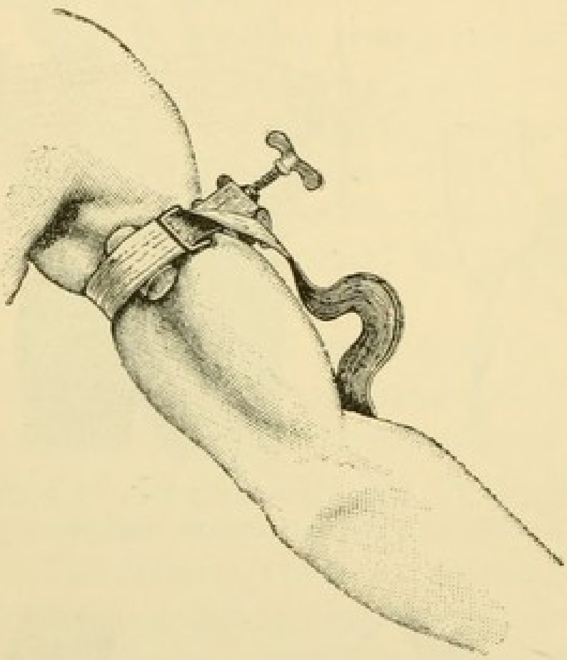


Fig. 422. Compression of Brachial Artery by Tourniquet

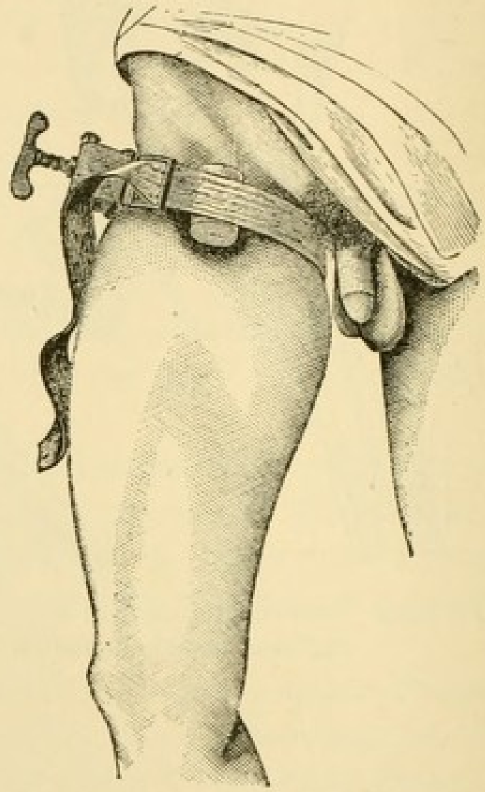


Fig. 423. Compression of Femoral Artery by Tourniquet

Petit's **screw tourniquet** was most generally used (Fig. 424); in this, the circular band is stretched by a strong screw, and the pressure exerted by the pad upon the artery can be increased at pleasure.

The **Spanish windlass** (Fig. 425) consists of a strap with a buckle, to which a hard pad is fastened, a plate, and a short stick. After the pad has been applied over the trunk of the artery, the strap is buckled loosely around the limb and then firmly drawn tight across the plate by twisting with the stick.

Pancoast's **aorta tourniquet** (Fig. 426) is operated with a long screw, which moves a broad pad against the posterior cushion.

Of similar construction is: —

Von Esmarch's **aorta tourniquet** (Figs. 427, 428). Its pad, provided with a handle, is pressed against the vertebral column by elastic bandages, which are stretched between the adjustable hooks of the posterior cushion. The steel handle of the pad is provided with a slit, through which the turns of

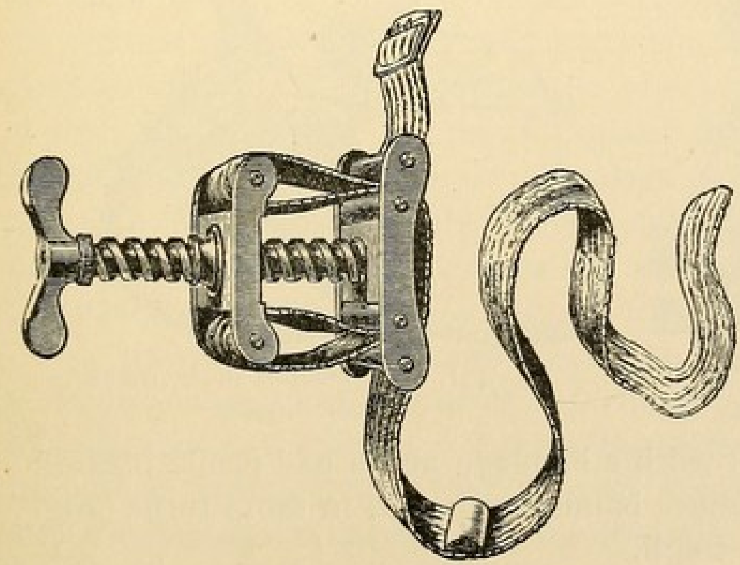


FIG. 424. PETIT'S SCREW TOURNIQUET

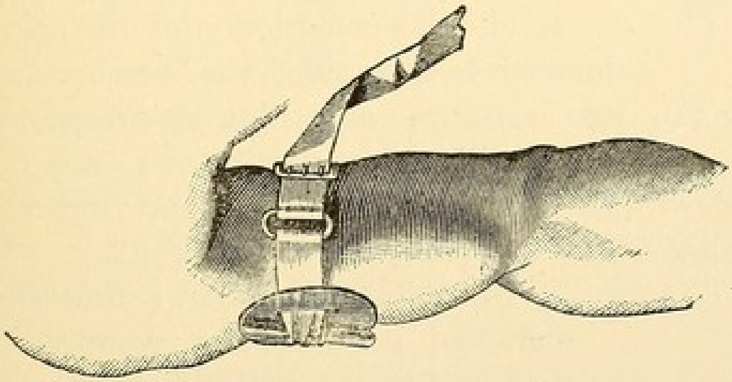


FIG. 425. SPANISH WINDLASS

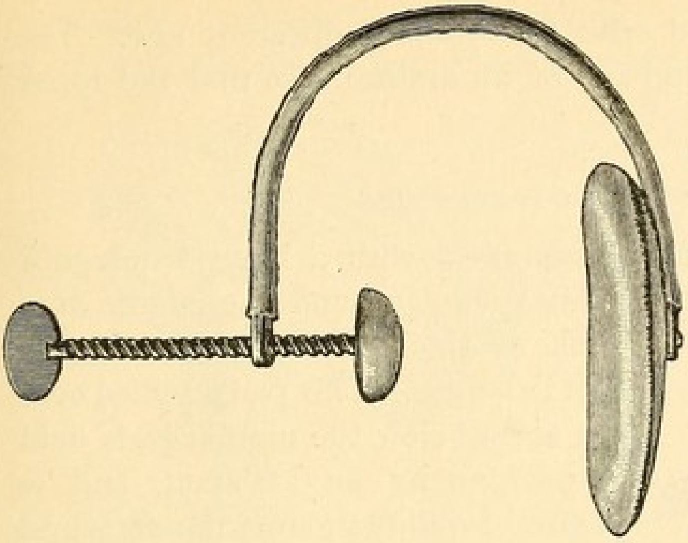


FIG. 426. PANCOAST'S AORTA TOURNIQUET

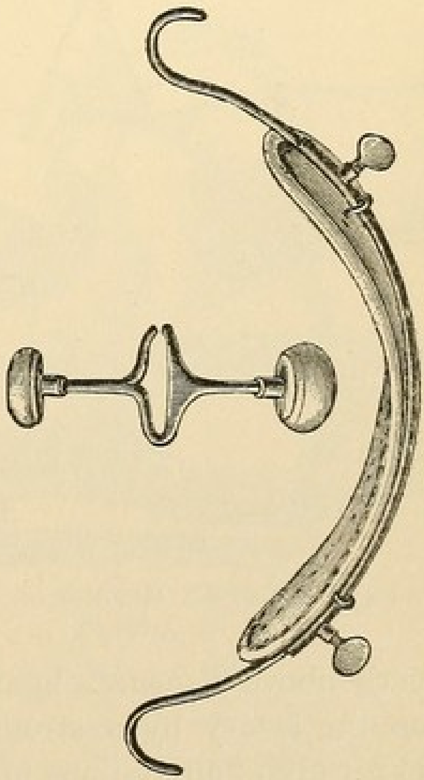


FIG. 427. VON ESMARCH'S AORTA TOURNIQUET

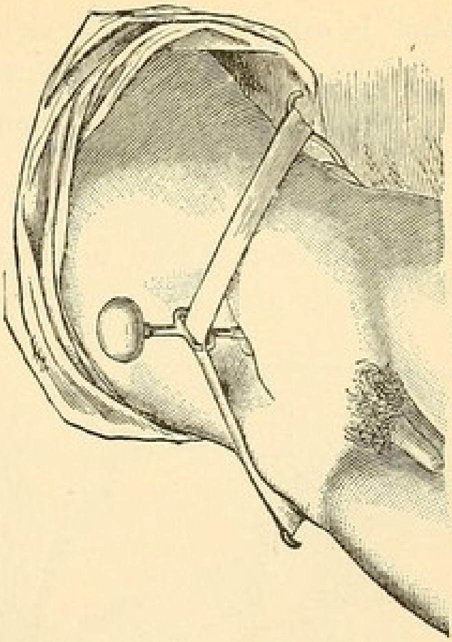


FIG. 428. VON ESMARCH'S AORTA TOURNIQUET

rubber bandage can be drawn, and with two pads of different size. The upper pad is kept in position by the hand of an assistant, so that the lower one cannot slip off from the aorta.

IMPROVISED ARTERY COMPRESSORS

The **aorta can also be successfully compressed** with a linen bandage 8 meters long and 6 centimeters wide, firmly wound around the middle of a stick as thick as the thumb and a foot in length. This pad, applied over the aorta below the umbilicus, is held in position by an assistant, and is pressed forcibly against the vertebral column by a number of turns of a rubber bandage 6 centimeters broad, carried around the body (Fig. 429).

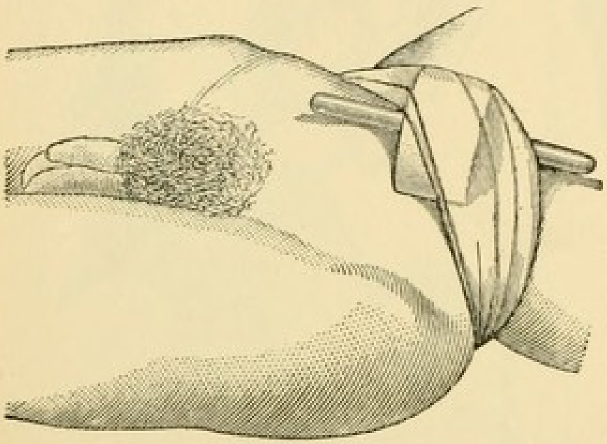


FIG. 429. COMPRESSION OF THE AORTA BY PAD AND RUBBER BANDAGE

If circular constriction of the abdomen is to be avoided, the linen bandage is wound, according to *Brandis*, around the middle portion of a longer stick, and its ends are pressed downward through the turns of the rubber bandage and passed under the plate of the operating table (Fig. 430).

In a similar manner, a tourniquet can be made for compression of the **external iliac artery,**

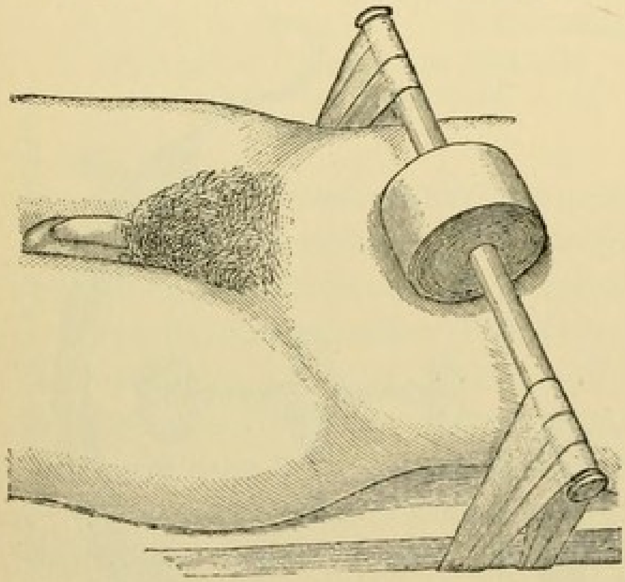


FIG. 430. BRANDIS'S METHOD OF COMPRESSING AORTA

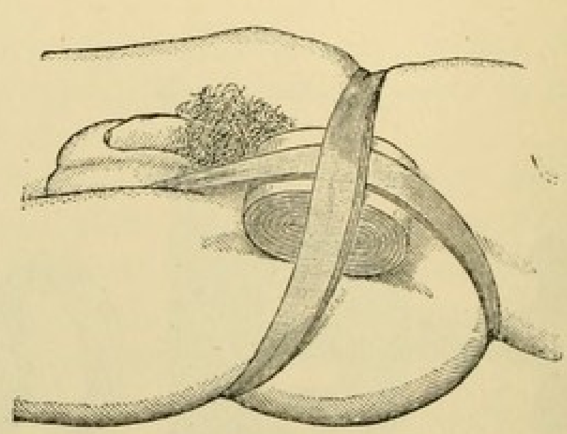


FIG. 431. COMPRESSION OF EXTERNAL ILIAC ARTERY

directly above *Poupart's* ligament, with a bandage and a pad firmly pressed upon the artery by a strong rubber bandage, applied in cross turns (Fig. 431) for high amputations of the thigh.

A **stick tourniquet** (Spanish windlass) can also be improvised by winding around the limb a handkerchief or a triangular cloth, which is tied into

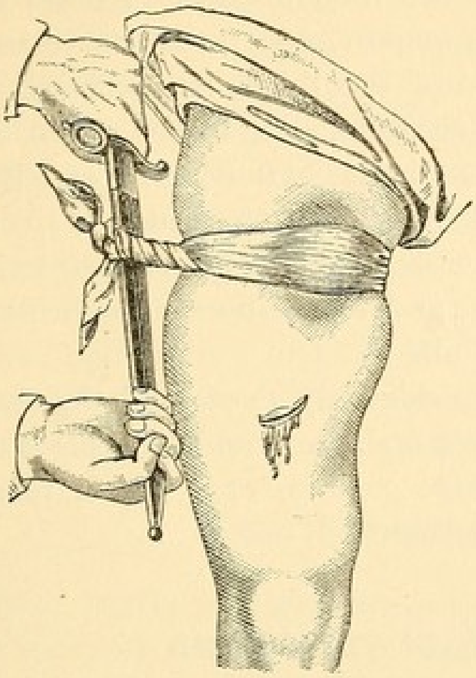


FIG. 432. IMPROVISED SPANISH WINDLASS

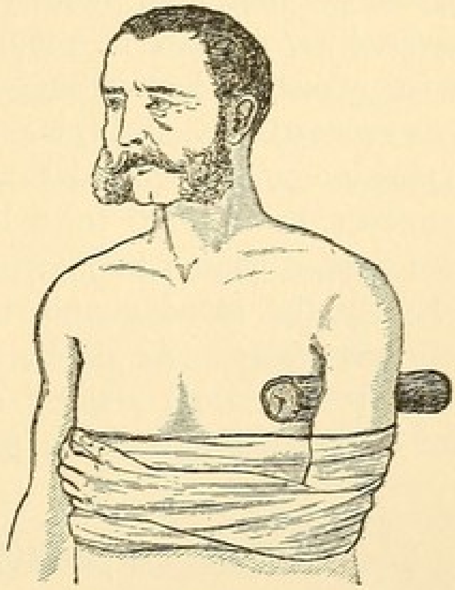


FIG. 433. COMPRESSION OF THE BRACHIAL ARTERY

a firm knot or in which a flat, smooth stone has been wrapped; by twisting it with a stick or some similar object (sword, ramrod, key) inserted under the cloth, it can be firmly constricted (Fig. 432).

For compressing the **brachial artery**, a comparatively light pressure exerted with a thick stick against the internal surface of the arm is sufficient (Fig. 433); this pressure forces apart the bellies of the muscles in an anterior and posterior direction, and presses the artery flat against the bone. The arm is pressed firmly against the body by a cloth or a bandage. The arm can also be very effectually compressed between two sticks tied together on both sides (*Völcker's* **stick tourniquet** — Fig. 434).

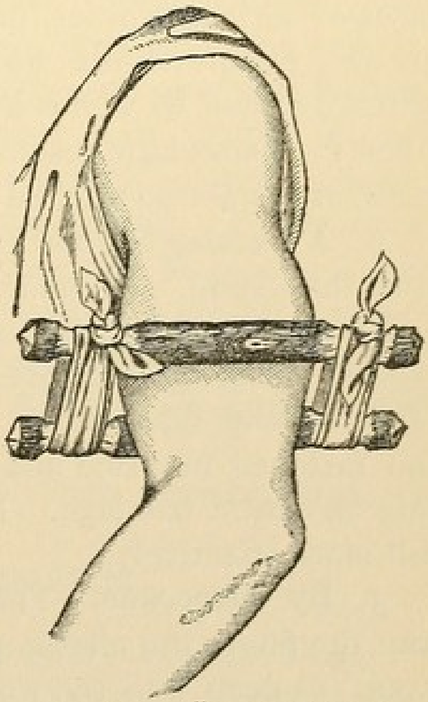


FIG. 434. VÖLCKER'S STICK TOURNIQUET

3. By position: *Adelmann* recommended as a remedy for arresting arterial hemorrhages **hyperflexion** of the limbs. By this, the arteries become so strongly bent that they do not permit the passage of blood. If, for instance, in

arterial hemorrhages from the forearm or the hand, the forearm in supination is strongly flexed and firmly tied against the arm by a bandage or a cravat, the pulse in the *radial artery* ceases immediately. In the same manner, by a forcible flexion of the knee, hemorrhage from the vessels of the leg and the foot, and, by a hyperflexion of the thigh, hemorrhage from the *femoral artery*, can be momentarily arrested. In cases where other means for arresting hemorrhage are not at hand, hyperflexion can be resorted to successfully. Still, it must not be forgotten that such a strongly flexed position as is required for safely arresting the hemorrhage cannot, in most cases, be endured for a long time, and if the bones are broken at the same time, it cannot be made use of at all.

4. Lastly, the blood supply is very considerably decreased by **raising the limb vertically.** At times, *venous* hemorrhage yields to this simple expedient, provided all articles of clothing, garters, etc., which tend to promote congestion have been previously removed.

ARRESTING HEMORRHAGES IN THE WOUND

Violent hemorrhage from injured vessels endangers life directly, and must be arrested as rapidly as possible. In the simplest manner, at least temporarily, the hemorrhage is arrested by **compressing the wound**: —

1. **By the finger** or the hand, which, of course, must be clean. In some cases of serious injuries, the injured person may compress the wound with his own finger. Since, however, the pressure of the finger, for any length of time, cannot be well continued — for instance, during transportation and when the hemostatic resources discussed in the preceding section are not at hand, or cannot be applied — it is necessary that —

2. **A dressing** be substituted for them, which shall exert sufficient pressure upon the wound. Before applying such a compressive dressing, the wounded limb must be bandaged carefully and completely from below upward, to prevent the dangerous collection of blood in the meshes of the cellular tissue (*diffuse bloody infiltration*). Next, a firm dressing is laid upon the wound, and fastened in place under considerable pressure by a bandage — preferably an elastic bandage. In deep wounds, the hemorrhage can be arrested still more effectively.

3. **By tamponade.** The cavity of the wound is packed firmly by forcing with the finger the middle portion of a piece of antiseptic gauze (iodoform gauze) as deep into the wound as possible, and, after the finger has been withdrawn, the cavity is firmly packed with sterilized gauze. In tubular

wounds, first smaller, then larger, tampons can be introduced into the cavity packed with gauze, until the last reach far beyond the surface of the skin. The tampons are firmly pressed upon the wound by a bandage, if possible an elastic bandage; this, if packed with aseptic material, can remain in position for many days, until the bleeding vessel or vessels have become occluded by thrombosis. This is especially the procedure in hemorrhages from the cavities of the body — for instance, from the nose, vagina, uterus, rectum. It is necessary to provide these several tampons, or portions of gauze, with a long thread by which they can be removed again in the gentlest manner.

The inflation of a small elastic bag, introduced in a collapsed condition, with air or ice water (Rhineurynter, Colpeurynter, see Fig. 1412) is likewise very effective, but it is not so simple as the common tamponade.

MEDICINAL HEMOSTATICS (STYPTICS)

These partly promote the coagulation of the blood, and the contraction of the vascular walls, partly produce a firmly adhering crust. They should be used only in case of greatest necessity, when the hemorrhage cannot be arrested by tamponade, for fresh wounds are more or less irritated, and even strongly cauterized, by all these agents, so that healing by primary intention is made impossible. To the oldest agents of this kind belong *agaric*, the *cautery iron* (see page 26), and the *solution of ferric chloride* (*liquor ferri sesquichlorati*); even now the latter is used in the form of a dry, yellow, styptic cotton, just like *Penghawar Yambi*. To this class of agents belong also vinegar, solution of alum, of creosote (1 : 100 — aqua binelli), *oil of turpentine* (*Baum*, *Billroth*), *chloride of zinc* in saturated solution, *tannin* (*Graf*) in powder form, *peroxide of hydrogen* (*von Nussbaum*). To the more modern styptics belong *antipyrine* in a 20% solution, or in powder form (*Bosworth*), a 20% *cocaine solution*, *fibrin ferment* solution (*Wright*), *cornutine*, sclerotinic acid, ferripyrine and gelatine. Irrigation with ice cold or hot sterile water and the use of steam (vaporization, Atmokausis, Zestokausis) may be mentioned here.

The best and safest procedure for arresting hemorrhage permanently is: —

LIGATION OF THE VESSELS (LIGATURE)

All bleeding vessels, arteries, and veins in a wound (after operations or injuries) are grasped and clamped with hemostatic forceps. These instruments are now relied upon exclusively in grasping bleeding orifices, and are variable in their construction, the principal object of all of them being to seize and compress the bleeding vessel (Figs. 435–437). In major operations — for instance, in amputations — large vessels are drawn somewhat forward

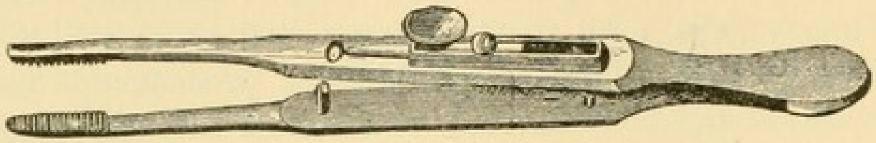


Fig. 435

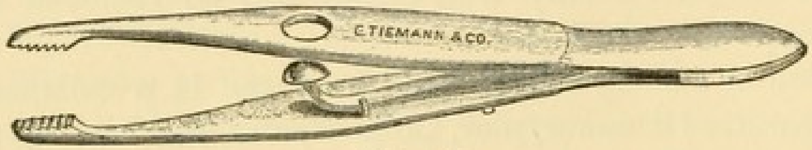


Fig. 436

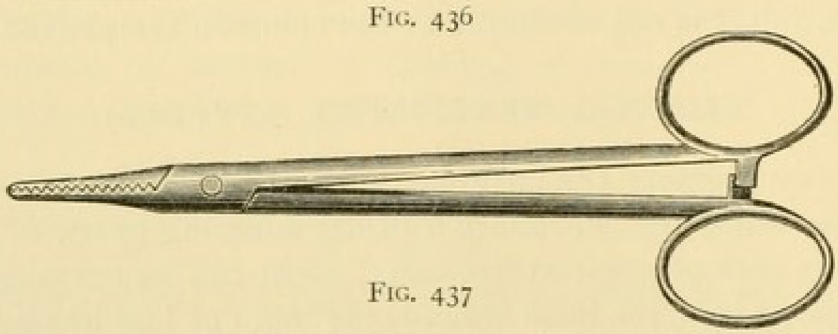


Fig. 437

Spencer Well's Artery Forceps

from the surface of the wound with forceps, and are then securely closed by torsion with the aid of a second transversely applied forceps. If larger vessels cross the field of operation, they are grasped transversely with two hemostatic forceps, and divided between them (Figs. 438, 439). As many

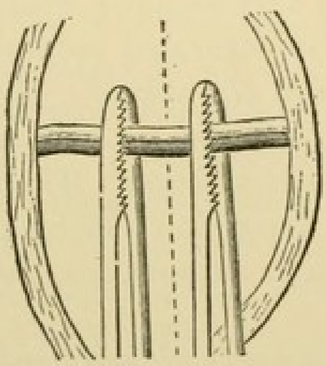


Fig. 438

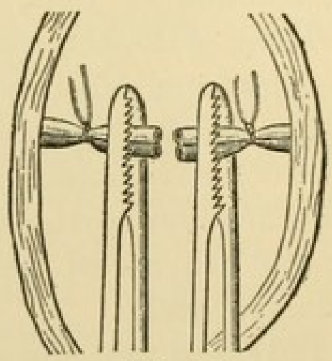


Fig. 439

Ligation between Two Hemostatic Forceps

hemostatic forceps as are required are applied, and allowed to remain in position. *Ligation with catgut* does not commence until all the bleeding vessels have been temporarily secured with forceps (Fig. 440). The procedure is as follows: —

Make slight traction on the instrument which grasps the vessel; pass a simple knot around its point; push it with the tip of the forefingers over the vessel (Fig. 441), draw it tight, place a second knot ("reef knot") upon it, next cut off the two threads closely in front of the knot with a pair of curved scissors, and remove the forceps. For ligating large vessels it is advisable not to use too heavy catgut, because its knots loosen more easily, especially if the threads have been cut off very closely. Many surgeons prefer silk for ligatures.

(The editor has for the last ten years applied a double ligature $\frac{1}{4}$ to $\frac{1}{3}$ of an inch apart in ligating arteries the size of the brachial. The bloodless space between the two ligatures is securely closed in the course of 7 days by definitive obliteration of the lumen of the vessel. The proximal ligature includes the accompanying vein or veins.)

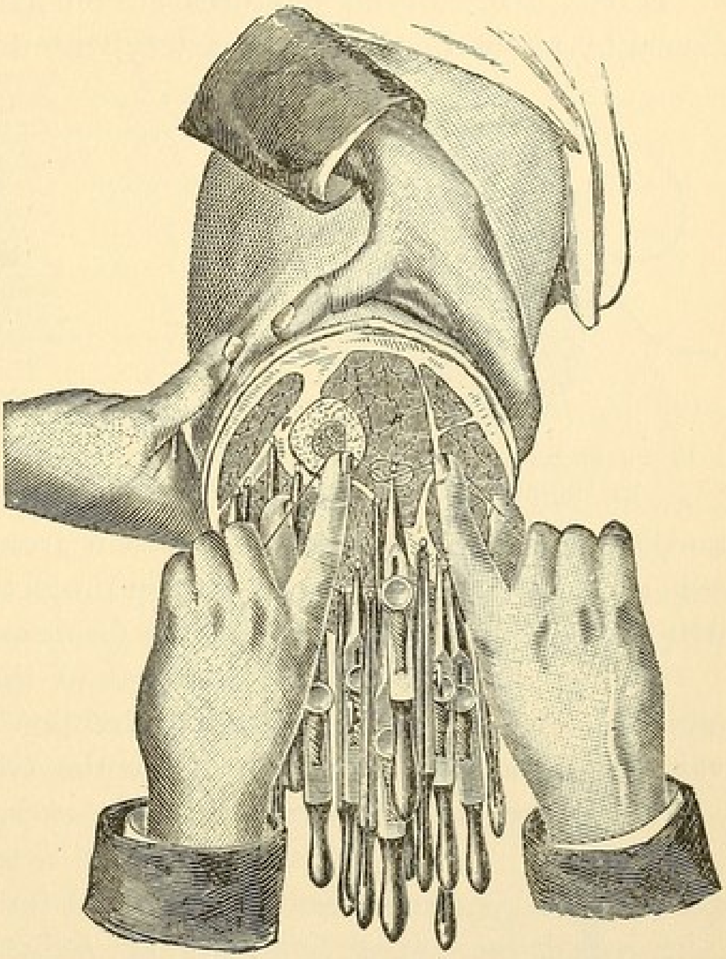


FIG. 440. LIGATION WITH NUMEROUS HEMOSTATIC FORCEPS

Ligation. If a bleeding vessel cannot be well drawn forward from its surrounding tissue, or if it cannot be grasped — for instance, in the scalp or in hardened cicatricial tissue — it must be *ligated* with an ordinary round curved needle armed with the ligature. The needle is carried through the connective tissue surrounding the bleeding portion, and with the loose connective tissue included the ligature is tied (Fig. 442). If many vessels are found in tough, broad layers of connective tissue, they can be grasped separately with care and time. The same object can be accomplished more rapidly, however, and with the same degree of certainty by ligating

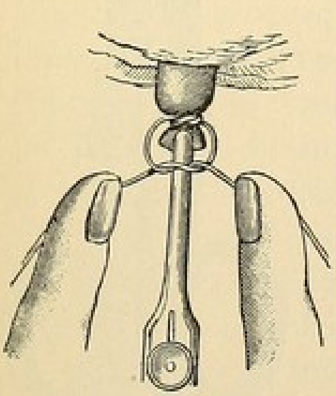


FIG. 441. LIGATION OF BLOOD VESSEL

tissues, including the vessels, in sections by indirect ligatures. Thinner layers are clamped with hemostatic forceps, and secured with a double ligature (**Ligature en masse**).

If only a few or no ligatures are on hand, smaller arteries can also be closed by **torsion.** Grasp the artery with torsion forceps, draw it forward,

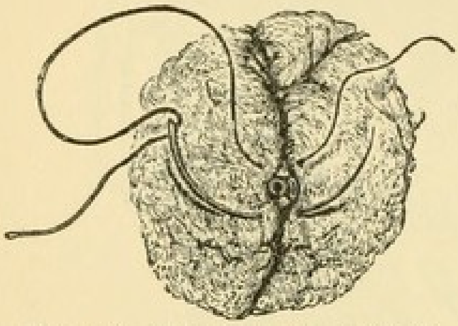


FIG. 442. LIGATION OF ARTERY BY INDIRECT LIGATURE

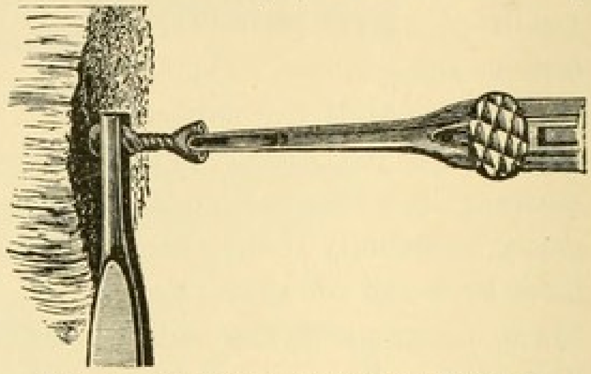


FIG. 443. CLOSING ARTERY BY TORSION

and, according to its thickness, twist it from six to eight times around its axis, holding the central end of the projecting portion with the fingers or, better, with another pair of forceps (*Amussat's* clamp forceps — Fig. 443).

By this procedure, the inner coat of the artery (tunica intima) is torn, and is rolled up in an upward direction, thereby forming a very safe valvular occlusion, strengthened by the twisted tissues.

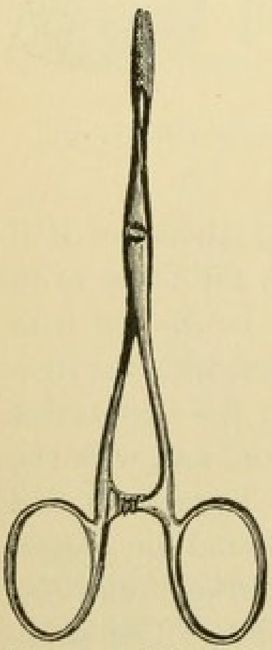


FIG. 444. KOBERLÉ-PÉAN'S CLAMP FORCEPS

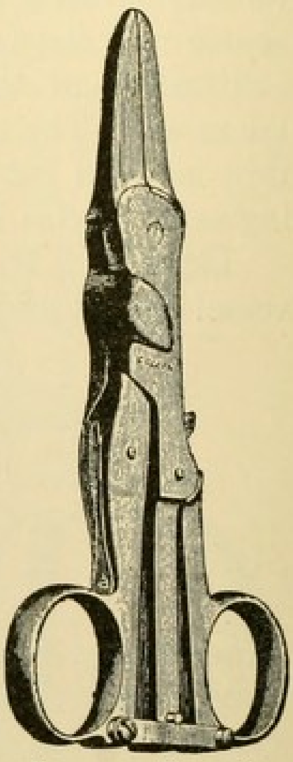


FIG. 445. DOYEN'S ANGIOTRIBE

The same effect is produced by a *very strong pressure* exerted upon the artery. *Köberlé* and *Péan* have devised for this purpose *clamp or pressure forceps* (Fig. 441) similar to small dressing forceps, which greatly contuse the grasped tissue by the fixation of its compressed ends. After a quarter of an hour the forceps may be removed without any previous ligature, since the contused inner coat (tunica intima) is rolled up like a cuff in the lumen of the vessel, and the tissues, from the strong pressure, become as desiccated as if they were burned (*forcipressure*). The clamp forceps are used especially in places where a ligature can be applied only with difficulty or not at all, and as a substitute for the ligatures *en masse.* As the contused tissue does not become necrotic, forcipressure has the advantage over the ligature of not introducing any foreign substance into the wound. When applied to large arteries the forceps must remain in situ from 12 to 24 hours.

A still greater effect is produced by angiotripsy (*Doyen*). By means of it, with very strong forceps (vasotribe, Fig. 445) under an immense pressure (up to 2000 kilometers), not only the vessels, but also all tissues grasped by the forceps (as in ligations of pedicles and "en masse"), are crushed to plates as thin as paper, from which no hemorrhage can occur any more.

HEMORRHAGE FROM PUNCTURED AND GUNSHOT WOUNDS

If the injury in question is a hemorrhage from a larger vessel which, in the depth of a punctured or a gunshot wound, manifests itself directly or after some time by a continued oozing of blood through the bandages, or which occurs in the subsequent course of the wound from erosion of the vascular wall or from thrombosis of the veins (phlebostatic hemorrhage, *Stromeyer*), no time should be lost in *exposing* at once the bleeding vessel *at the place of injury* and in ligating it in the wound itself (**direct ligation**).

Before this often very difficult task is attempted the anatomical position of the trunks of the vessels should always be called to mind. Figs. 446–450 may serve to recall the anatomical locations and surgical relations of the principal arterial trunks.

The paramount condition for executing such operations *easily*, *rapidly*, and thoroughly is a *large external incision*, which is made from the wound in an upward and downward direction and longitudinally to the limb in such a manner that it corresponds to the course of the injured vessel. Where it is a matter of life it is indifferent whether the incision is an inch or a foot in length. If arresting the hemorrhage meets with success and the wound remains aseptic, the *large* incision heals as well and as rapidly without suppuration as a small one.

As to the rest, the procedure is exactly the same as that described in secondary antiseptics (page 57). Having incised the skin to the requisite extent, the operator penetrates in the depth of the wound with the left forefinger, divides with a probe-pointed knife the deeper layers, the cellular tissue, the fascias and muscles as far as necessary; the divided parts are then retracted with large sharp or blunt retractors.

Next, the blood clots filling the whole cavity of the wound (the so-called aneurysma traumaticum diffusum) are quickly and thoroughly removed with the fingers and sponges, and in most cases in the depth of the wound the injured vessel or at least a bloody infiltrated layer of tissue is found, in

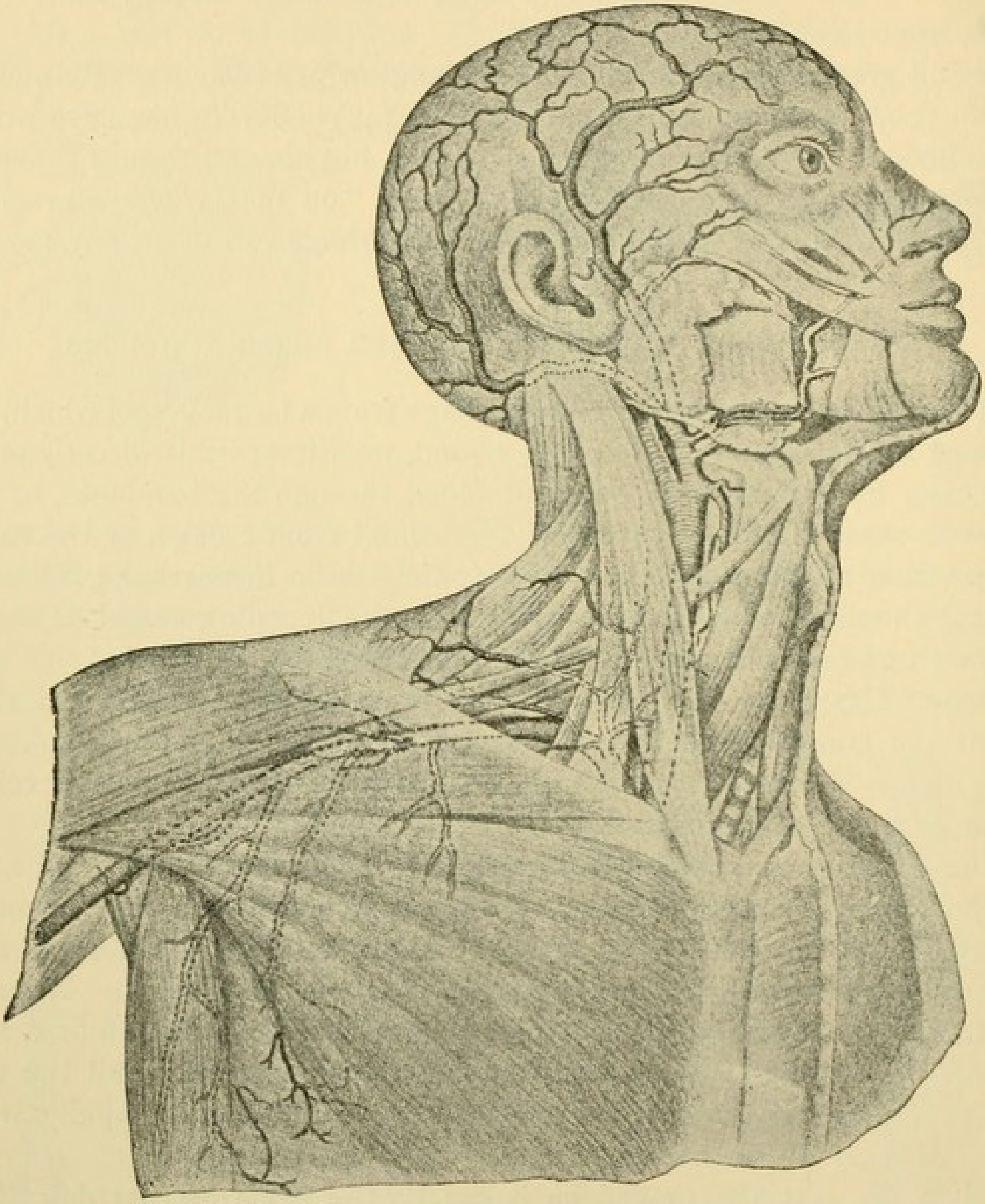


FIG. 446. ARTERIES OF HEAD, NECK, AND AXILLA

which the artery, veins, and nerves can eventually be found and identified. The operator should try to separate these several parts by careful dissection.

The finding of the injured vessels is essentially facilitated by making use of the *bloodless method*. If, however, the trunks of the veins are entirely empty and have collapsed, it may be difficult to distinguish them from the layers of cellular tissue. For this purpose it is advisable to form a *blood reservoir* below the wound by placing, for instance, before the elastic bandaging of the injured arm, a constrictor band around the wrist. If this constrictor is subsequently removed, and if the arm is raised, the blood which had remained confined in the hand fills the veins, and, in case one of the veins is injured, gushes from the vein wound.

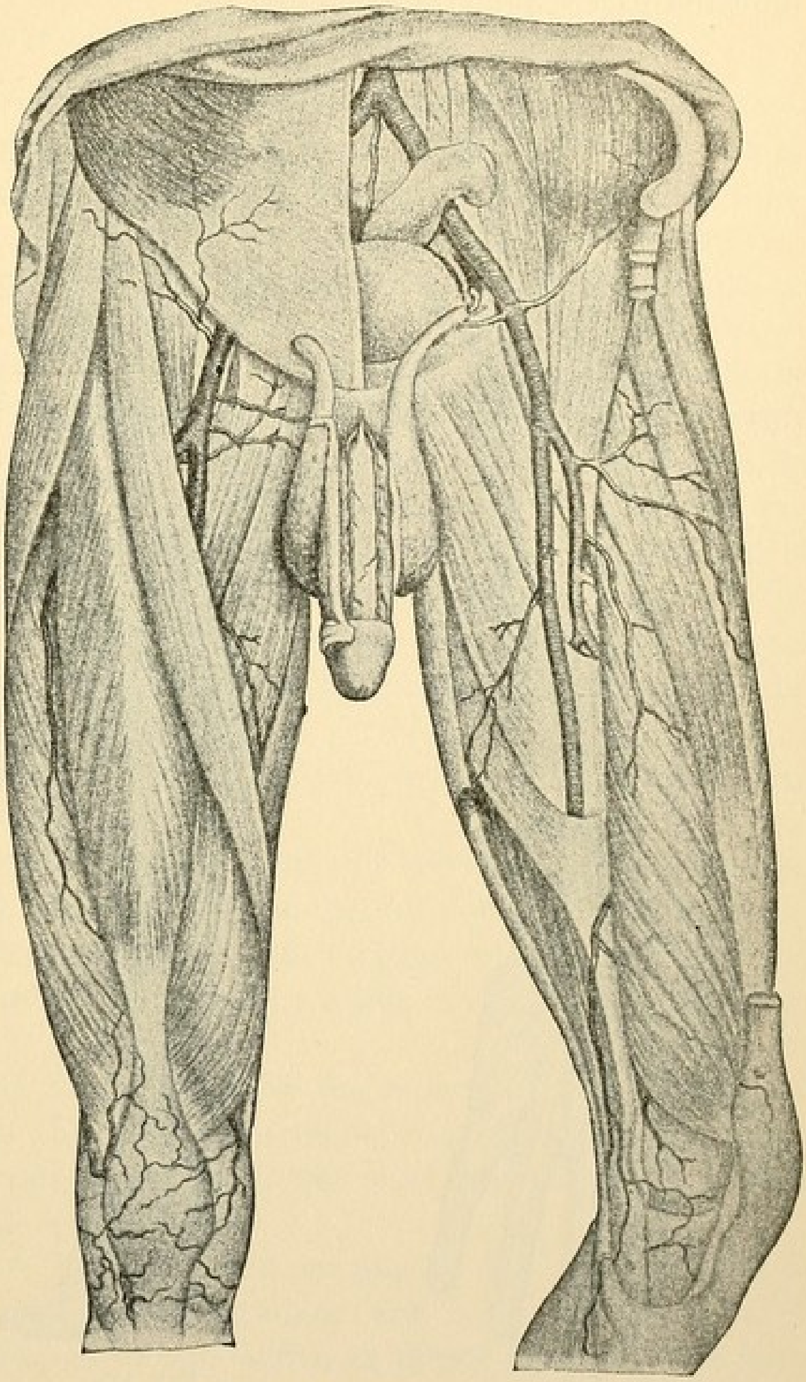


FIG. 447. ARTERIES OF THE THIGH

When the injured place of the artery or the vein has been found, and has been exposed so far that the whole extent of the injury can be surveyed or inspected, the vessel must be isolated and firmly and securely ligated in the healthy part above and below the injury with catgut or silk ("reef knot"). Next, if the continuity of the vessel is not already interrupted by the injury, it is *divided* in the middle between the two ligatures, and the operator convinces himself that no principal branches of the vessel are interposed between the two ligatures. If such branches are found they must also be well isolated, ligated, and separated from the trunk of the vessel. In order to proceed with absolute safety the injured portion of the vessel lying between the two ligatures can be *excised*.

Next, the constrictor band is removed, and all the vessels from which blood is still oozing are carefully ligated, while the limb is raised in order to limit the parenchymatous hemorrhage.

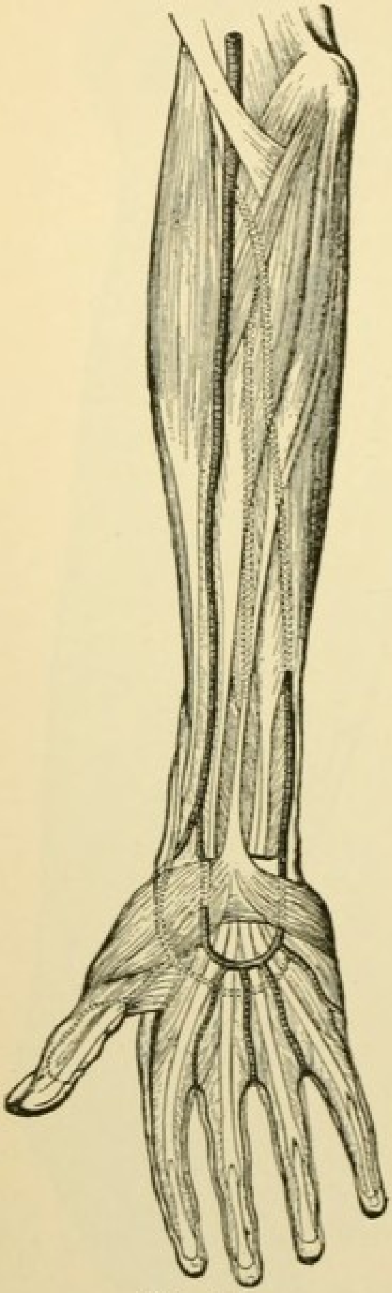
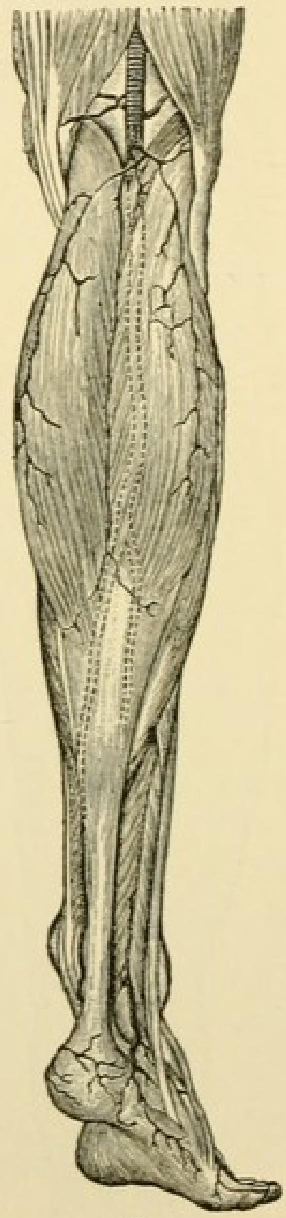


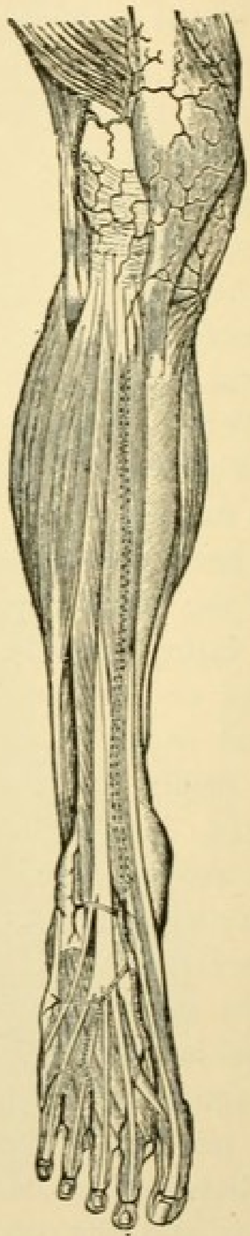
FIG. 448

ARTERIES OF ARM



a

FIG. 449



b

FIG. 450

ARTERIES OF LEG. *a*, posterior side; *b*, anterior side

LIGATION OF ARTERIES AT THE PLACE OF SELECTION

(HUNTER'S INDIRECT LIGATION)

The ligation of an artery above the wound is hardly ever resorted to at the present time *for arresting hemorrhages;* but it is much to be recommended for practising the technique and for testing the knowledge of topographical anatomy. Ligation of arteries, however, is often made to prevent permanently the flow of blood to certain parts of the body in important and bloody operations, or to heal diseased conditions. Thus the carotid artery is ligated in resection of the upper jaw; the lingual, in operations on the tongue; the thyroid arteries, in struma vasculosa (vascular goitre); the subclavian, in the disarticulation of the shoulder joint; the common iliac, in disarticulation of the thigh; the hypogastric, in tumors of the pelvis and hypertrophy of the prostata. (Preliminary ligation of large arteries in performing the operations mentioned above is seldom performed at the present time, since the surgeon has been placed in possession of local hemostatic resources which, if properly applied, make him master of the situation in arresting the hemorrhage.)

The following rules should be observed in finding and ligating the trunks of the principal arteries: —

1. The surgeon should recall very exactly and vividly to his memory the anatomical relations of the place of ligation before commencing the operation. The direction and length of the skin incision is made accordingly. It is of advantage to indicate the incisions by a line drawn upon the surface of the skin.

(This advice may be of some benefit to the novice in surgery, but no experienced surgeon would think for a moment of adopting it.)

2. The portion of the body is placed in the most advantageous position for the operation, and in the best light.

3. If the operation is to be performed on one of the extremities, it is advantageous to constrict the same previously, and to *cut off* the flow of blood with the modification mentioned above in direct ligation. As soon as it is of importance to feel the pulsation of the artery, the upper constrictor is removed.

4. The *external incision* is made either *free hand*, while the fingers of the left hand stretch well the surrounding integument and the knife penetrates everywhere the whole thickness of the skin (Fig. 335), or when the artery or other important parts are lying directly under the skin, by raising

a *transverse cutaneous fold*, which is divided with one sweep of the knife (Fig. 338).

5. In penetrating deeply, with care, the operator and his assistant grasp with two good forceps the uppermost layer of cellular tissue on both sides of the axis of incision, and at the same time raise the cellular tissue so that the air can enter into its meshes (emphysema). One sweep with the knife divides the raised cellular tissue (Fig. 451).

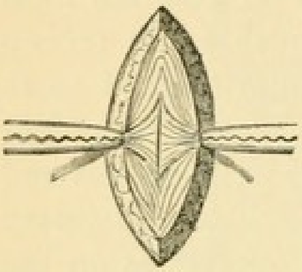


Fig. 451. Division of Cellular Tissue between Two Forceps

Immediately both forceps release their hold and grasp, now above and now below, the slit thereby made; again the layer of cellular tissue is lifted up toward the knife, which divides the fibres until the layer is divided from one angle of the wound to the other. This procedure is repeated in dividing the remaining layers until the *sheath of the artery* is reached. Any veins, small arteries, nerves, and muscles which are met are drawn aside with blunt retractors.

6. As soon as the **sheath of the artery** has been exposed, the forceps grasp the middle of the sheath of the artery, lift it upward, and raise it in the form of a cone; the handle of the knife is lowered laterally and so far in an exterior direction that the lateral surface of the blade is turned against the artery, while the point of the knife enters at a right angle to the point of the forceps, and under it into the grasped cone (Fig. 452).

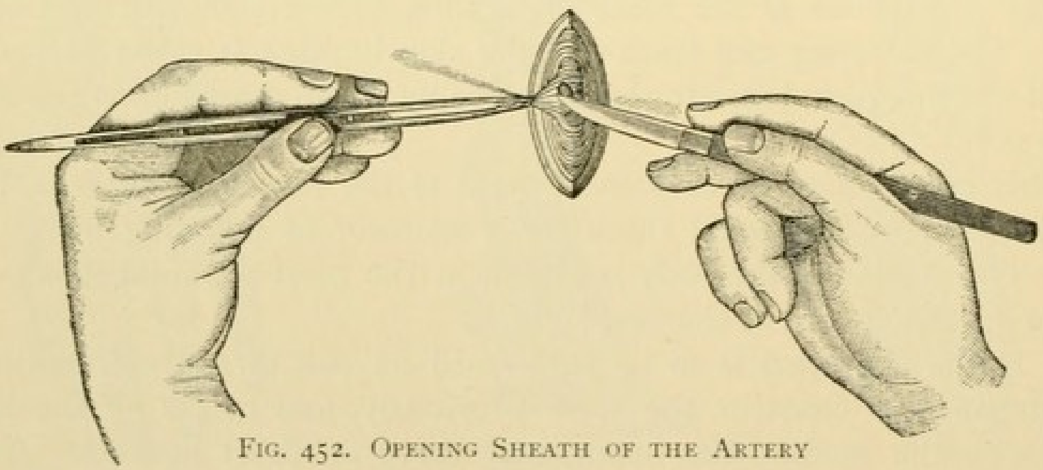


Fig. 452. Opening Sheath of the Artery

A small incision opens the sheath, and while the forceps lift up the triangular segment formed thereby, the point of the knife carefully separates the sheath of the artery from the arterial wall.

(In ligating large vessels, their sheaths should be incised freely, as it facilitates their isolation from adjacent important structures, and does in no way interfere with the nutrition of the ligated ends. By applying the ligature through a small slit in the sheath, important structures are often included in the ligature.)

7. In the case of large arteries, this procedure is continued as follows: while the surgeon still holds the divided cone, he introduces with his right hand another pair of closed forceps into the opening at the base of the cone between the artery and the cellular sheath; here he grasps the inner wall of the cellular sheath and draws it forward. By this means, the artery is gently rolled around its axis, and the cellular tissue fibres, which fasten the sheath to the lateral and posterior wall of the artery, appear to view; they are detached in the same careful manner and only as far as the opening first made. If the sheath of the artery is detached too far, the artery can become necrotic, and then secondary hemorrhage occurs at the place of ligation.

(In his experiments on the lower animals, the editor isolated arteries the size of the common carotid to the extent of 2 inches or more, and after double ligation never observed necrosis or secondary hemorrhage.)

In case of the largest arteries, the procedure must also be repeated on the other side after one-half of the circumference has been liberated.

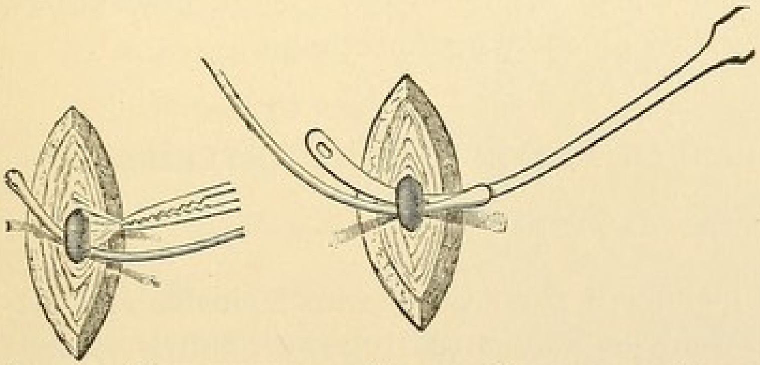


Fig. 453. Introducing Curved Probe   Fig. 454. Introducing Aneurism Needle

8. As soon as the artery has been freed on all sides, a *curved probe* (or a strabismus hook) is carefully introduced, and *always* carried around the vessel *from the side on which the principal vein lies*, while with a forceps the margin of the incision of the sheath is held taut (Fig. 453).

9. With a probe, the artery is lifted up so far that a small *Cooper's* or *Syme's* **aneurism needle** (Fig. 455) with an eye at its point can be passed around the same in an opposite direction (Fig. 454).

10. Next, the probe is removed, a strong *catgut or silk thread* is passed through the eye of the needle, and the needle is with-

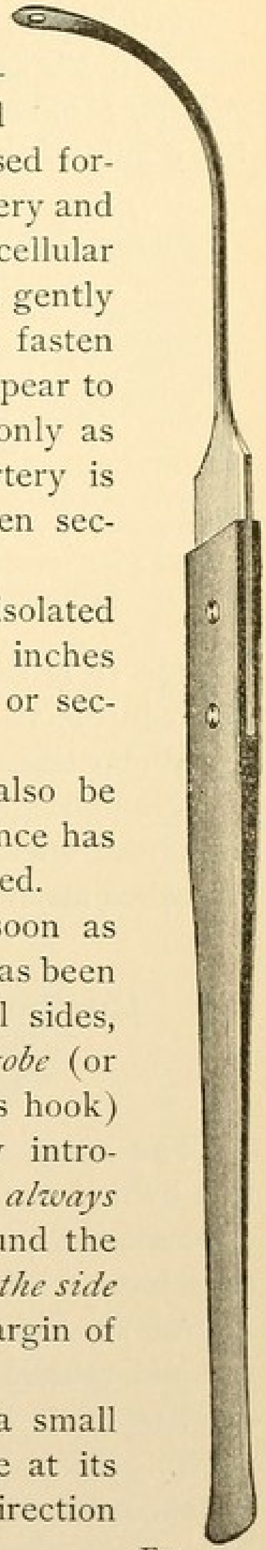


Fig. 455 Syme's Aneurism Needle

drawn; the middle portion of the ligature remains in position under the artery.

11. The ligature is tied around the artery and tied in a "**reef knot**" — see Fig. 365 (**not** with a "*granny knot*" — see Fig. 366) and *without displacing the artery;* the knots must be tied in the depth of the wound with the points of the two index fingers (Fig. 456).

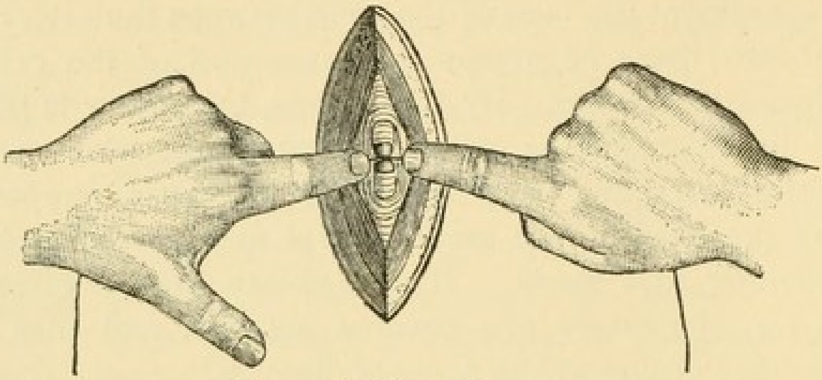


FIG. 456. TYING LIGATURE

12. It is advisable to *ligate* the artery *doubly* and to *divide* the vessel between the two ligatures so that the two ends can retract into the sheath of cellular tissue.

(Double ligation of an artery in its continuity without division of the vessel, if the operation is performed under the necessary aseptic precautions, furnishes absolute protection against secondary hemorrhage.)

LIGATION OF THE PRINCIPAL TRUNKS OF THE ARTERIES

CAROTID ARTERY

The *common carotid* takes its course from the sternoclavicular articulation behind the sternocleidomastoid perpendicularly upward, and is crossed opposite the lower margin of the cricoid cartilage by the omohyoid muscle on a level with the sixth cervical vertebra (tuberculum caroticum — *Chassaignac*). *Below* the omohyoid muscle it lies *behind* platysma, fascia, sternomastoid muscle, sternohyoid, sternothyroid, and the anterior jugular vein; *in front* of it lies the inferior thyroid artery and the recurrent laryngeal nerve. *Above* the omohyoid muscle, the artery lies only behind the platysma, cervical fascia, and the internal margin of the sternocleidomastoid. The strong *sheath of the artery* contains, toward the median line, the carotid, laterally the internal jugular vein, and in a posterior direction between the two the nervus vagus (pneumogastric); the descendant branch of the hypoglossal nerve passes *over it*, and closely *behind* it the sympathetic nerve (Fig. 457). At the height of the third cervical vertebra opposite the superior margin of the thyroid cartilage, the common carotid divides into the external and the internal carotid.

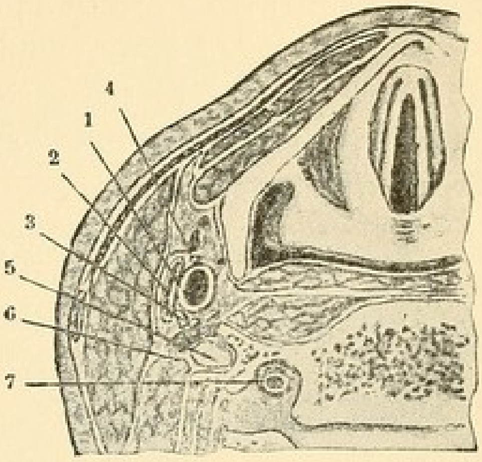


FIG. 457. SITUATION OF THE CAROTID ARTERY (Cervical Section). 1, carotid; 2, jugular vein; 3, pneumogastric nerve; 4, hypoglossal nerve; 5, brachial plexus; 6, sympathetic nerve; 7, vertebral artery

The *external carotid* is covered at its origin from the common carotid at the height of the superior margin of the thyroid cartilage, only by skin, platysma, cervical fascia, sternocleidomastoid, and the facial vein, ascends in a gentle curve to the height of the neck of the lower jaw (collum mandibulæ), and is crossed in its course at the height of the hyoid bone by the biventer muscle, the hypoglossal nerve, and further up by the stylohyoid muscle. Upon its external margin, the descending ramus of the hypoglossal nerve takes its course. At its

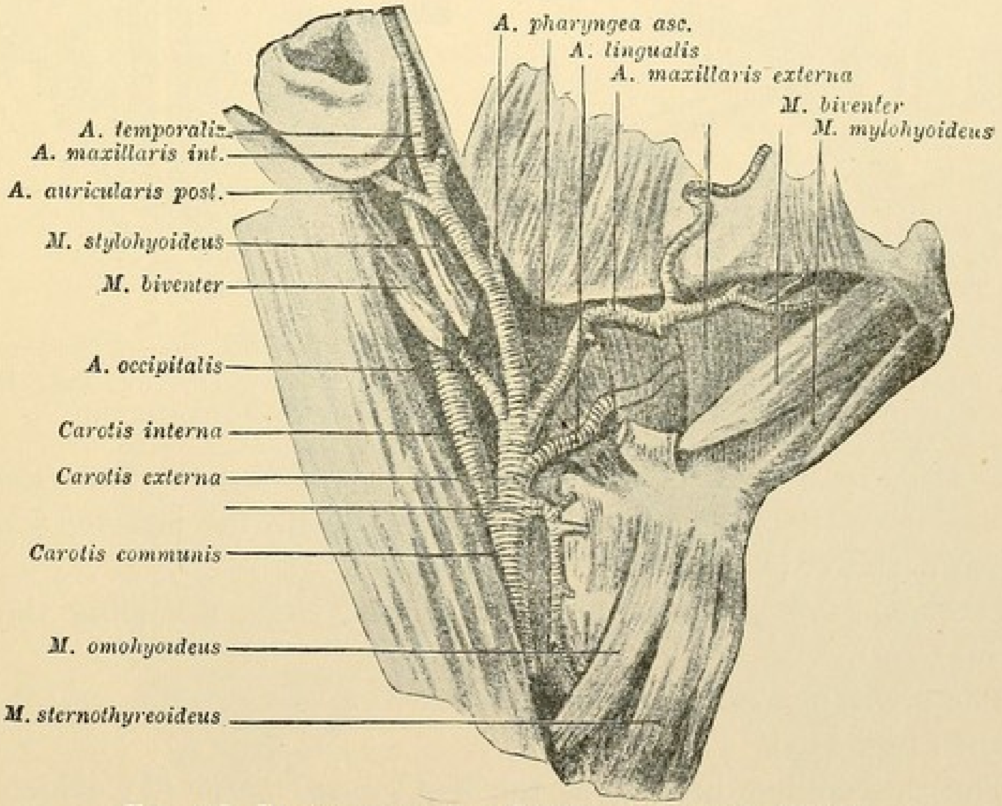


FIG. 458. BRANCHES OF THE EXTERNAL CAROTID ARTERY

posterior surface it is crossed by the superior laryngeal nerve, a branch of the lingual artery, and the glossopharyngeal nerve above the biventer muscle. It can be ligated most easily between the branches given off as the superior thyroid artery and the lingual artery.

The *internal carotid* ascends from the bifurcation of the common carotid as its continuation to the carotid canal in the petrous portion of the temporal bone, and lies somewhat *posteriorly* and *externally* from the external carotid (Fig. 458).

LIGATION OF THE COMMON CAROTID

(*a*) **On a level with the cricothyroid ligament** (Fig. 459, Plate I. 1).

1. After a *pillow* has been placed under the *shoulders*, the *head* is well extended.

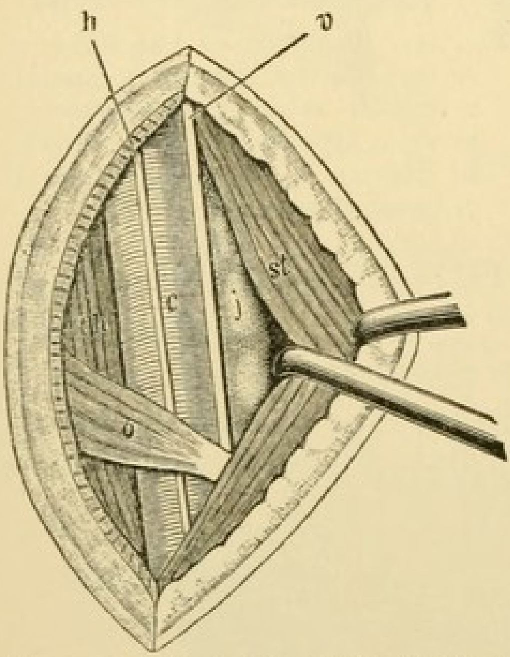


FIG. 459. LIGATION OF THE COMMON CAROTID ARTERY

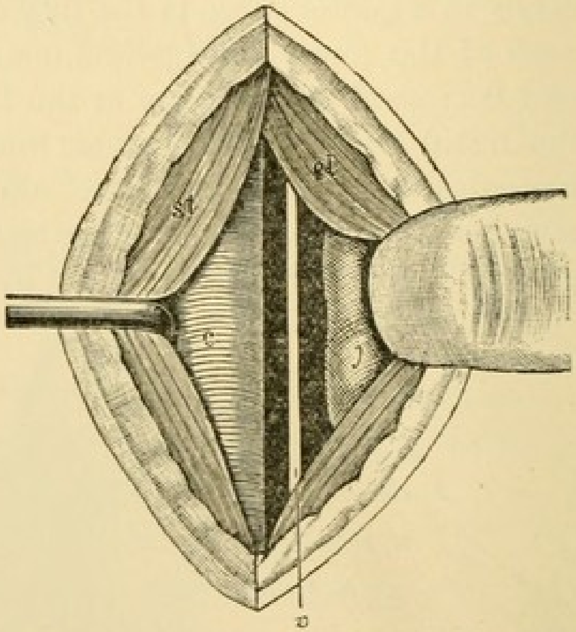


FIG. 460. LIGATION OF THE COMMON CAROTID ARTERY BETWEEN THE TWO HEADS OF THE STERNOCLEIDOMASTOID

2. *External incision* 6 centimeters in length, along the *inner margin* of the *sternocleidomastoid*, commencing on a level with the *superior margin of the thyroid cartilage* (Plate I. 1).

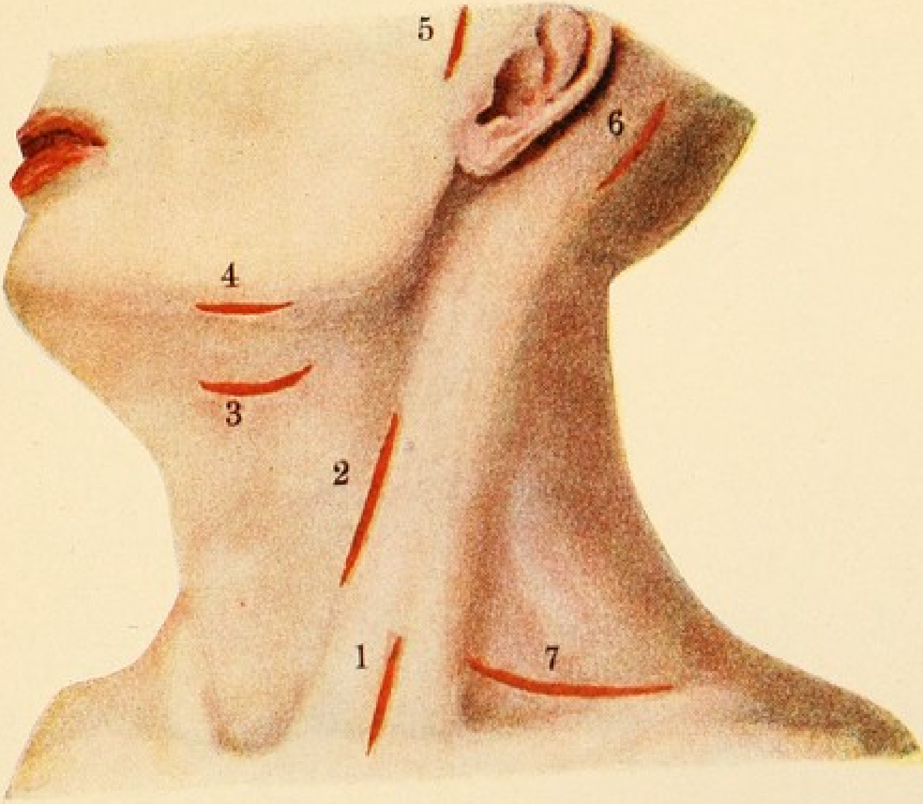
3. *Division of the platysma* and the cellular tissue (avoiding the superficial veins).

4. The *sternocleidomastoid* (*st*) is drawn *outward;* the *omohyoid* (*o*), *downward* (Fig. 459).

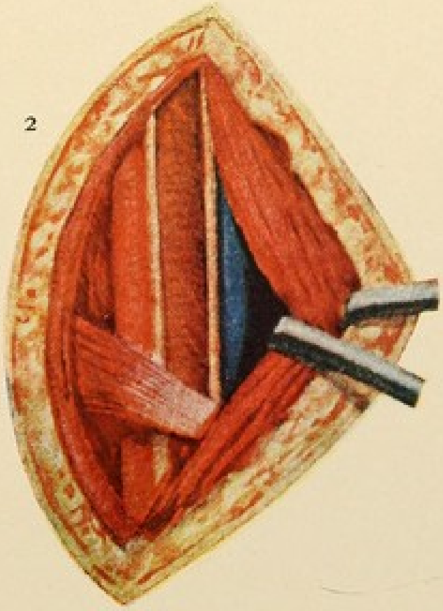
5. The descending branch of the *hypoglossal nerve* (*h*), which passes *over* the artery in a downward direction, is drawn *outward.*

6. *Opening* of the common *sheath* over *the middle portion of the artery.* The same (*c*) lies *inwardly;* the internal jugular *vein* (*j*), *externally* and a

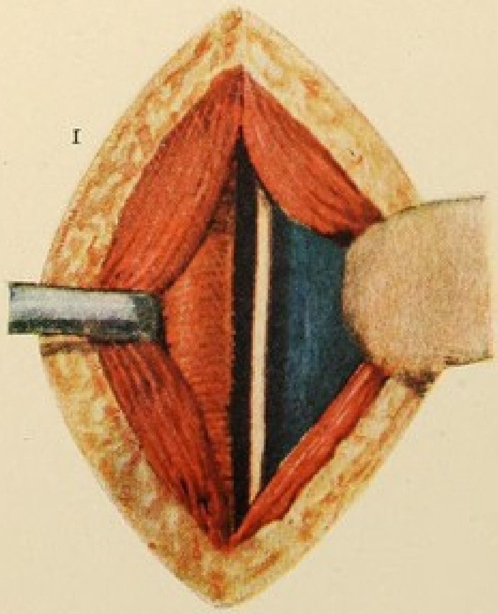
PLATE I



External Incisions for ligating the arteries. 1, 2, Common Carotid. 3, Lingual. 4, Masseteric. 5, Temporal. 6, Occipital. 7, Subclavian.



Ligation on a level with the crico-thyroid ligament.



Ligation between the two heads of the sterno-cleido mastoid muscle.

Ligation of the Common Carotid Artery

little more superficially; the *pneumogastric nerve* (v), deeply between the two. The sympathetic nerve courses behind the carotid (Fig. 457).

7. The artery needle with a silk thread must be carried around it *from the outside.* Great care should be taken not to injure the pneumogastric nerve.

(b) **Between the two** (Plate I. 2) **heads of the sternocleidomastoid muscle** (Fig. 460).

1. *External incision,* 6 centimeters in length; between the two heads of the sternocleidomastoid downward to the clavicle, 2 centimeters outward from the sternal articulation (Plate I. 2).

2. *Division of the platysma.* The *slit* between the sternal and the clavicular portion of the sternocleidomastoid is enlarged *with the fingers* until the internal jugular vein appears to view (Fig. 460, j).

3. The *vein,* with the *clavicular portion* (cl), is drawn carefully *outward* by the finger of the assistant; the *sternal portion* (st), with the sternohyoid and the sternothyroid muscles, is drawn *inward.*

4. At the *inner side of the vein* appears the *pneumogastric nerve* (v); a little more inwardly and deeply lies the artery (c). On account of the deep position of the artery this place is selected for ligation only in exceptional cases.

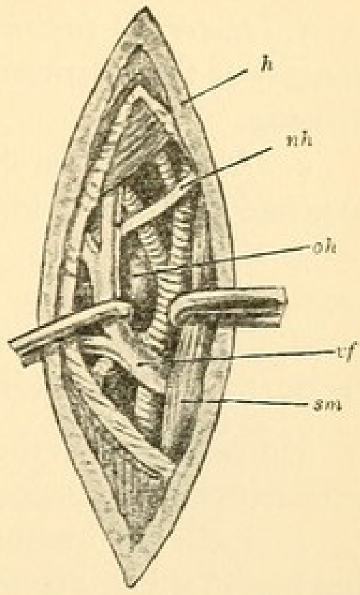


FIG. 461. LIGATION OF THE EXTERNAL CAROTID ARTERY. h, skin; nh, hypoglossal nerve; oh, hyoid bone (greater cornu); vf, facial vein; sm, sternocleidomastoid

LIGATION OF THE EXTERNAL CAROTID

(Plate II. 1)

1. Position as described above.

2. *External incision* 6 to 7 centimeters in length, along the inner margin of the sternocleidomastoid, from the level of the thyroid cartilage toward the angle of the lower jaw.

3. Division of the *platysma* and the *superficial fascia.*

4. The *digastric muscle* and the *hypoglossal nerve* in the superior angle of the wound are drawn *upward;* the *superior thyroid vein* and the facial vein in the lower angle are drawn *downward;* the *internal carotid* and the *jugular vein* are drawn *outward.*

5. After the artery has been exposed, the artery needle is carried around it from without inwardly, guarding against any injury to the *superior laryngeal nerve.*

LIGATION OF THE INTERNAL CAROTID

1. *External incision* 6 centimeters in length, parallel to the anterior margin of the sternocleidomastoid, a little more outward than the preceding incision.

2. After division of these several layers of tissue, the *external carotid* is exposed and drawn inward; the digastric muscle is drawn upward.

3. *Opening of the sheath* covering the internal carotid, which is now exposed. The artery needle is carried around it carefully from without inward, since the internal jugular vein, the pneumogastric nerve, the sympathetic, and the ascending pharyngeal artery are lying close to the vessel.

Kocher exposes the bifurcation of the carotids and the branches of the external carotid by means of a transverse incision (Plate II. *a*, 1), as follows:—

1. External incision, a finger's breadth below and behind the angle of the jaw in a line extending from the anterior extremity of the mastoid process to the middle of the hyoid bone.

2. After division of the platisma the external jugular vein and the great auricular nerve coursing behind it are drawn backward.

3. By division of the fascia, the anterior margin of the sternocleidomastoid is exposed and drawn backward, whereby the common facial vein appears to view as far as its place of anastomosis with the common jugular vein. It is drawn downward and outward.

4. The external carotid is now exposed, distinguishable by the superior thyroid artery branching off directly above its origin; at its side and behind it lies the internal carotid (without branches).

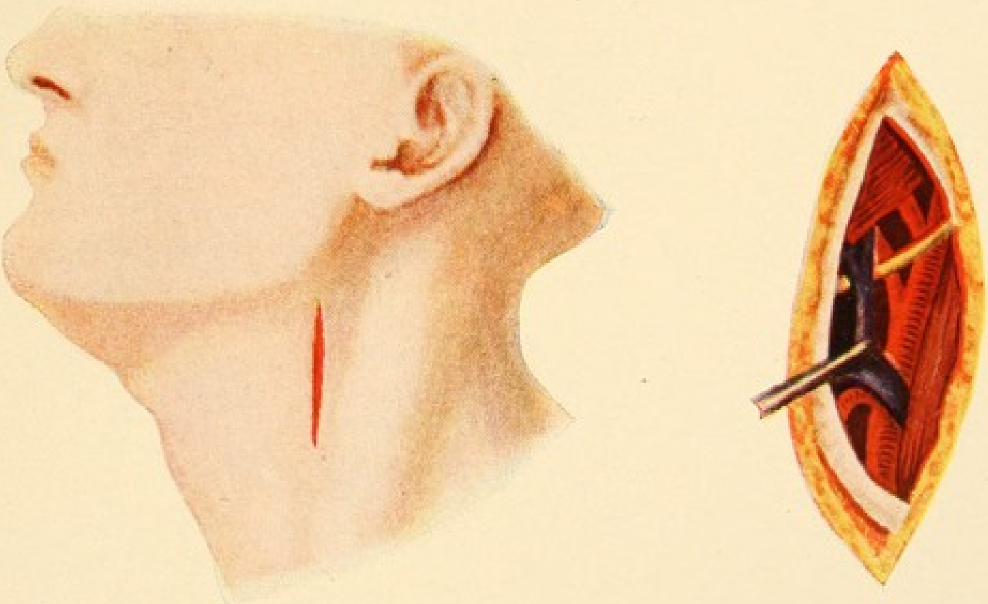
5. In exposing the external carotid care must be taken not to injure the descendant ramus of the hypoglossus (anteriorly upon the artery), and the superior laryngeal nerve (coursing obliquely behind the artery). At the point of exit of the external maxillary artery the hypoglossal nerve surrounds the external carotid from behind and exteriorly.

From this incision also the trunk of the lingual artery, the external maxillary artery, and the occipital artery can be ligated (Fig. 457).

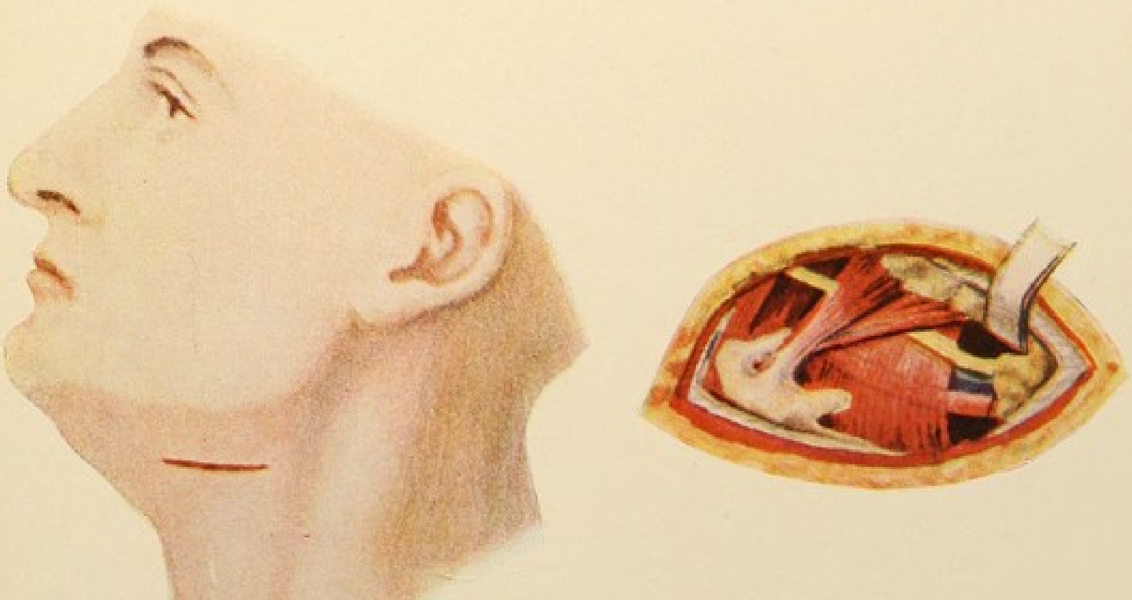
The **external maxillary artery** (facial) is found at the lower margin of the inferior maxillary bone, near the *anterior margin of the masseter* under the skin (Plate I. 4).

The **temporal artery** is exposed by a vertical incision 2 centimeters in length upon the *zygomatic arch* between the tragus and the condyle of the lower jaw (Plate I. 5).

PLATE II



Ligation of the External Carotid Artery



Ligation of the Lingual Artery

The **occipital artery** is found in the line between the posterior margin of the mastoid process and the external occipital protuberance (Plate I. 6).

LINGUAL ARTERY

The *lingual artery*, as the second branch from the external carotid (2 centimeters above its bifurcation) arising on a level with the greater cornu of the hyoid bone (Fig. 458), ascends a short distance, is crossed by the digastric and the sternohyoid muscles, passes transversely upon the mylohyoid muscle beneath the posterior margin of the hyoglossus muscle, *behind* which it takes its course along the upper border of the greater cornu of the hyoid bone, parallel to the hypoglossal nerve, passing over it and *upon* the hyoglossus muscle, thence upward to ramify at the under surface of the tongue (ranine artery).

LIGATION OF THE LINGUAL ARTERY

(Plate II)

1. *External incision* 4 centimeters *along* the *upper margin* of the *greater cornu of the hyoid bone.*

2. *Division of the platysma;* the *posterior facial vein* is drawn *outward.*

3. The *external belly of the digastric muscle is now exposed* (Fig. 462, *d*), *behind* and *beneath* which the *hypoglossal nerve* (*hp*) appears. The submaxillary gland (*gl*) is drawn *upward.*

4. The *hypoglossal nerve* passes in front of the *hyoglossus muscle* (*hg*) accompanied by the lingual vein; *beneath* the nerve, the *lingual artery* (*a*) lies *behind the hyoglossus muscle.*

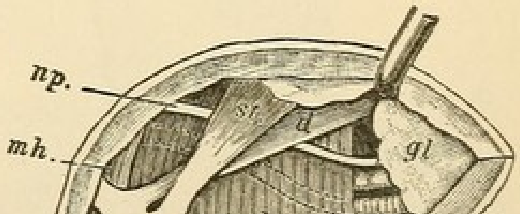


Fig. 462. Ligation of Lingual Artery

5. *Between the hypoglossal nerve* and the *greater cornu of the hyoid bone* (*oh*), the *fibres of the hyoglossus muscle* are carefully *divided;* directly behind it lies the *lingual artery*, accompanied by a vein.

Also, in the *trigonum linguale* (lingual triangle) between the external belly of the digastric and the lateral margin of the mylohyoid muscle (*mh*), the artery can be ligated after division of the hyoglossus muscle (*Hueter*).

SUBCLAVIAN ARTERY

The *subclavian artery* takes its origin on the left from the arch of the aorta, on the right from the innominate artery, courses in a slight curve behind the clavicle between the scalenus anticus and medius muscles, thence crossing obliquely over the surface of the first rib to the axilla. The scalenus medius and posticus muscles lie behind and across the artery. Beneath and in front of the scalenus anticus muscle will be found the subclavian vein.

LIGATION OF THE SUBCLAVIAN ARTERY

(*a*) **In the supraclavicular fossa** (Plate III. 1).

1. The arm is drawn downward; the head, toward the *healthy* side; a pillow is placed under the back.

2. *External incision* 6 to 8 centimeters in length in the form of a curve from the external margin of the sternocleidomastoid to the external third portion of the clavicle, obliquely across the supraclavicular fossa.

3. The *platysma* is divided; the *margin* of the *sternocleidomastoid* (*st*) *is exposed;* the external jugular vein (*j*) must not be injured! (Fig. 463.)

4. *Division* of the superficial layer of the *fascia of the neck* and of the adipose cellular tissue in the supraclavicular fossa.

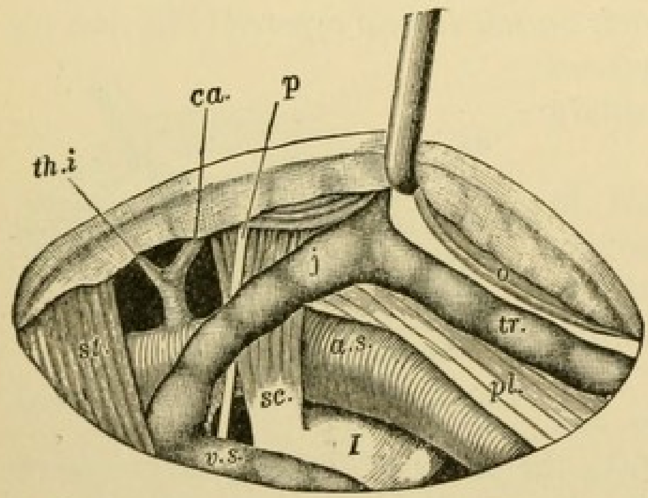


Fig. 463. Ligation of Subclavian Artery in the Supraclavicular Fossa

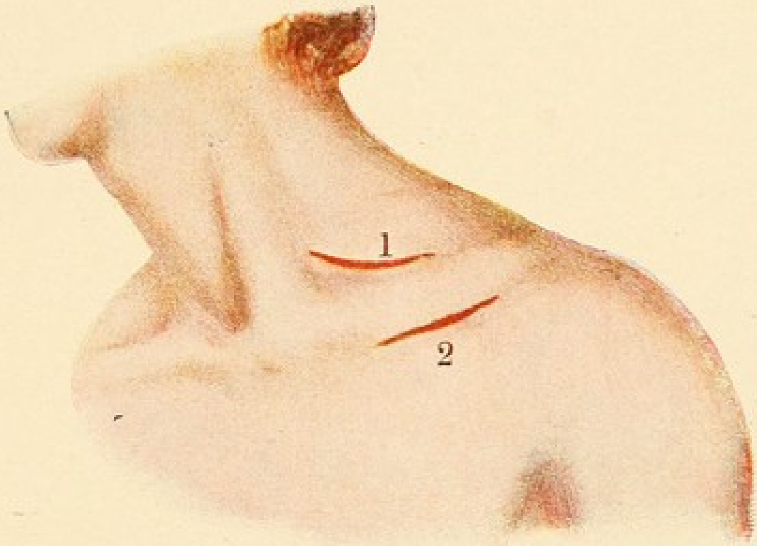
5. The *omohyoid* (*o*) is separated and drawn upward.

6. Incision through the *adipose* and *cellular tissue* (with veins!) to the scalenus muscle (*sc*), the tendon of which can be felt at the side of the tubercle of the first rib.

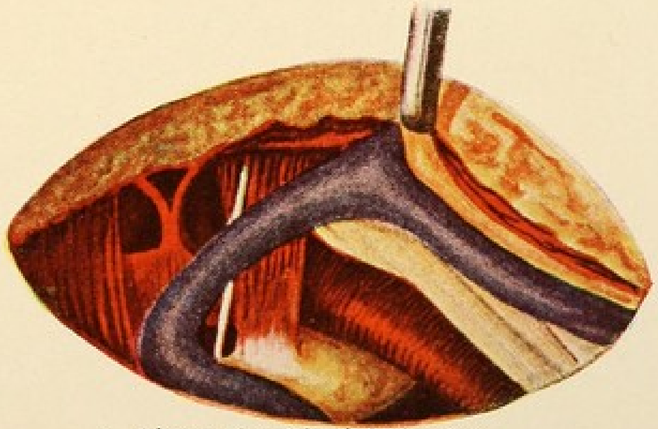
7. The *internal margin of the brachial plexus* (*pl*) appears to view and is drawn *upward and outward.*

8. Between the scalenus muscle and the brachial plexus, but a little deeper than the latter, lies the artery; it becomes visible after division of the deep layer of the deep fascia of the neck.

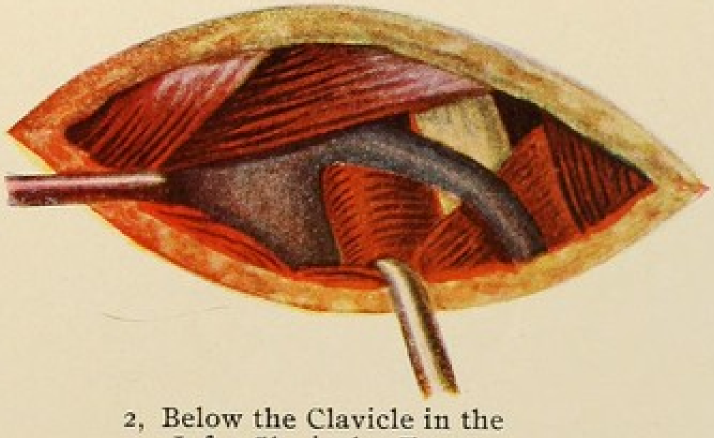
PLATE III



1, Above the Clavicle
2, Below the Clavicle



1, Above the Clavicle in the
Supra-Clavicular Fossa



2, Below the Clavicle in the
Infra-Clavicular Fossa

Ligation of the Sub-Clavian Artery

9. The *subclavian vein* (*vs*) lies in *front* and *beneath* the tendon of the scalenus muscle and *closely behind* the clavicle.

Injury to the external jugular vein (along the external margin of the sternocleidomastoid), to the suprascapular artery (near the clavicle), to the transverse cervical artery (upon the brachial plexus), to the phrenic nerve (*p*) (which descends upon the scalenus), must be avoided.

(*b*) **In the infraclavicular** (Plate III. 2) **fossa.**

1. The *shoulder* is forced *upward*.

2. An *external incision* 6 to 8 centimeters in length, beginning at the *coracoid process parallel* to the *external half* of the clavicle, exposes the *triangular depression* between the deltoid and the pectoralis major muscles (trigonum Mohrenheimii, Mohrenheim's fossa), in which the *cephalic vein* joins the subclavian vein.

3. The *cephalic vein* (*ce*) is drawn *externally* with the margin of the *deltoid muscle* (*d*), the margin of the *pectoralis major* muscle (*pmj*) (which in case of necessity is freed to some extent from the clavicle) is drawn *inward* (Fig. 464).

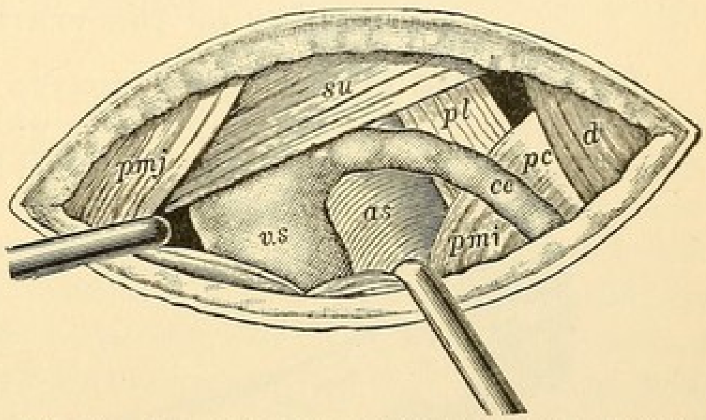


FIG. 464. LIGATION OF SUBCLAVIAN ARTERY IN THE INFRACLAVICULAR FOSSA

4. After *division of the adipose cellular tissue*, the *coracoclavicular fascia* appears in the depth of the opening; this is carefully divided. In most cases, the *external thoracic artery* must be ligated.

5. The *pectoralis minor muscle* (*pmi*) can be seen; its internal (upper) margin forms with the *subclavius* muscle an angle opening inward. The artery lies deeply in this angle between the *brachial plexus* (*pl*) and the *subclavian vein* (*vs*), the vein lying inward, the nerve outward.

In case of necessity, the pectoralis minor muscle may be detached from the coracoid process, and the artery ligated nearer the axilla. *Temporary resection of the clavicle* and drawing apart the bone, after it has been sawed through, may also facilitate the operation in difficult cases, and enlarge the field of operation (*von Langenbeck*). This is especially of great advantage in punctured wounds of the artery behind the clavicle (*Rotter*).

VERTEBRAL ARTERY

The *vertebral artery* takes its origin from the *superior and posterior* circumference of the subclavian opposite the external mammary artery, passes close to the inner edge between the internal margin of the scalenus anticus muscle and the longus colli muscle in an upward direction, in order to enter the opening of the *intertransversary canal* in the transverse process of the sixth cervical vertebra; immediately *behind* its entrance into the canal lie the sympathetic and the transverse process of the seventh cervical vertebra (carotid tubercle). *In front* of it are located the internal jugular vein, the vertebral vein, and the inferior thyroid artery.

LIGATION OF THE VERTEBRAL ARTERY

(*a*) **According to** *Chassaignac.*

The patient is placed in position, with thorax elevated. His head is turned toward the opposite side; the arm is drawn downward.

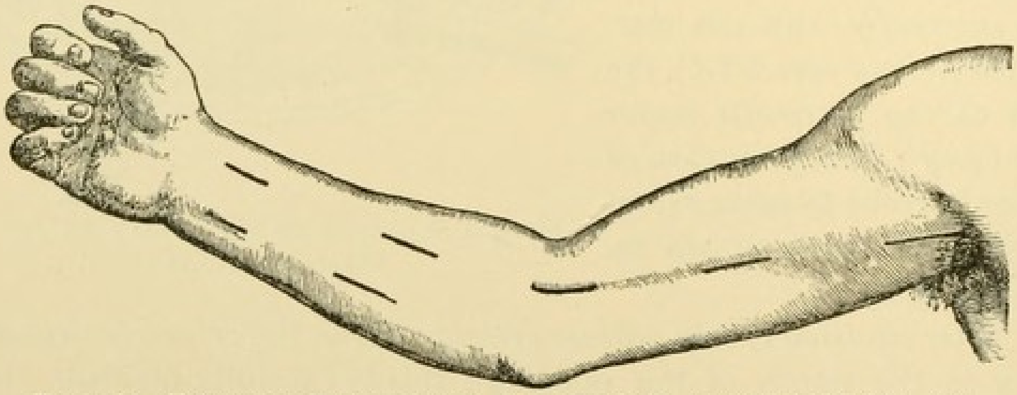


FIG. 465. EXTERNAL INCISIONS FOR LIGATIONS OF ARTERIES OF THE ARM

1. *External incision* 5 centimeters in length from the clavicle upward along the posterior margin of the sternocleidomastoid.

2. After division of the fascia (external jugular vein!), the sternocleidomastoid and the sheath of the carotid are drawn *inward;* the external jugular vein, *outward.*

3. Palpating in an upward direction along the *scalenus anticus* muscle, the operator seeks the *carotid tubercle*, and advances beneath it into the space between the scalenus anticus and the longus colli muscles.

4. The artery lies here *behind the vertebral vein*, which should be drawn aside; the aneurism needle is carried around it from without, inward.

(*b*) **According to** *Kocher* (Plate II. *a*, 2).

1. *Transverse incision* from the clavicle across the sternocleidomastoid obliquely outward and upward.

2. The anterior border of the sternocleidomastoid is forcibly reflected outward; the omohyoid and sternohyoid downward and inward. The common jugular vein, the carotid, and the pneumogastric nerve are reflected outward at their inner border.

3. Between this bundle of vessels and the *thyroid gland*, which, after division of its external capsule, is drawn inward and elevated, the *inferior thyroid artery* is reached, which ascends tortuously upward and inward. Above the same divide the prevertebral fascia longitudinally; on the longus colli muscle below the carotid tubercle (of the sixth cervical vertebra) palpate for the *vertebral artery* ascending perpendicularly *behind* the inferior thyroid artery. In an *outward direction* from it courses the *phrenic nerve* upon the scalenus anticus, in an *inward direction* the *recurrent nerve*.

THE AXILLARY ARTERY

The *axillary artery* lies laterally to the uppermost portion of the thorax, and from thence passes obliquely through the axilla, the anterior border of which is made up by the pectoralis major muscle, the posterior, the latissimus dorsi, and the teres major muscles. The artery lies in the axilla along the lower median border of the coracobrachialis under the integument and the fascia of the axilla, covered by the crossing of the bifurcated median nerve. In front of it, the internal cutaneous nerve lies toward the median side; beneath it lies the ulnar nerve. Toward the middle from these, the great axillary vein takes its course.

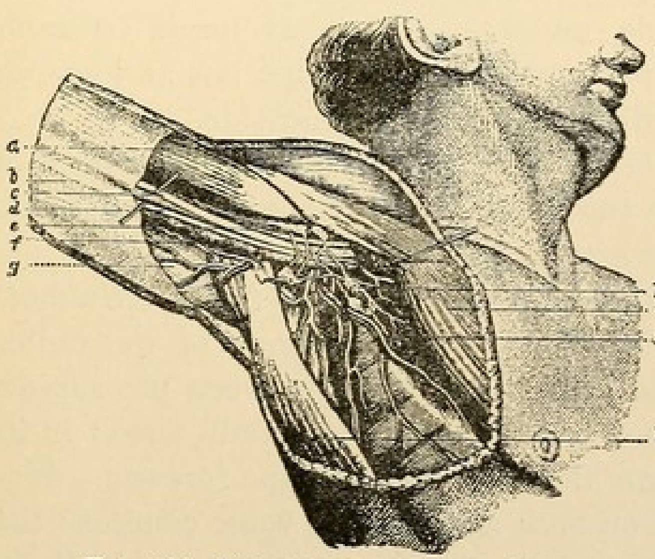


FIG. 466. TOPOGRAPHY OF THE AXILLA

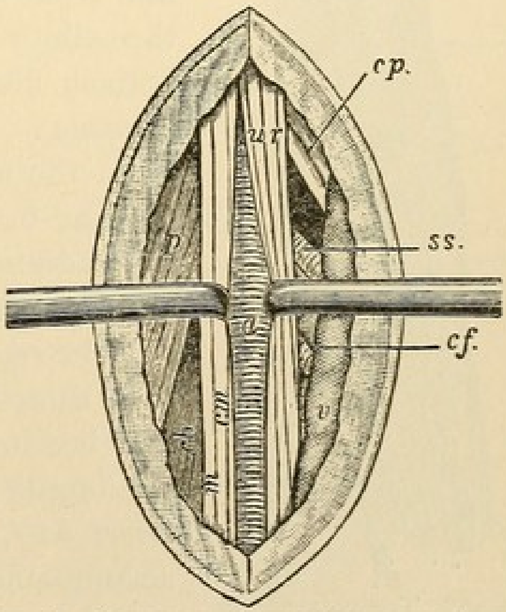


FIG. 467. LIGATION OF THE AXILLARY ARTERY

LIGATION OF THE AXILLARY ARTERY

(Plate IV)

1. *External incision* 5 centimeters in length with the arm raised high, along the inner margin of the *coracobrachialis*, commencing where this muscle crosses at an obtuse angle the border of the *pectoralis major*.

2. After *division of the fascia*, a plexus of nerves containing the artery appears to view (Fig. 467).

The *axillary vein* (*v*) lies at the *posterior* border of the plexus and a little more superficially.

3. *Divide the sheath of the nerve plexus;* draw the anterior cords (the median nerve and the internal cutaneous nerve) forward; the posterior (the ulnar and the radial nerve) (musculospiral), backward; and open the sheath of the artery.

In the middle of the axilla, the subscapular arteries (*ss*) and the circumflex (circumflex humeri) (*cf*) branch off from the subclavian artery in a posterior direction.

BRACHIAL ARTERY

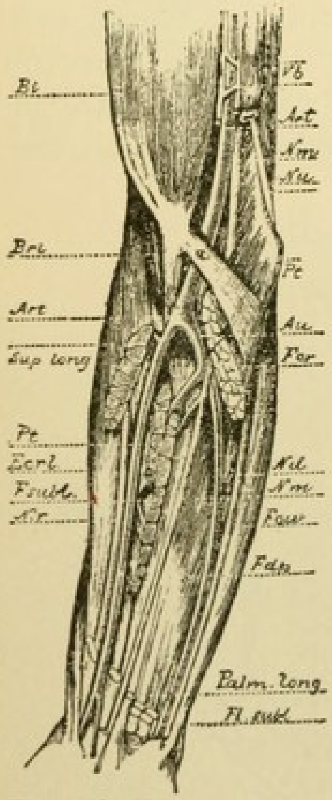


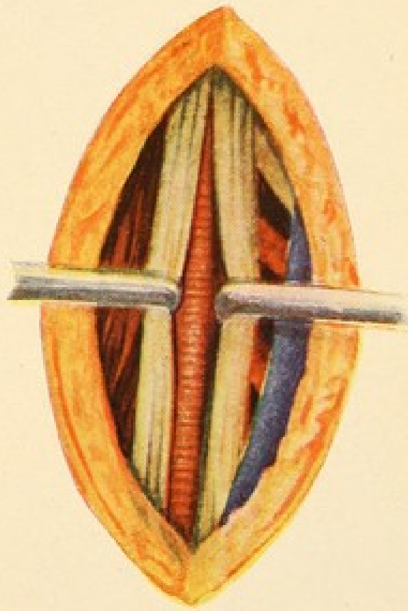
FIG. 468. TOPOGRAPHY OF THE ARTERIES OF THE ARM

The *brachial artery*, accompanied by two veins, lies internal to the humerus, along the inner margin of the biceps muscle, behind the median nerve and the internal cutaneous nerve. Toward the median line from it lies the ulnar nerve. At the flexure of the elbow joint, it crosses the internal brachialis anticus muscle under the bicipital fascia (lacertus fibrosus). The tendon of the biceps lies at its outer side; the median nerve, at its inner side.

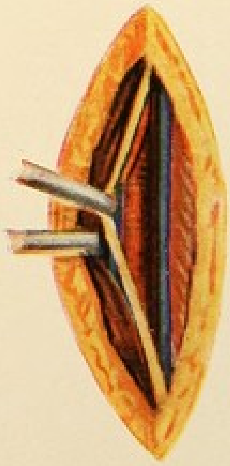
The brachial artery divides opposite the neck of the radius in the bend of the elbow, into the radial and the ulnar artery.

The *radial artery* takes its course from here almost in a direct line to the styloid process of the radius and lies in its *upper half* deeply between the supinator longus muscle and the pronator radii teres; in its *lower half*, near the deep fascia of the forearm. It is accompanied on both sides by the venæ comites; the radial nerve (musculo spiral) accompanies it only in the middle of the forearm.

PLATE IV



Ligation of the Axillary Artery



Ligation of the Brachial Artery

Ligation of the Cubital Artery

Ligation of the Axillary and the Brachial Artery

The *ulnar artery* lies in its upper half beneath the superficial flexors, pronator radii teres, the flexor carpi radialis, the palmaris longus, and the flexor sublimis digitorum; in the middle part of the forearm beneath the flexor carpi ulnaris, closely above the wrist, between the flexor carpi ulnaris and the flexor sublimis digitorum, upon the flexor profundus digitorum, near the deep fascia, accompanied on its ulnar side by the ulnar nerve.

LIGATION OF THE BRACHIAL ARTERY

(Plate IV. 1)

(*a*) **At the middle of the arm.**

1. *External incision* 4 centimeters in length, along the *inner* margin of the biceps muscle.

2. The *biceps* (*b*) is drawn *outward* with blunt retractors. The *median nerve* (*m*), lying directly upon the artery, appears to view.

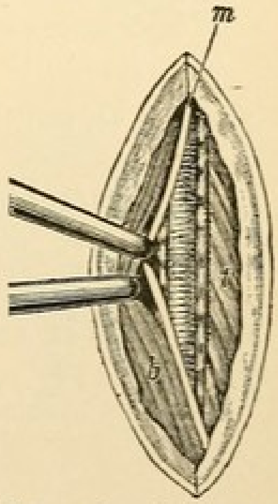


Fig. 469. Ligation of the Brachial Artery

3. The *median nerve* is liberated and drawn outward (Fig. 469) with a blunt hook, the sheath of the artery is opened; it lies between two veins (brachial veins).

Sometimes the brachial artery divides into the ulnar and the radial in the upper third part of the arm; in this case, the latter is generally more superficial and lateral (upon the biceps), and the former is remarkably *small.*

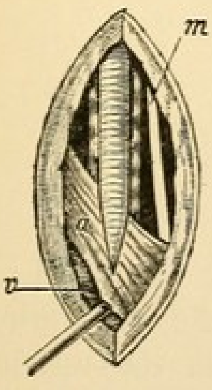


Fig. 470. Ligation of Arteria Anconea

(*b*) **At the bend of the elbow (arteria anconea)** (Plate IV. 2).

1. *External incision* 3 centimeters in length, 5 millimeters *inward* from the internal margin of the tendon of the biceps (Fig. 470). This incision must be made with care lest the *median vein* (*v*) should be injured. The median vein is drawn *downward.*

2. *Division of the aponeurosis of the biceps* (*a*). Directly under it lies the artery upon the internal brachialis anticus between two veins.

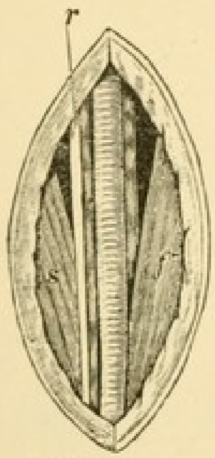
The *median nerve* (*m*) lies a few millimeters farther *inward* and passes down beneath the pronator teres muscle.

LIGATION OF THE RADIAL ARTERY

(Plate V. 1, 3)

(*a*) **In the upper third of the forearm.**

1. *An external incision*, beginning 3 centimeters below the bend of the elbow, takes its course 4 centimeters in length, along a line dividing the radial third of the flexor side of the forearm in supination, from the middle third.



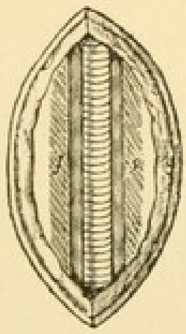


FIG. 471 FIG. 472

LIGATION OF THE RADIAL ARTERY

2. After *division of the antibrachial fascia*, the space between the bellies of the supinator longus (*s*) and the flexor carpiradialis (*f*) is sought for, and the incision is enlarged with the tip of the index finger (Fig. 471).

3. In the depth lies the artery accompanied by two veins; on its radial side, the superficial branch of the radial nerve (*r*).

(*b*) **Above the wrist joint.**

1. *External incision* 3 centimeters in length at the radial side of the *flexor carpi radialis.*

2. Careful *division* of the superficial layer of the *deep fascia* of the forearm.

3. The artery, accompanied by two veins, lies between the *flexor carpi radialis* — or radialis internus (*f*) — and the supinator longus (*brachioradialis*) (*s*) (Fig. 472).

LIGATION OF THE ULNAR ARTERY

(Plate V. 2, 4)

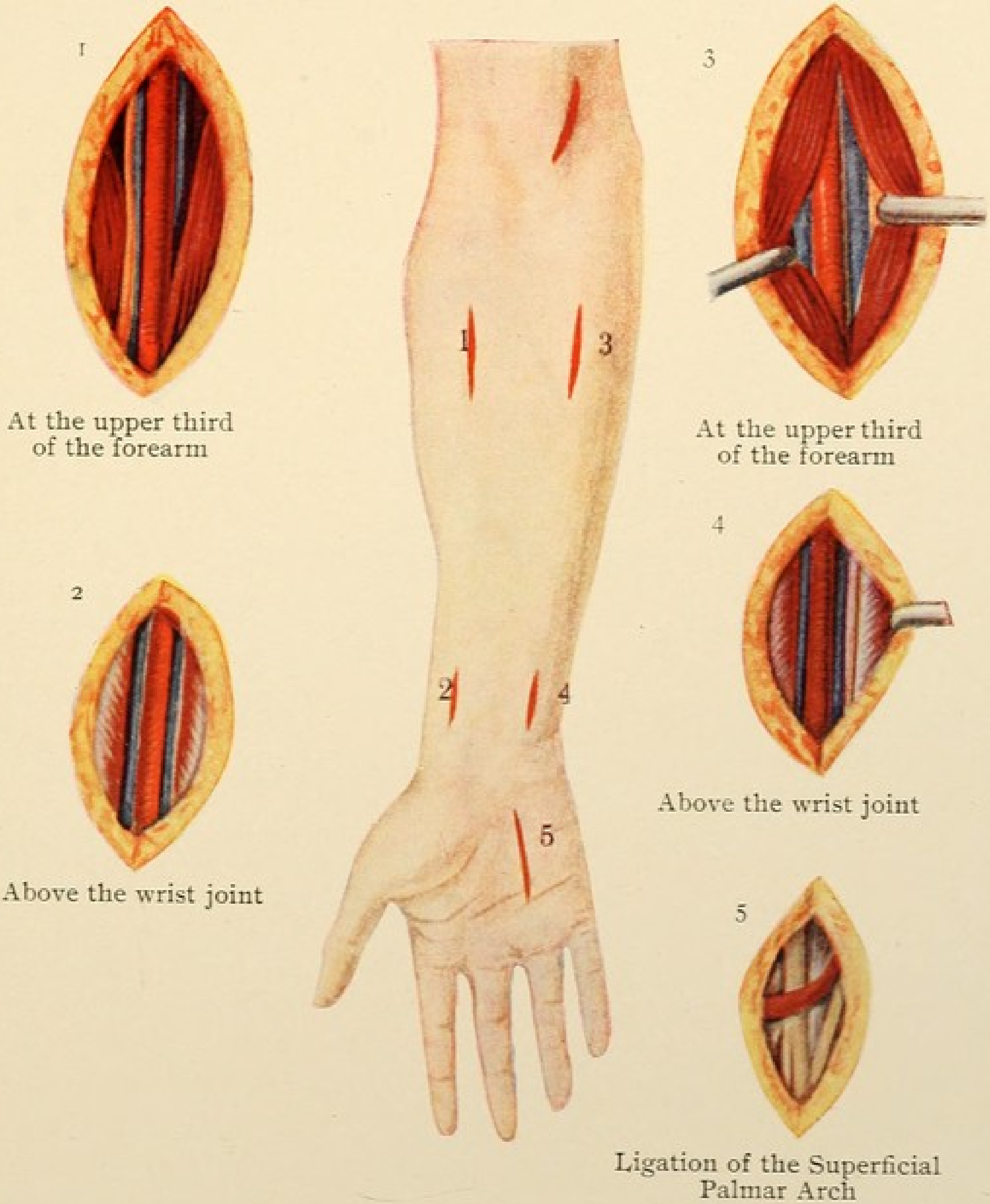
(*a*) **In the upper third of the forearm.**

1. *An external incision*, commencing 3 centimeters below the band of the elbow, courses 4 centimeters in length on a line dividing the ulnar third of the flexor side of the forearm placed in supination from the middle third.

2. After *division of the deep fascia*, the space between the bellies of the flexor carpi ulnaris (*c*) and the flexor sublimis digitorum (*d*) is sought for and enlarged with the point of the forefinger and blunt retractors (Fig. 473).

3. In the depth lies the artery accompanied by two veins; on its ulnar side, the ulnar nerve (*n*).

PLATE V



Ligation of the Radial and the Ulnar Arteries

(*b*) **Above the wrist joint.**

1. *External incision* 3 centimeters in length along the tendinous radial margin of the *flexor carpi ulnaris* (ulnaris internus), which is inserted into the pisiform bone.

2. Careful division of the superficial layer of the *deep fascia* of the forearm (Fig. 474).

3. The artery, accompanied by two veins, lies between the tendon of the *flexor carpi ulnaris* (*f*) and the tendon of the *flexor sublimis digitorum* (*a*), which lie in most cases toward the ulnar side.

On its ulnar side lies the *nervus ulnaris volaris* (*n*).

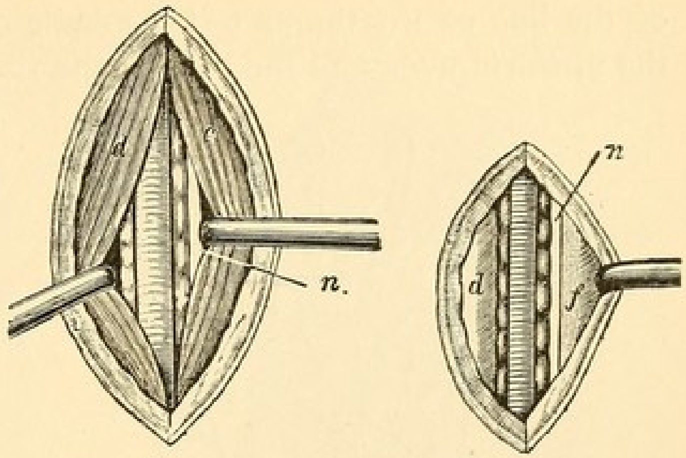


Fig. 473 Fig. 474
Ligation of the Ulnar Artery

SUPERFICIAL PALMAR ARCH

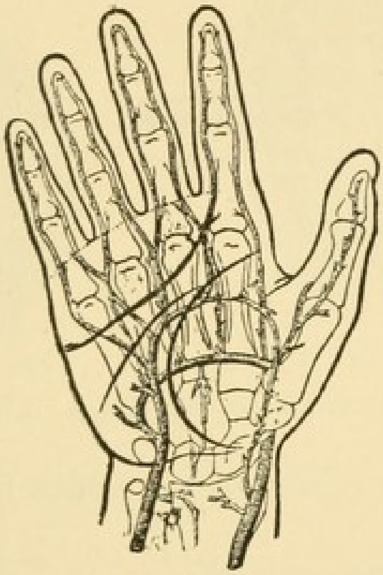
The superficial palmar arch, the anastomosis of the superficial branch of the ulnar artery with the volar branch of the radial artery, lies under the palmar fascia and courses below the middle transverse palmar fold, surrounded by two smaller veins. Under it lies the median nerve and its anastomosis with the ulnar nerve and the palmar bursa on the ulnar side (Fig. 475).

LIGATION OF THE SUPERFICIAL PALMAR ARCH

Longitudinal incision from the place of union of the thenar eminence and hypothenar eminence to the fourth finger (*Kocher*, Plate V. 5). Beneath the crossing of this incision with the middle transverse fold of the skin the artery is felt, which, after division of the adipose tissue and the palmar fascia, appears to view. If it is not found here, the strong ulnar branch on the pisiform bone can be ligated.

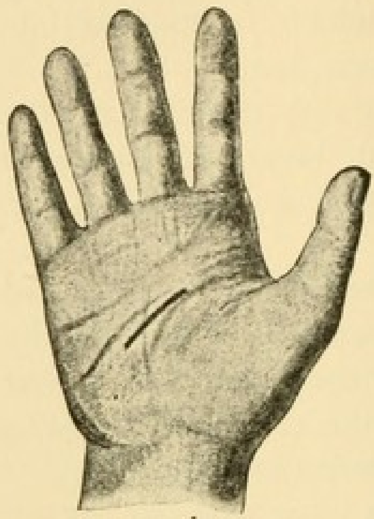
According to *Böckel*, the *arch* is found by means of a *transverse incision* in the middle of the palm, *i.e.* in the centre of a line drawn from the web of the greatly hyperextended thumb obliquely across the palm and the middle palmar fold (Fig. 476).

Vogt makes a *curved incision* from the limit of the middle and lower third of the line of the thumb to the middle of the communicating line between the pisiform bone and the base of the ring finger.



a

FIG. 475



b

FIG. 476

SUPERFICIAL PALMAR ARCH. *a*, topography; *b*, external incision

In injuries of the **deep volar arch**, which, on account of its deep position, can be isolated and ligated only with difficulty, hemorrhage is best arrested by firm tamponing.

AORTA, ILIAC, AND FEMORAL ARTERIES

The *abdominal aorta*, descending along the anterior surface of the vertebral column a little more *to the left*, near the vena cava, divides at the level of the lower margin of the fourth lumbar vertebra into the *common iliac arteries*, descending on both sides of the fifth lumbar vertebra along the inner margin of the psoas muscle covered by the peritoneum, only loosely connected with it to the sacro-iliac synchondrosis, where they divide into the hypogastric artery (internal iliac) and the external iliac artery. The *common iliac vein* lies *on the left to the inner side, on the right behind* the artery (Fig. 477). The *ureter* passes obliquely from without inward over the bifurcation of the common iliac artery.

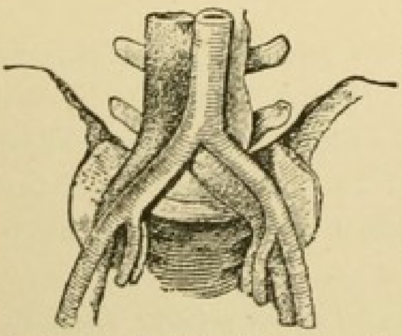
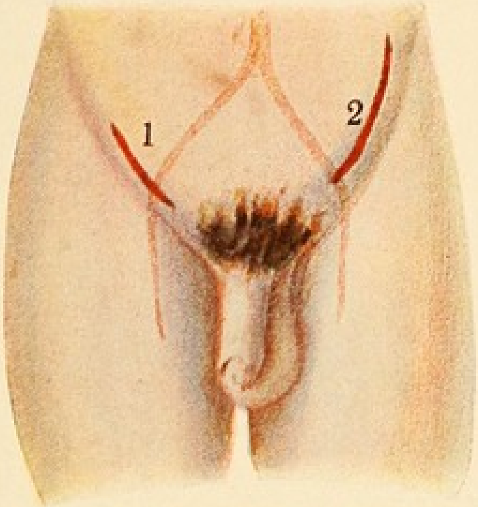


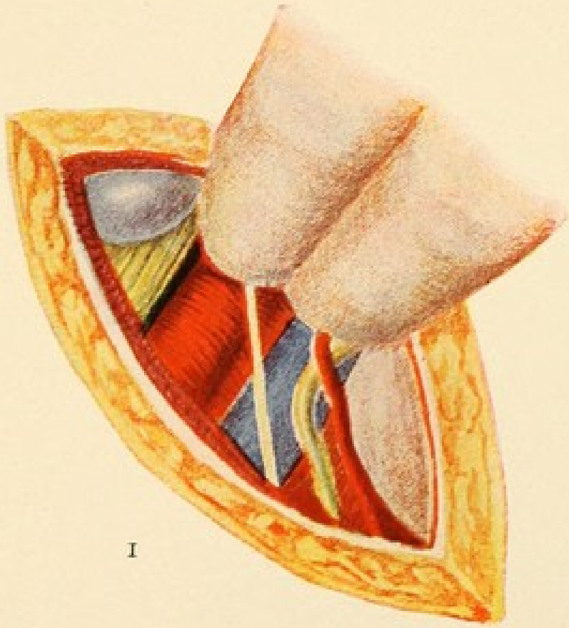
FIG. 477. ILIAC ARTERIES AND VEINS

PLATE VI



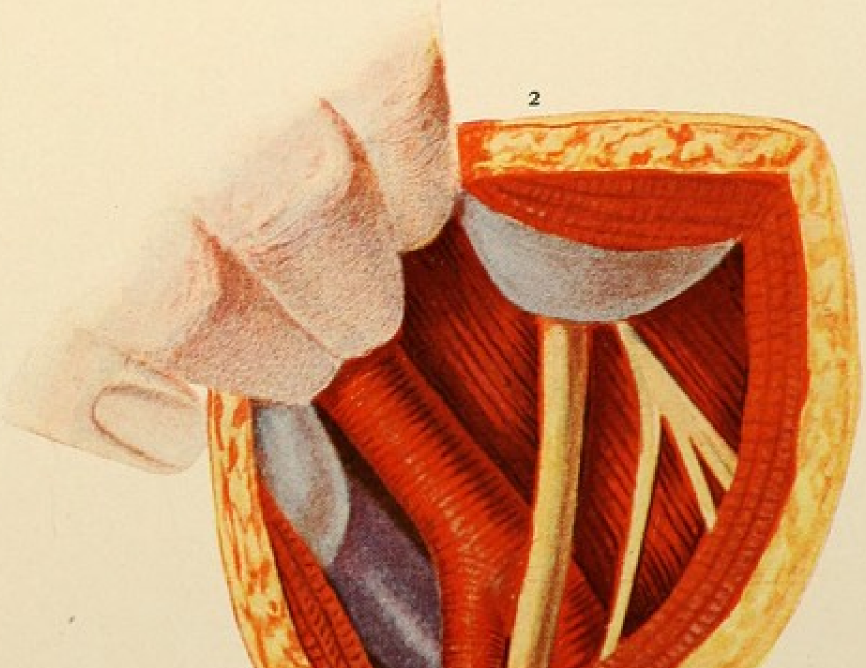
External Incisions. 1, External Iliac Artery. 2, Common and Internal Iliac Arteries

1



Ligation of the External Iliac Artery

2



Ligation of the Common Iliac and the External Iliac Artery

The *internal iliac artery*, the trunk of which is only 2 to 4 centimeters in length, descends obliquely in an anterior direction in front of the sacro-iliac synchondrosis and into the true pelvis.

The *external iliac artery* takes its course obliquely outward upon the iliac fascia covering the psoas muscle to the groin, covered on its anterior and internal side by the parietal peritoneum and crossed by the *spermatic vessels*. The lumbar nerves take a lateral course.

The *femoral artery* begins at the middle of *Poupart's* ligament, and passes to the lower end of the middle third of the thigh, along its anterior and internal side in an almost straight line drawn from the middle of Poupart's ligament to the epicondylus internus femoris; in the upper third of the thigh lies the artery, with the vein of the same name on its inner side traversing *Scarpa's triangle*, bounded on the outside by the sartorious muscle, on the inside by the adductor longus. At the lower end of Scarpa's triangle it gives off a large branch, the *deep femoral artery* (profunda). In the middle of the thigh the femoral artery lies upon the vein beneath the sartorious muscle, between the vastus internus and the adductor magnus muscle, perforates next the insertion of this muscle (*Hunter's canal*), in which behind the long saphenus nerve it enters on the posterior surface of the thigh the popliteal space.

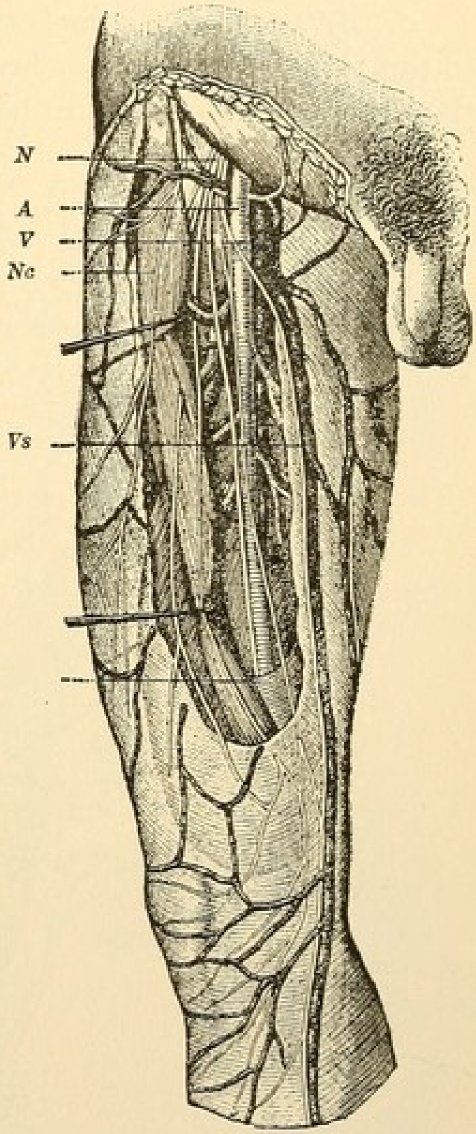


FIG. 478. TOPOGRAPHY OF FEMORAL ARTERY

LIGATION OF THE ABDOMINAL AORTA BELOW THE RENAL ARTERIES

(*a*) *Extraperitoneally* (*Maas*, *Murray*).

1. *External incision* along the anterior margin of the *left quadratus lumborum*, from the last rib to the crest of the ilium.

2. After division of the *abdominal muscles* and the *transversalis fascia*, the wound is drawn apart with blunt retractors, so far that the *retroperitoneal* space can be inspected below the kidney and the aorta can be exposed.

(*b*) *Transperitoneally* (*Cooper*, *von Nussbaum*).

1. *External incision*, 15 to 20 centimeters in length, in the linea alba, as in *laparotomy*.

2. *After the abdominal cavity has been opened*, the intestines are displaced to the right, the posterior layer of the parietal peritoneum is incised over the artery, which then can be easily reached; next, the aorta is ligated.

LIGATION OF THE COMMON AND INTERNAL ILIAC ARTERIES

(Plate VI. 2)

1. *External incision*, 10 to 12 centimeters in length, beginning 3 centimeters inward and downward from the anterior superior spine of the ilium and ascending in a slightly concave curve vertically and near to the last rib.

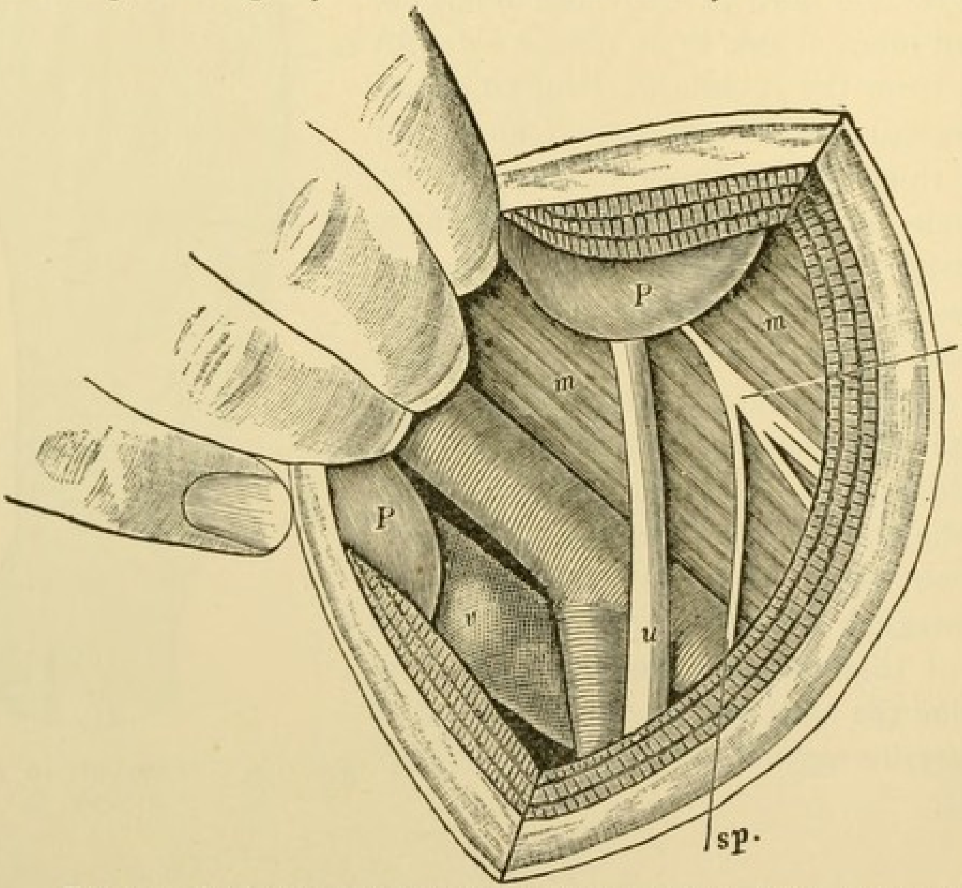


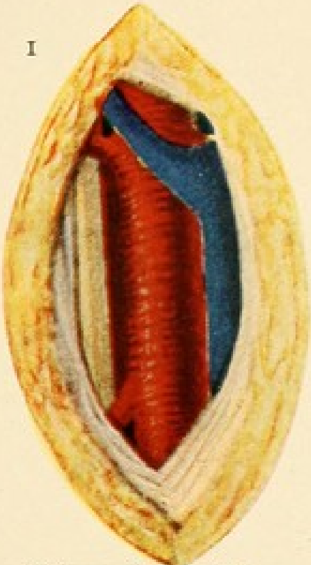
FIG. 479. LIGATION OF THE COMMON AND INTERNAL ILIAC ARTERIES

2. *Division of the fatty layer* of the thin *superficial fascia* of the *muscular layer of the obliquus externus*, the *obliquus internus*, the horizontal fibres of the *transversalis* and the thin *transversalis fascia*, until the *peritoneum* is exposed.

3. The *peritoneum* (*p*) is carefully pushed *inward toward the umbilicus*, and, *with the fingers*, drawn toward the internal margin of the wound (Fig. 479).

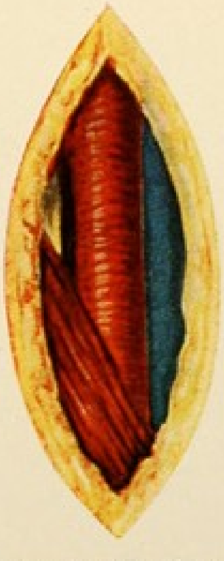
PLATE VII

1

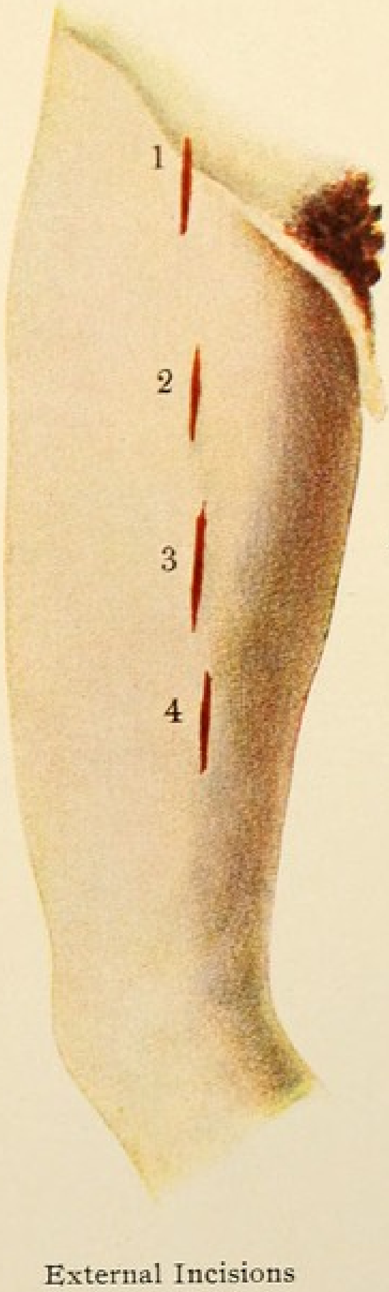


Below Poupart's Ligament

2

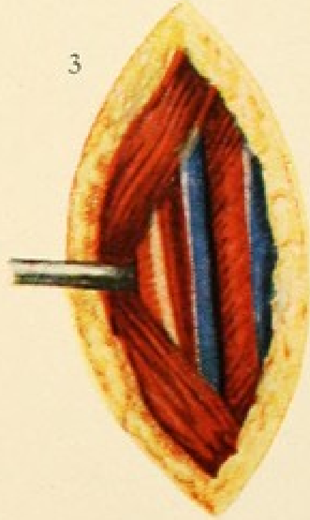


Below the Profunda Femoris Artery



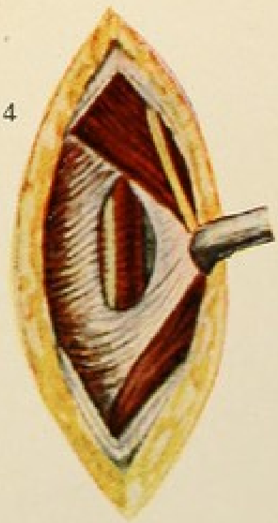
External Incisions

3



At the middle of the thigh behind the Sartorius

4



At the orifice at the lower end of Hunter's canal

Ligation of the Femoral Artery

4. The *ureter* (*u*) usually remains in contact with the peritoneum, else it is seen coursing together with the external spermatic nerve (*sp*) obliquely across the bifurcation of the common iliac artery. Care must be taken not to injure it.

5. The *whole common iliac artery* is now exposed at the internal margin of the iliopsoas muscle (*m*) from the aorta to its bifurcation. The iliac vein lies to the left on its inner side; on the right it lies behind the artery.

For ligating **the internal iliac artery**, draw the external iliac artery and the common iliac vein inward; carry the needle from within around the trunk of the internal iliac artery. On account of the great depth of the operating wound and the extensive detachment of the peritoneum, it is better to expose this artery by means of laparotomy ("transperitoneally" in pelvic high position). The external incision extends, then, either toward the median line in the linea alba, or along the outer border of the rectus.

LIGATION OF THE SUPERIOR GLUTEAL ARTERY

(Plate VIII. 1)

1. *External incision* obliquely across the gluteal in a line between the *posterior superior spine of the ilium* and the *great trochanter* (Fig. 480).

2. After *division of the fascia* and the fibres of the *gluteus maximus*, the lower border of the *gluteus medius* is exposed and drawn *upward*.

3. Along the upper margin of the *greater sciatic notch* above the *pyriformis*, the artery is found at the side of the *superior gluteal nerve*.

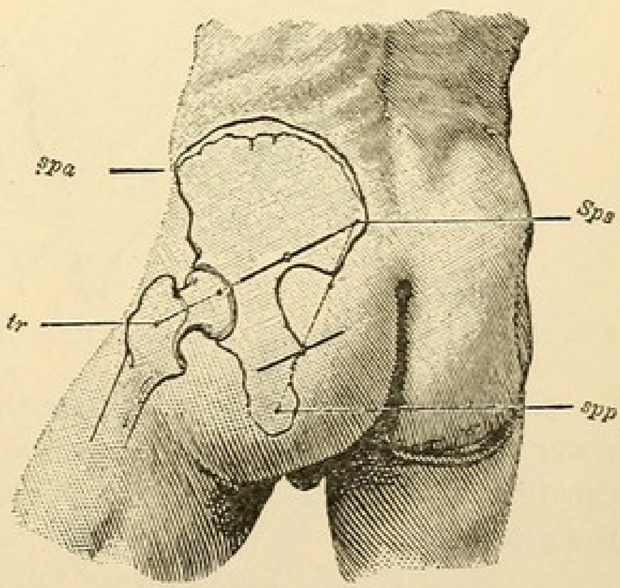


FIG. 480. LIGATION OF THE SUPERIOR GLUTEAL AND OF THE SCIATIC ARTERY

LIGATION OF THE SCIATIC ARTERY

(Plate VIII. 2)

1. *External incision*, 8 to 10 centimeters in length, from the *posterior inferior* spine of the ilium to the outer margin of the *tuberosity of the ischium*.

2. After division of the *fascia* and the fibres of the *gluteus maximus*, the pyriform muscle and the great *sacrosciatic ligament* are exposed.

3. The artery is found on the *inner* border of the *pyriform* muscle after its exit from the inferior margin of the *sciatic notch.*

LIGATION OF THE EXTERNAL ILIAC ARTERY

(Plate VI. 1)

1. *External incision,* 1 centimeter above Poupart's ligament and parallel to the same, 8 to 10 centimeters in length, *begins* in a *flat convex* manner, 3 centimeters inward from the anterior superior spine, and *ends* over the internal inguinal ring (*without* exposing it and the spermatic cord).

2. *Division of the fatty layer* of the thin *superficial fascia,* of the strong tendinous *aponeurosis of the obliquus externus,* next the *muscular fibres of the obliquus internus;* next the horizontal *muscular fibres of the transversalis abdominis* in the external angle of the wound (Fig. 481).

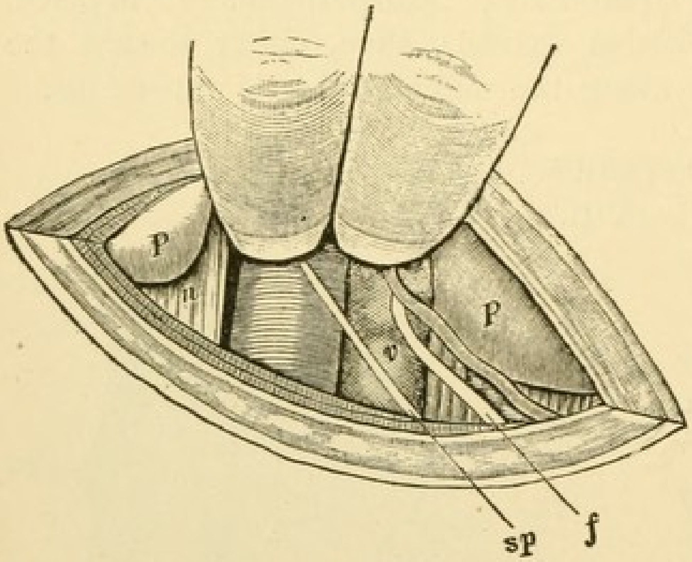


FIG. 481. LIGATION OF THE EXTERNAL ILIAC ARTERY

3. Careful division of the thin *transversalis fascia,* followed in the corpulent by still another thin layer of fat.

4. The *peritoneum* (*p*) must be pushed carefully *toward the umbilicus* with the fingers bent like a retractor (without stripping the *iliac fascia* and the larger vessels from the pelvic wall!).

5. The *artery* lies on the *inner* border of the iliopsoas muscle; on its *inner side* the vein (*v*), on its *external side* the crural nerve (*n*), covered by the iliac fascia. The *external spermatic nerve* (*sp*) passes obliquely across the artery.

LIGATION OF THE FEMORAL ARTERY

(Plate VII. 1–4)

(*a*) **Under Poupart's ligament.**

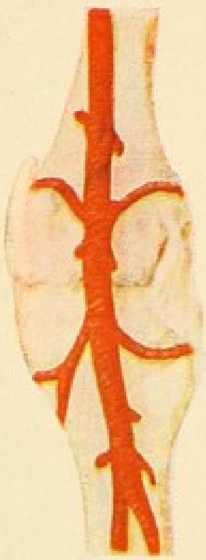
1. The *external incision* begins in the *middle between the anterior superior spine* and the *symphysis,* 2 millimeters above Poupart's ligament, and is extended 5 centimeters downward.

2. *Division of the superficial fascia.*

3. *Division of the fatty layer; removal of the lymphatic glands,* either by drawing them aside or by extirpating them.

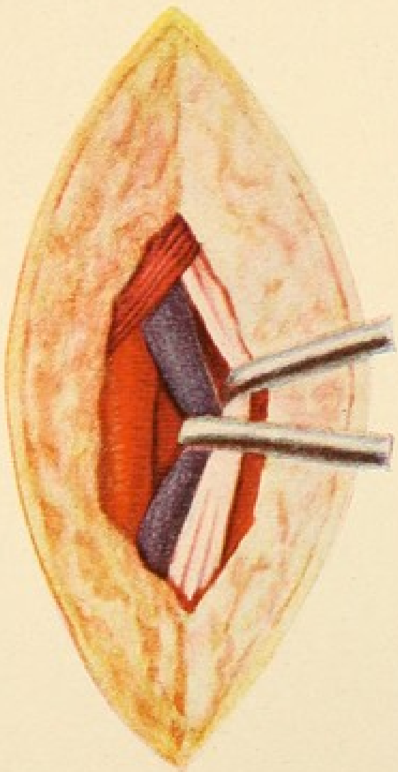
4. *Division of the fascia lata.*

PLATE VIII



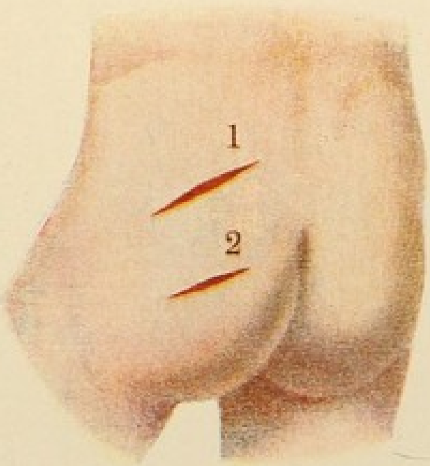
Artery

External Incision



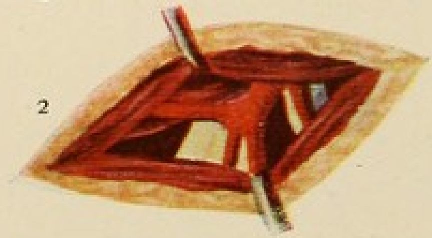
Ligation

Ligation of the Popliteal Artery



External Incisions

Ligation of the Gluteal Artery



Ligation of the Sciatic Artery

Ligation of the Superior and Inferior Gluteal Arteries

5. *Division of the sheath of the vessel,* 1 centimeter *below* Poupart's ligament (*l*) (because the deep circumflex iliac artery (*ac*) and the deep epigastric artery (*ae*) branch off *directly* under it — Fig. 482).

6. The *femoral vein* (*v*) lies *inside,* the *crural nerve* (*n*) *outside, of the artery.*

(*b*) **Below the profunda femoris artery** (*at the inferior point of the trigonum ilio femorale,* Scarpa's triangle).

1. *External incision,* 5 centimeters in length along the internal margin of the sartorius muscle, commences six fingers' breadth (8 to 10 centimeters) below Poupart's ligament (Fig. 172, 2).

2. The border of the *sartorius muscle* (*s*) is *exposed* and drawn *outward.*

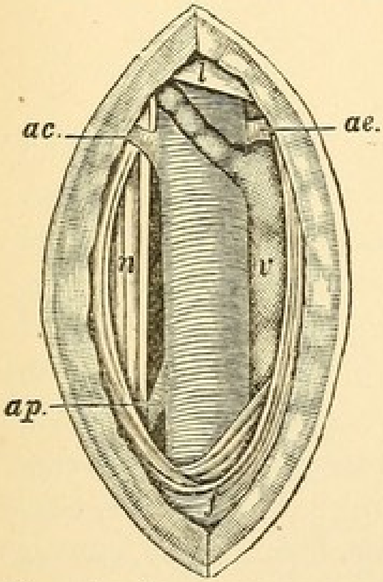


FIG. 482. LIGATION OF THE FEMORAL ARTERY UNDER POUPART'S LIGAMENT

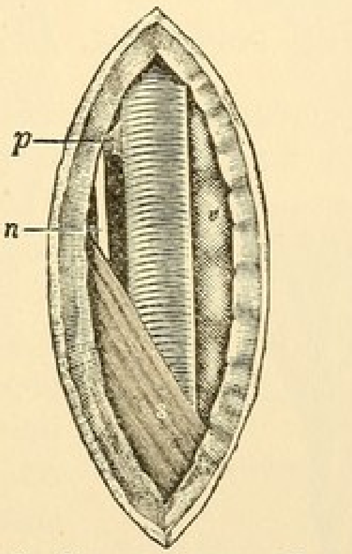


FIG. 483. LIGATION OF THE FEMORAL ARTERY BELOW THE PROFUNDA FEMORIS ARTERY

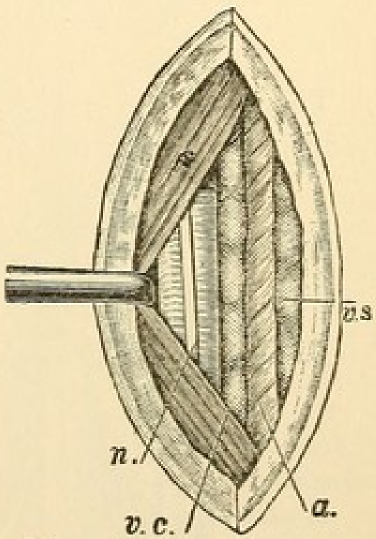


FIG. 484. LIGATION OF THE FEMORAL ARTERY IN THE MIDDLE OF THE THIGH

3. *Opening of the sheath of the vessel.* The *femoral vein* (*v*) lies to the *inner side* and somewhat *behind* the artery; the *femoral nerve* (*n*) on the *outer side* (Fig. 483).

(*c*) **In the middle of the thigh** (*behind the sartorius*).

1. *Skin incision* 8 to 10 centimeters long *down to the sartorius* in the *middle* of a line drawn *from the anterior superior spine to the internal condyle of the femur.*

2. *The sheath of the sartorius is divided.* The muscle (*s*) is *freed* and *drawn outward,* until the *posterior wall of the sheath of the muscle* appears to view, which covers the vessels.

3. After the sheath has been opened, the *artery* is exposed. The *saphenus nerve* passes over it (*n*); the *femoral vein* is behind it (*vc*). The *saphenus vein* (*vs*) lies superficially and more inwardly (Fig. 484).

(*d*) **At the orifice at the lower end of Hunter's Canal.**

1. *External incision* 10 centimeters long at the beginning of the lower third of the thigh, flexed at the hip and knee, and abducted at the *outer* border of the sartorius muscle (long saphenus vein!).

2. *Division of fascia.* The *sartorius muscle* is drawn *inward; under it* lies, on the inner surface of the internal vastus muscle, the white shining tendinous band of the *abductor magnus* muscle (cover of Hunter's canal).

3. Division of the tendons on a grooved director *from below.* The artery appears to view (rather close to the bone), *inwardly and behind it* the vein; *above it lies the internal saphenus nerve.*

THE POPLITEAL ARTERY

The *popliteal artery* occupies the middle of the popliteal space surrounded by adipose tissue, usually a little *toward* the inner side of the *middle line.* The popliteal vein and the tibial nerve lie on its *outer side* (Fig. 485). Along the upper border of the soleus muscle, often in the popliteal space, the artery divides into the *anterior* and *posterior tibial arteries.* The former, covered by the soleus muscle, *crosses the interosseous ligament* in a line drawn between the external condyle of the tibia and the first intermetatarsal space, on the anterior side of the leg downward between the tibialis anticus and the flexor communis digitorum. At the *ankle joint* it lies between the tendons of the tibialis anticus and the extensor hallucis. It passes then as the *dorsalis pedis artery* along the dorsum of the foot between the tendons of the extensor hallucis longus and brevis obliquely in the space between the first two metatarsal bones.

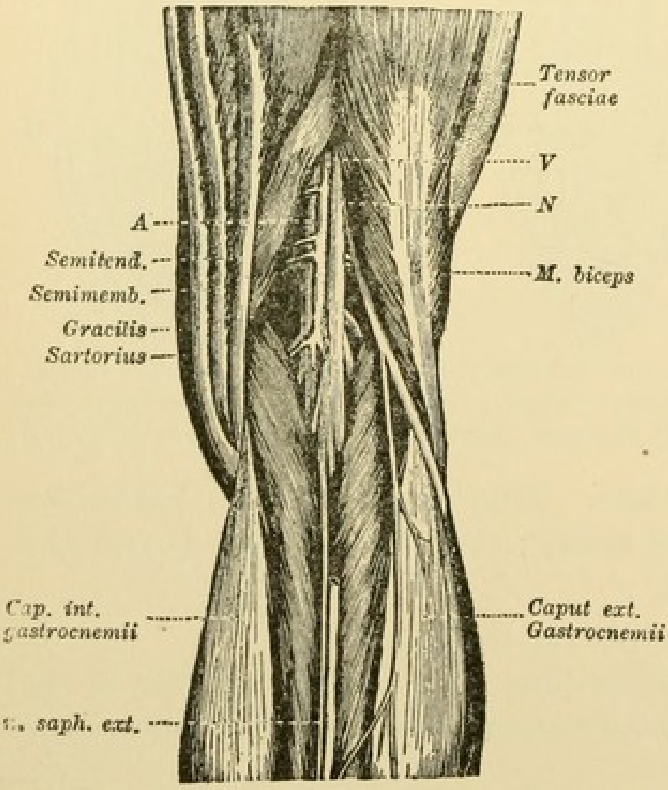
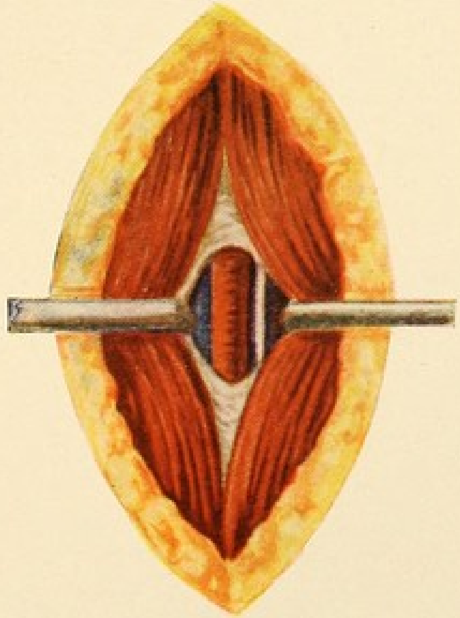


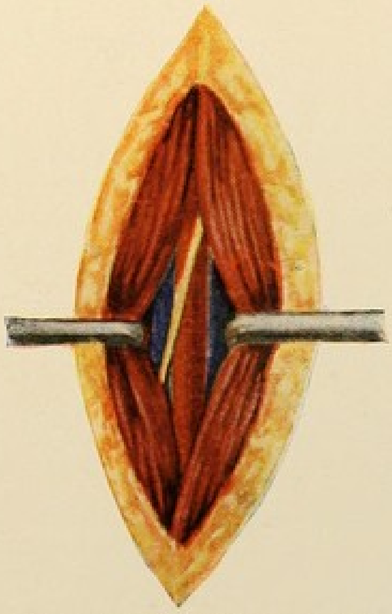
FIG. 485. TOPOGRAPHY OF THE RIGHT POPLITEAL SPACE

The larger *posterior tibial artery* passes along the inner side of the leg, covered by the peroneus muscles, between the tibialis posticus and the flexor

PLATE IX



Ligation above the middle
of the leg



Ligation at the lower third
of the leg

Ligation of the Anterior Tibial Artery

longus digitorum. It is accompanied by two veins; the tibial nerve takes its course along its external side. Behind the internal malleolus the artery lies superficially under the integument and fascia, between the accompanying veins and beneath the plantar nerve.

LIGATION OF THE POPLITEAL ARTERY

(Plate VIII)

1. *External incision* 8 centimeters in length along the *external* border of the semi-membranosus, down through the whole popliteal space.

2. *Division of the thick adipose layer*, until the *tibial nerve* appears to view (Fig. 486).

3. The *tibial nerve* (*n*) is drawn in a lateral direction; behind it and a little toward the median lies the *popliteal vein* (*v*), which is freed and drawn somewhat aside; behind the vein and a little toward the median lies the *artery*.

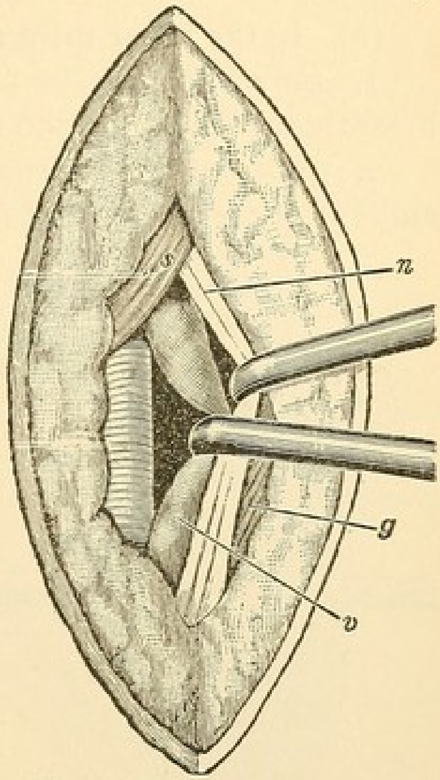


Fig. 486. Ligation of the Popliteal Artery

LIGATION OF THE ANTERIOR TIBIAL ARTERY

(Plate IX)

(*a*) **Above the middle of the leg** (Plate IX. 1).

1. *External incision* 6 to 8 centimeters in length, 3 centimeters outward from the crest of the tibia (in the middle between the tibia and the fibula).

2. *Division of the fascia* in the direction of the tendinous white line, which indicates the space *between the tibialis anticus* (*ta*) and the *extensor hallucis longus muscles* (*eh*). This intermuscular space is *sought for* and *enlarged* with the *point of the index finger*, until the deep fascia is reached (Fig. 487).

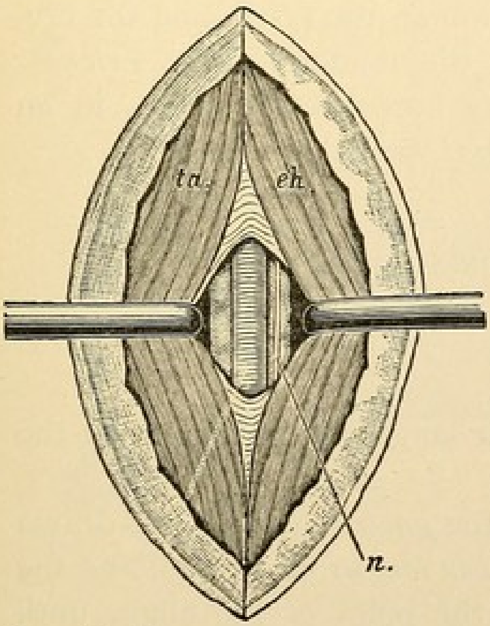


Fig. 487. Ligation of the Anterior Tibial Artery above the Middle of the Leg

3. After a careful *division of the deep*

fascia, the artery is exposed between the two accompanying veins; on its *outer side* lies the *anterior tibial nerve* (*n*).

(*b*). **In the lower third of the leg** (Plate IX. 2).

1. *External incision* 5 to 6 centimeters in length, vertical, a finger's breadth outward from the crest of the tibia.

2. *Division of the fascia.* In the space *between the tibialis anticus* (*ta*) and the *extensor hallucis longus* (*eh*), the index finger is inserted, and by upward and downward strokes separates the bellies of the muscles as far as the interosseous membrane (2 to 3 centimeters deep) (Fig. 488).

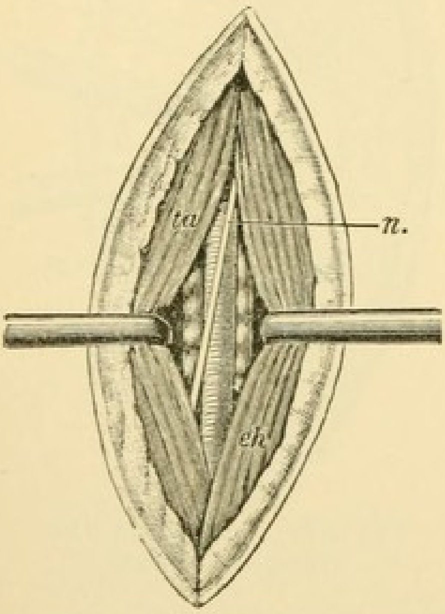


Fig. 488. Ligation of the Anterior Tibial Artery in the Lower Third of the Leg

3. On this lies the *artery* between two veins, accompanied in front and on the inside by the deep branch of the *anterior tibial nerve* (*n*).

(*c*) **On the dorsum of the foot** (**Dorsal artery of the foot**) (Plate IX. 3).

1. *External incision* 4 centimeters long closely at the outer border of the tendon of the extensor longus hallucis from the scaphoid bone downward.

2. The musculo-cutaneous nerve is drawn outward. Division of the fascia and the cruciate ligament; the tendon of the *extensor hallucis* is drawn *inward;* the artery appears between two veins, in an inward direction and upon it the *anterior tibial nerve.*

LIGATION OF THE POSTERIOR TIBIAL ARTERY

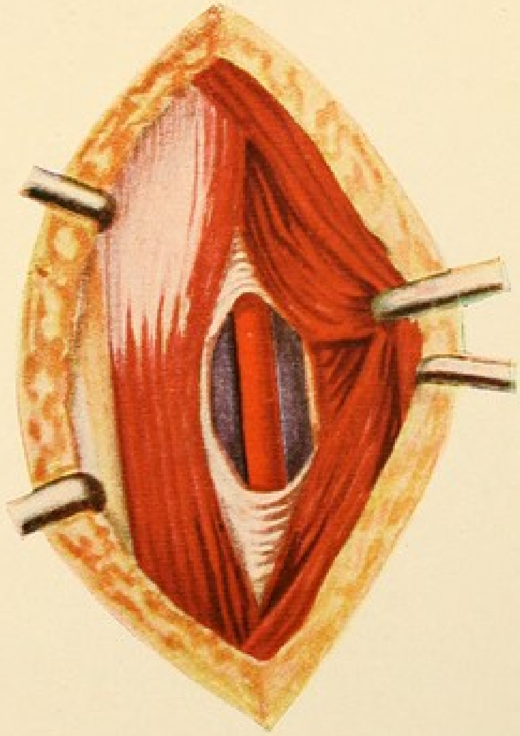
(Plate X)

a. **Above the middle of the leg** (Plate X. 1).

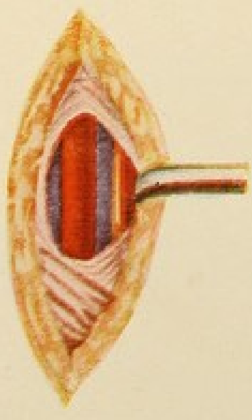
1. *External incision* 8 to 10 centimeters in length, 1 centimeter to the inner side of the internal border of the tibia.

2. *After division of the fascia*, the border of the *gastrocnemius* (*g*) is drawn *backward;* the *soleus* is separated from the *flexor longus digitorum*, and the space between these muscles is enlarged with the point of the finger until the *deep aponeurosis* is reached, which consists of the tendinous fibres of the soleus and the deep fascia of the leg.

PLATE X



Above the middle
of the leg



Behind the Internal
Malleolus

Ligation of the Posterior Tibial Artery

3. After *division* of this *aponeurosis*, the *artery* appears between two veins; under it lies the *tibial nerve* (*n*).

b. **Behind the internal malleolus** (Plate X. 2).

1. *External incision* 3 to 4 centimeters in length in the *middle* between the *internal malleolus* and the *tendon of Achilles*.

2. *Division of the sural fascia* (*f*), strengthened by the fibres of the *ligamentum laciniatum* (Fig. 490, l).

3. Directly *beneath* lies the *artery* between the two accompanying veins, behind it the *tibial nerve* (*n*). The *sheaths of the tendons* of the *tibialis posticus*, of the *flexor longus digitorum*, and the *flexor longus hallucis* must not be opened.

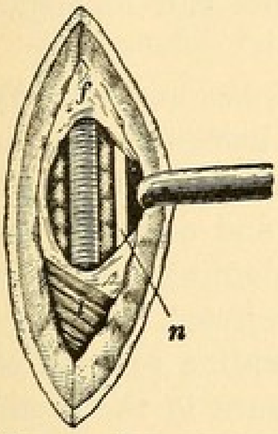


Fig. 490. Ligation of the Posterior Tibial Artery behind the Internal Malleolus

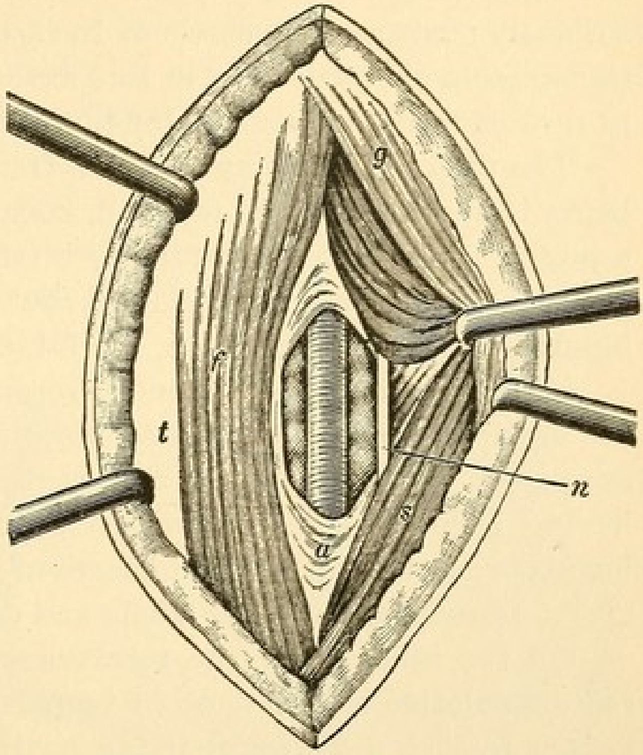


Fig. 489. Ligation of the Posterior Tibial Artery above the Middle of the Leg

TRANSFUSION AND INFUSION

After a sudden great loss of blood from injuries or from long-continued bloody operations, especially in weak patients, the arterial blood pressure, on account of the defective filling of the blood vessels, soon sinks to such a degree that the heart is no longer able to propel the contents of the vascular system.

It acts like an empty pump, without producing any effect, and hence **death ensues from excessive hemorrhage** at a time when there still remains in the vessels a sufficient quantity of blood for the preservation of life.

It is, therefore, of importance to fill the vascular system sufficiently to enable the heart to perform its function effectually.

The **direct transfusion of blood** from the artery of a healthy human being into the vein of a person who is bleeding to death fills the arteries again, and thus saves life. Unfortunately, however, in doing this it is not possible, in the conducting canula, to prevent absolutely the formation of coagula, which seriously obstruct the vessels of the patient receiving the blood. Moreover, the surgeon succeeds only in rare cases in obtaining a willing, healthy person to furnish the blood supply for the purpose of saving the life of another.

The direct transfusion of blood from *an animal* into the veins of a human being is absolutely to be rejected, because by mixing various kinds of blood a poison is formed, which rapidly dissolves the red and the white corpuscles, and causes not only coagulation, but also hemoglobinæmia and hemoglobinuria, which, in most cases, are fatal.

Moreover, according to more recent investigations (*Köhler* and others), the *transfusion of* **defibrinated blood** even from human beings is just as dangerous, because during the beating of the blood, the fibrin ferment, having been set free, produces coagula in the circulation and dissolves the blood corpuscles (ferment intoxication, *Köhler*). Hence, according to modern views, **transfusion of blood whole and defibrinated is to be rejected.**

On the other hand, the **intravenous infusion of an alkaline solution of sodium chloride** is sufficient in increasing the blood pressure in the blood vessels to such a degree that the heart can again propel the blood column and convey nutrient material to the organs (*Kronecker*). The sodium chloride solution is prepared as follows: Dissolve 7 grams of pure salt in one liter of sterilized water; add three drops of a solution of soda or one gram of sodium carbonate. *Landerer* (*Ludwig*) adds to this 3% to 5% of sugar, which best preserves the blood corpuscles, and serves as a nutrient material; the blood pressure is rapidly raised by an active endosmosis.

In performing the operation, a subcutaneous **vein** (for example, the median basilic vein at the bend of the elbow, or the great saphenous vein in front of the internal malleolus) is *exposed* by incising a fold of skin, and isolating it to such an extent that *two catgut ligatures* can be passed under it.

With *one* ligature, the peripheral side of the portion of the vein is *ligated;* the other ligature is pushed under the central part.

The exposed vein is *opened;* the upper wall is lifted with fine tenaculum forceps, and an oblique incision is made with the scissors, so that a small flap wound results (Fig. 491).

By raising the flap, the vein is made to gape, and into the central end of the vein a *canula*, rounded at its point (of glass, hardened caoutchouc, or silver), is introduced and securely tied with the second catgut ligature.

The canula and the rubber tube fastened to it, together with the hard rubber tip, are completely filled with the sodium chloride solution, and closed by means of a stopcock.

For pouring in the sodium solution, either a glass funnel or a graduated glass cylinder (Fig. 492), of the capacity of 300 to 400 fluid grams, is used, terminating below in a perforated olive-shaped point, over which a rubber tube 30 centimeters long is drawn. To the lower end of the latter a small perforated attachment of hardened caoutchouc or glass is fastened, which fits exactly into the connecting piece.

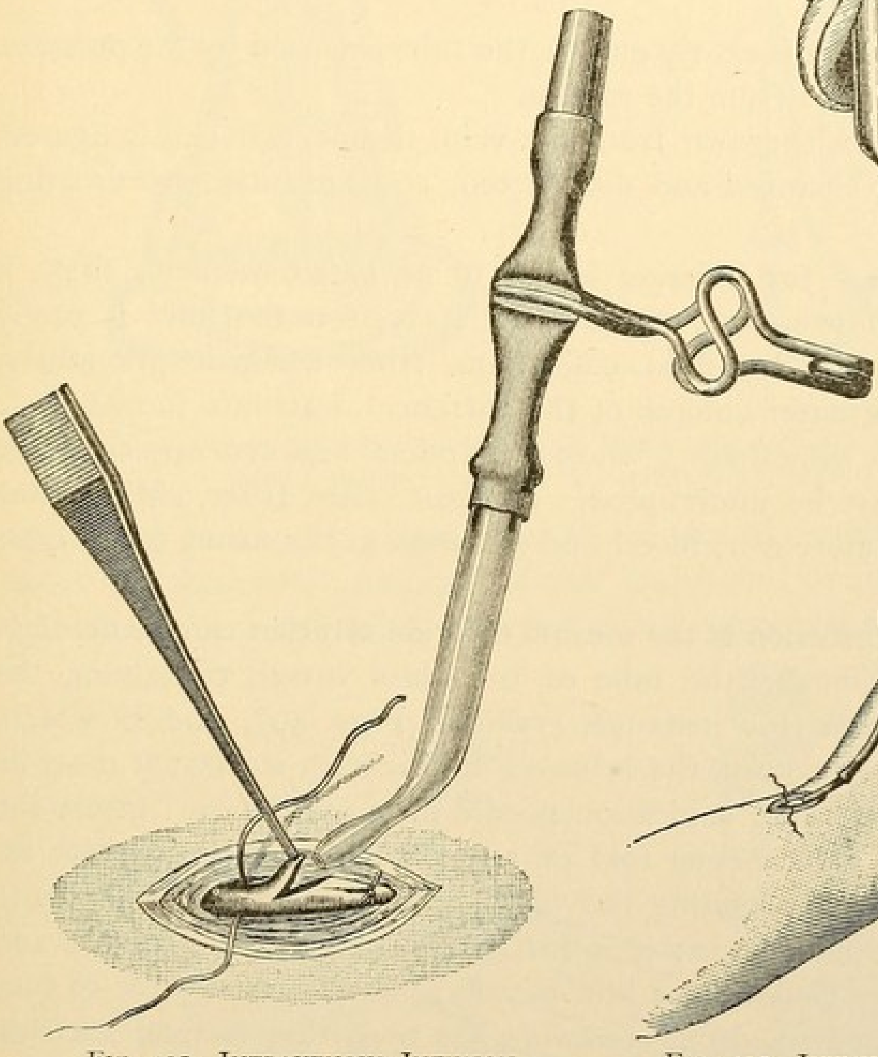


FIG. 491. INTRAVENOUS INFUSION INTRODUCING THE CANULA

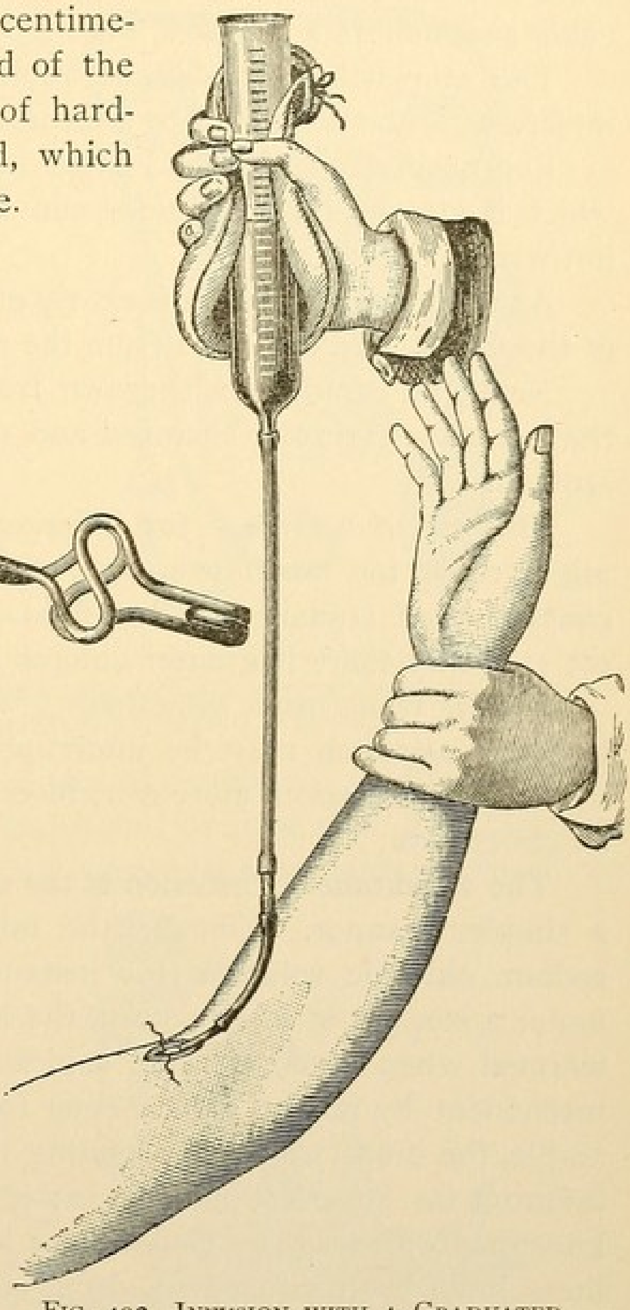


FIG. 492. INFUSION WITH A GRADUATED GLASS CYLINDER

After the vessel has been most carefully cleansed and sterilized, it is filled with the chloride of sodium solution heated to 40° C.; the end of the tube is lowered until the fluid escapes, and securely inserted into the canula.

After all air bubbles have been removed from the tube by pressing and stroking it upward, the operator raises the glass cylinder with one hand about half a meter high (corresponding to the blood pressure in the veins), and with the other hand opens the stopcock to such an extent that the column of water is seen to enter the vein *very slowly* (at the rate of 10 cubic centimeters a second).

The stopcock can also be removed entirely, and the rapidity of the injection can be regulated by raising and lowering the glass cylinder.

For preventing the fluid from cooling during the injection, the hand which holds the glass cylinder can hold against it a rubber bag filled with hot water (Fig. 492).

As soon as the cylinder is nearly empty, the tube is closed by the pressure of the finger, and detached from the canula.

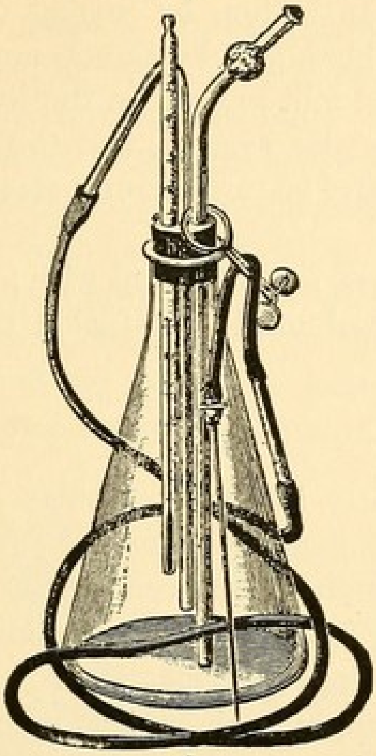
Next, the canula is withdrawn from the vein, the central end is ligated, the wound is carefully cleansed and disinfected, and an antiseptic dressing applied.

The use of a *syringe* for infusion is not to be recommended; first: it might cause too much pressure; second: by its piston the fluid is easily contaminated (rancid oil, dry fluid collections from using it previously, etc.); third: there is greater danger of the entrance of air into the vein.

During transfusion sometimes cyanosis, dyspnœa, and syncope occur, so that the operation must be interrupted. In most cases, fever, chills, pains in the lumbar region, moreover, blood and albumen in the urine, occur *after its* conclusion.

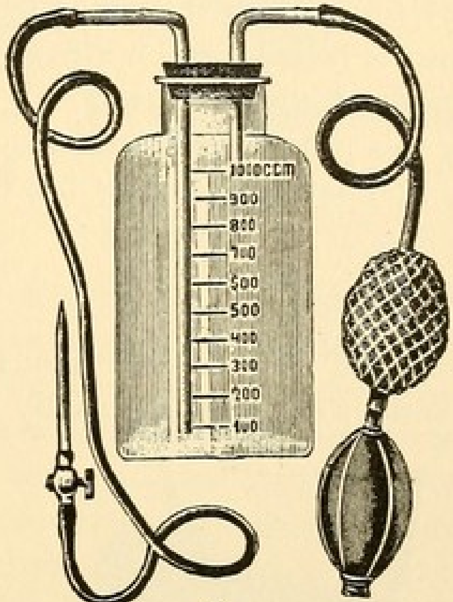
The **subcutaneous infusion of the sodium chloride solution** can be made in a simpler manner. Connect the tube of the glass vessel, containing the sodium chloride solution (for instance, syringes, Figs. 493, 494, in which, under a stopper of loose cotton, the infusion fluid is kept sterile; it must be warmed when used), with an aspiration needle or a fine trocar; insert the instrument by raising a cutaneous fold on any portion of the body (for example, the breast), and by elevating the vessel, allow the fluid very slowly to infiltrate the loose cellular tissue; it is further distributed by pressure and kneeding (effleurage). Generally a liter is sufficient, still even three to four liters have been infused (*Sahli*). *Cantani* has used this method successfully as a **hypodermoclysma** in the inspissation of blood causing desiccation in the algid stage of cholera; likewise it has proved successful in extensive burns, carbonic oxide poisoning (after previous venesection), also after prolonged laparotomies; but the *intravenous infusion* produces a better effect even in this case.

If the hemorrhage has not been so great that life is in immediate danger, but if only great weakness and syncope exist, an attempt is made to



a

Fig. 493



b

Fig. 494

Syringe Bottles for Subcutaneous Infusion. *a*, Sahli's apparatus with hollow needle and thermometer; *b*, Fürbringer's apparatus with trocar

revive the patient by placing him in the dorsal recumbent position with the head low to prevent anæmia of the brain, and by means of administering stimulants (smelling salts, camphor, ether, alcoholic stimulants) to rouse the

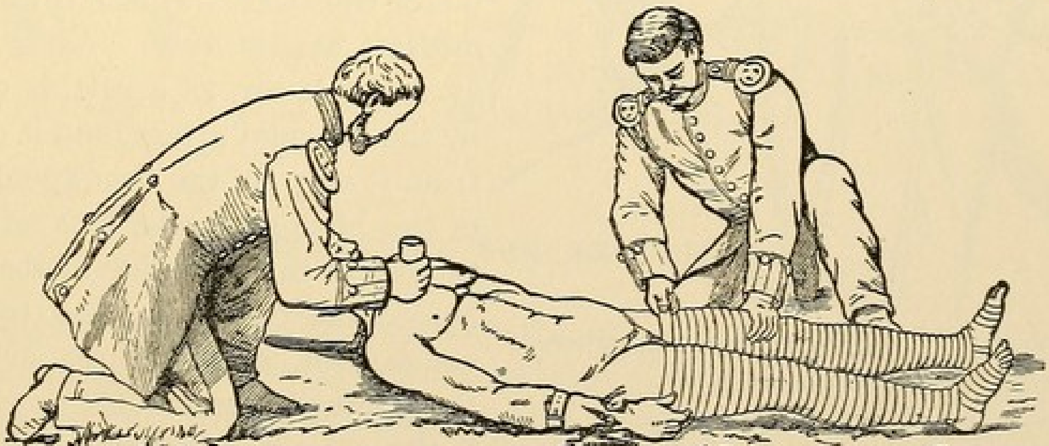


Fig. 495. Autotransfusion

cardiac function; the external applications of dry heat (hot bottles, blankets) to counteract the lowering of the body temperature should never be neglected, and large quantities of liquid nourishment, which is very rapidly absorbed, will prove valuable in increasing the contents of the vascular system. The latter is also effected by autotransfusion, by raising one or more limbs, or by rendering them temporarily bloodless by elastic constriction in the manner described before. The blood still present in the limbs is thereby forced into the other parts of the vascular system, and the blood pressure is raised to such a degree that the heart is capable of performing its function (**autotransfusion**, Fig. 495).

By this procedure, transfusion can sometimes be dispensed with; sometimes, at least, the ebbing life can be sustained until transfusion can be made.

BLEEDING

was resorted to in former times very frequently in the treatment of the most various diseases, especially in combating inflammation and in subduing congestion in different parts of the body. For this purpose, aside from puncturing, scarifications, leeches, and cupping, there was employed **venesection** (*phlebotomy*), which is now but rarely (œdema pulmonum pneumonia) performed.

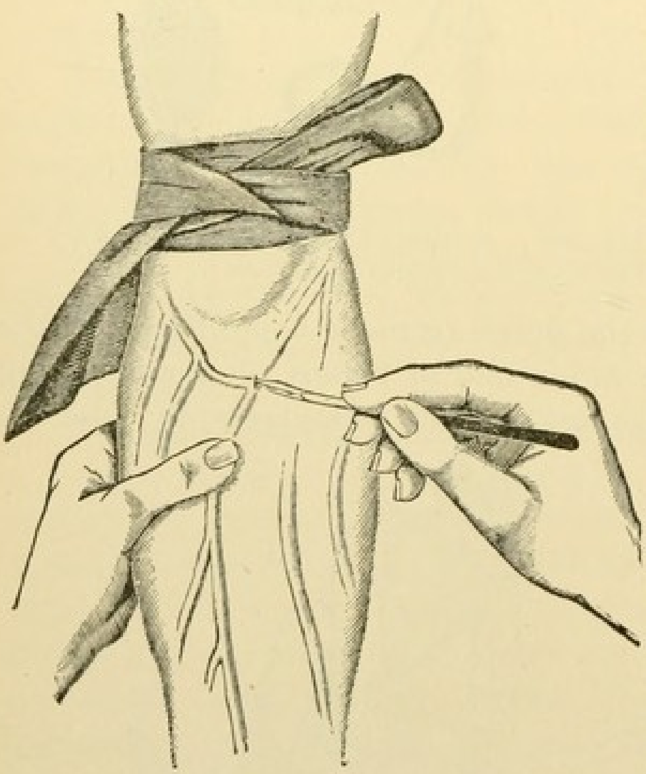


Fig. 496. Bleeding with the Phlebotome (Phlebotomy)

The operation is made exclusively **on the arm** and on that vein which is most distinctly prominent under the skin. This is mostly the **median basilic vein.** Since, however, the latter, as a rule, is crossed by the brachial artery, and is divided from it only by the thin aponeurosis of the biceps muscle, it is advisable to feel for the pulsation of the artery before the operation, and to make venesection either above or below the point of crossing.

1. The patient lies on his back with the arm in a hanging position in order that the veins may become distended with blood.
2. A bandage (or a folded cloth) is placed around the middle of the arm with sufficient firmness so that the return flow of the venous blood becomes

arrested, but not the afferent flow of the arterial blood (the radial pulse must not disappear); the knot of the bandage must be arranged in such a manner that it can be loosened by making traction on the end which hangs down (Fig. 496). The surgeon fixes the arm by forcing his hand between it and the breast; the vein is fixed by pressure of his thumb below the place of puncture.

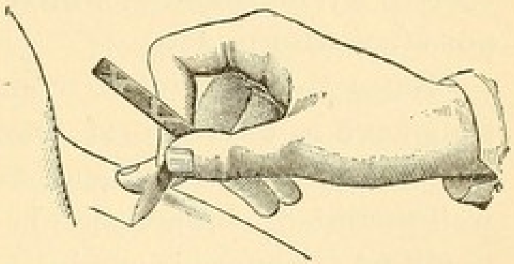


Fig. 497. Bleeding with the Lancet

3. With a lancet (Fig. 497), or better with *Lorinser's* phlebotome (Fig. 496), an *incision* is made through the skin into the vein, and the first cut is enlarged sufficiently by raising the point of the phlebotome to divide the anterior wall of the vein about 5 centimeters in an **oblique** direction.

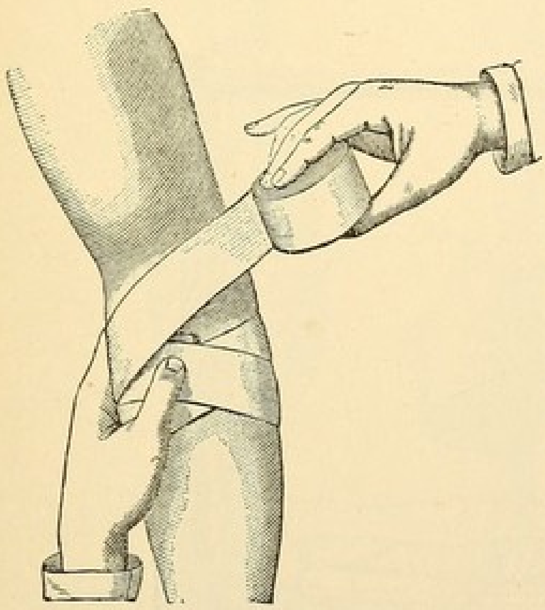


Fig. 498. Dressing after Bleeding

4. The blood must flow in a *free jet.* If the flow intermits because the wound, having been made too small, has become obstructed or was displaced under the skin (diffuse hæmatoma), it can be increased by alternate opening and closing of the hand.

5. When a sufficient quantity of blood has been abstracted, the constriction bandage is removed, the skin wound is somewhat displaced above the vein with the thumb; a small antiseptic compress is applied, and fastened by a figure-of-8 bandage, with the forearm slightly flexed (Fig. 498).

OPERATION FOR ANEURISMS

Fusiform or saclike dilatations of the wall of an artery occur in consequence of injuries or disease of the arteries. In a few rare cases they may heal of their own accord without surgical interference. In this case laminated coagula are deposited in the interior of the pouch, which are finally changed into a firm swelling, which gradually contracts. This condition is aimed at by all methods which endeavor to effect artificially **coagulation of the blood** in the aneurism.

1. By a **temporary lessening of the arterial current** :—

(*a*) By digital compression upon the proximal side of the artery involved (see p. 235).

(*b*) By *tourniquets*, which have been mentioned especially for this purpose (see also p. 239).

Since the continuous compression with the finger, whereby several persons have to alternate at fixed intervals, day and night, is very tedious and troublesome for the patient, and since the tourniquets in most cases are not well tolerated, compression is replaced, especially on the *femoral artery*, in popliteal aneurism occurring so frequently, by the more practical —

(*c*) *Pole pressure* (*von Esmarch*).

A long pole, crutch, or broomhandle, propped against the ceiling or a bedpost (Fig. 499), is applied, with its lower end carefully wrapped with

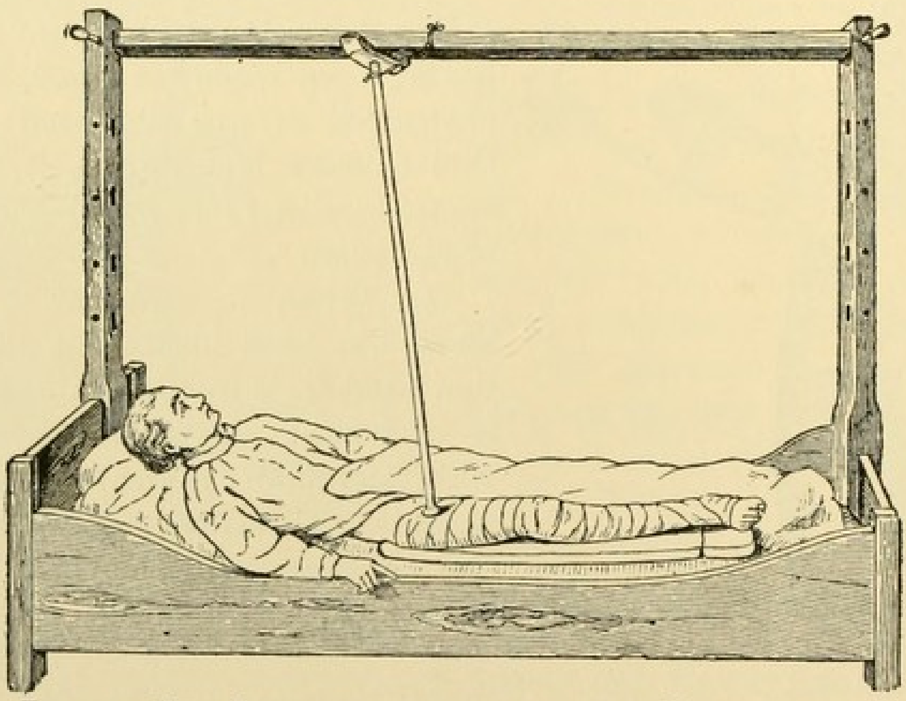


FIG. 499. POLE PRESSURE FOR COMPRESSING THE FEMORAL ARTERY IN POPLITEAL ANEURISM

some soft material, upon the trunk of the artery of the leg, which is wrapped with a bandage, and rotated outward. If the pressure is not well tolerated in one place it is changed to another. In most cases the patient himself learns in a short time to regulate the pressure correctly, especially when the points of pressure are marked by India ink.

By this simple method a considerable number of even large popliteal aneurisms have been healed.

2. By **arresting the circulation** (*Reid*).

The limb is encircled with an elastic bandage close to the swelling; the same is left free, and the bandaging is continued above the swelling.

Simpler still is the treatment by elastic constriction above the aneurism. The constrictor should be applied as often as possible in the daytime; it can remain in position almost an hour uninterruptedly. Before the constrictor is removed the limb, according to recent methods, must be again bandaged loosely with an elastic bandage to prevent subsequent hyperæmia after the constriction has been removed (*Billroth*).

3. **Ligation of the artery** in modern times is the safest procedure and the one most frequently employed.

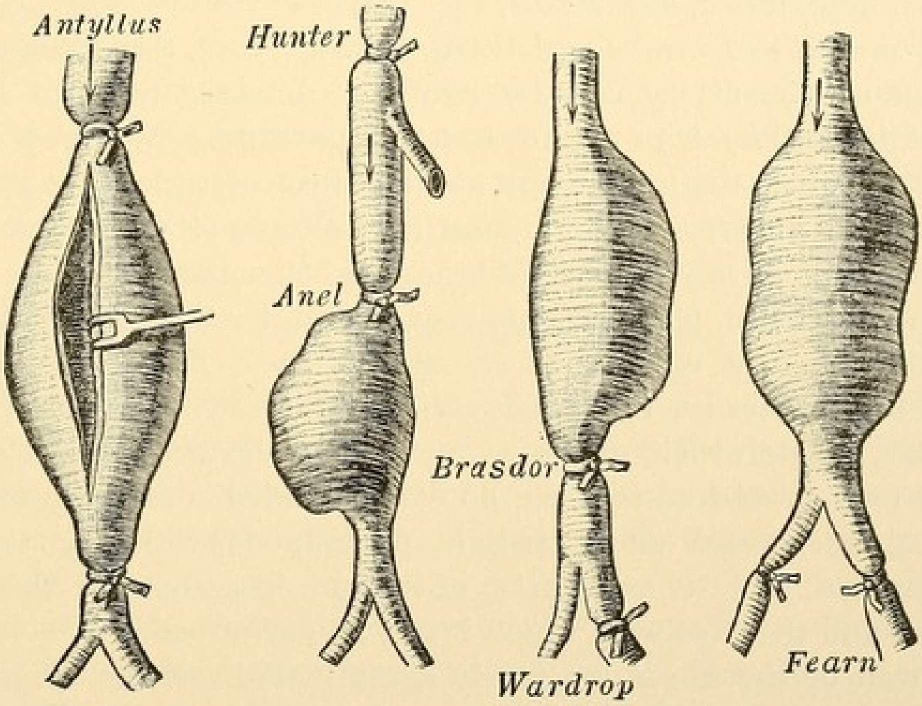


FIG. 500 FIG. 501 FIG. 502 FIG. 503

LIGATION OF THE ARTERY IN ANEURISMS

(*a*) *According to Antyllus* (Fig. 500). He exposed the aneurism in its whole extent by a longitudinal incision, ligated the artery closely **above and below** the aneurism, divided the sac, cleaned out its contents, and tamponed the wound. His contemporary, *Philagrius*, went still farther by **excising** the aneurism after double ligation.

(*b*) *According to Anel and Hunter* (Fig. 501).

The **afferent** central end of the artery is ligated either *closely* above the sac (*Anel*) or more distant from it at some easily accessible place (*at the place of selection — Hunter*), owing to the fear that the ligature would cut its way through the diseased wall of the artery near the aneurism, and thereby incur the risk of secondary hemorrhage. Since, however, with the more elastic catgut — the material now usually employed — this danger is no longer to be apprehended, the ligature, as closely above the sac as possible, is preferable on account of the greater probability that the circulation in the aneurism is not restored by collateral vessels. Moreover, some time after ligation of the afferent artery, when the aneurism has been decreased only moderately, the longitudinal division of the sac can be made. In that case remove all coagula and apply a compressive bandage for several weeks (*Mikulicz*).

If it is not possible to ligate the central part, for instance, in aneurisms of the aorta, innominate, subclavian, etc., then —

(*c*) According to *Brasdor and Wardrop* (Fig. 502), the **efferent** peripheral portion of the artery can be ligated. Brasdor tried to ligate the efferent portion as *closely* to the aneurism as possible. Wardrop contented himself with ligating the main trunk at an easily accessible place at a *greater* distance, thereby effecting a diminution in the force of the arterial current. *Fearn* ligated successively all efferent branches below the aneurism (Fig. 503).

A large experience, however, has proved that healing by ligation is obtained with certainty only after *all afferent and efferent* branches have been ligated. Otherwise the aneurism nearly always remains permeable through the collateral circulation which is established in a short time. Hence, the only procedure that can be recommended is the very old method of *Antyllus*, performed under aseptic precautions with the aid of the bloodless method, and the **extirpation of the sac**, on account of the certainty of the result and the ease with which it can be performed.

If the wall of the sac is too firmly agglutinated with its neighborhood, *partial resection* is sufficient (especially in the neighborhood of a vein) after double ligation ; this is made with catgut, because silk thread cuts through the thin vascular wall ; the wound is *tamponed* to prevent secondary hemorrhages. Sometimes grangrene of the peripheral section of the limb occurs if a sufficient collateral circulation has not been developed. To prepare this, so to say, it is advisable in all cases, where the operation (on account of inflammation, perforation, and others) is not urgent, to use for a few days previously the compression method (finger or pole pressure).

In aneurism of the leg, pole pressure should be first tried, and, if it fails, extirpation should be made.

The numerous methods formerly employed to effect **direct coagulation** in the aneurism (injection of ferric chloride, fibrin ferment, ergotin, alcohol, tannin, solution of subacetate of lead, wax, moreover filipuncture, introduction of needles, watchsprings, magnesium wire, silkworm, gut, horse hair, catgut threads) are dangerous to life, and should justly be abandoned. **Acupuncture** and **electropuncture**, however, are praised by several as having proved successful. Having arrested the circulation by applying the elastic band, *Macewen* inserted an acupuncture needle into the aneurism, and moved it to and fro, whereby gradual coagulation of the contents of the sac occurred. If the needle is connected with an electric battery of 20–30 ampères (anode in the aneurism, cathode plate on the chest), the contents of the sac, by the galvanic current, coagulate after several applications.

Lancereaux and other Frenchmen report a very good success with the injection of a **gelatine solution** (2 grams gelatine : 100 grams physiological sodium chloride solution). This solution increases the coagulability of the blood. It is injected into the sac or its immediate neighborhood (*Laborde*), but can also be infused *subcutaneously* (250 grams of a 2% solution at the highest, every 10 to 14 days, into the vascular region). Still, even with this method fatal cases have occurred (*Huchard*).

OPERATION FOR VARICES

Extensive dilatations of the walls of the veins (varices), which involve especially the veins of the leg in the course of the long saphenous vein, cause great inconvenience to the patient (muscular spasms, eczema, phlebitis, ulcers); and, by a sudden rupture of their wall, which is often very thin, cause violent hemorrhages.

In milder cases, some improvement of the condition, or at least some alleviation, is effected by *bandaging the leg* with a flannel or elastic bandage (elastic stocking). (Bandages of pure rubber are harmful, as they frequently produce maceration of the epidermis and eczema by retention of the secretions of the skin. The ideal bandage for such cases is the rubber webbing bandage, which is much cheaper and more effective than the elastic silk stocking.) Likewise, the *varix bandage of Landerer*, a pad or compress, which is fastened over the inside of the leg upon the vein below the knee joint, forms, so to say, an artificial valve of the vein and sometimes renders good service.

In the more aggravated forms of varices, and in those cases where pressure upon the trunk of the saphenous vein, after the veins have been made bloodless by elevation of the limb, prevents the blood from again filling the varices immediately, the best method of treatment is —

LIGATION OF THE LONG SAPHENOUS VEIN (*Trendelenburg*)

1. External incision 3 centimeters in length over the inner side of the thigh about the junction of the middle with the lower third; the vein at this point is almost subcutaneous (see also Fig. 504).

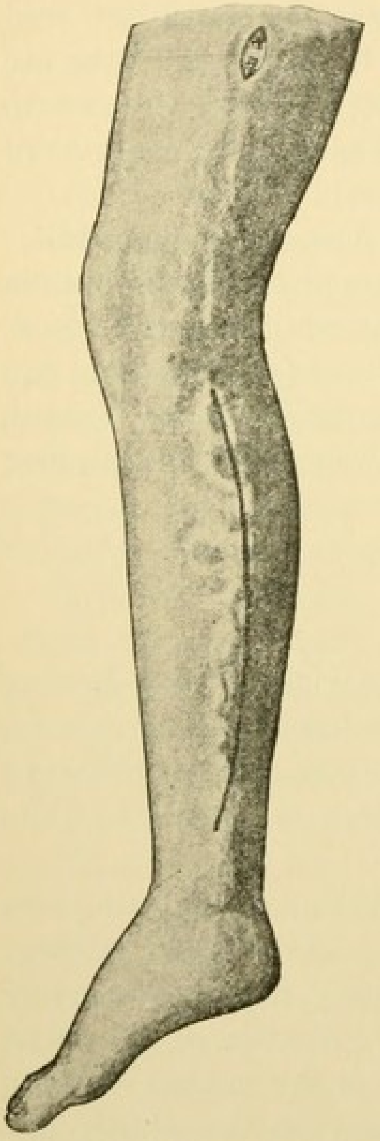


FIG. 504. LIGATION OF THE LONG SAPHENOUS VEIN

2. With the handle of the knife or a blunt hook, the vein is isolated to the extent of about 2 centimeters, and a double catgut ligature is carried around it with an aneurism needle.

3. The leg is then raised vertically to empty the vein; the ligatures are then tied and the vein divided between them.

4. The little skin wound is sutured throughout.

After the ligation, the whole peripheral section of the vein becomes thrombosed, and contracts in the course of time into thin cords.

The **obliteration** *of the diseased veins* by a multiple division, that is to say, the excision of numerous small pieces, and by double ligation, by *percutaneous ligature*, and by compression of the walls with small pieces of rubber tube tied upon them (*Schede*) usually fail and are no longer used.

Tillmanns recommends ignipuncture, that is, puncturing with the needle thermocautery. For the ligation of all superficial veins *Petersen* makes a circular incision through the skin of the circumference of the limb, which he carefully sutures again after ligation of all lumina.

Instead of it, if the ligation of the saphenous vein, which can easily be made, should be followed by relapse, then

EXTIRPATION OF THE VARICES (*von Langenbeck, Madelung*)

is made as a radical operation.

1. In order to make the vein very prominent, the constriction bandage is applied around the thigh firmly but *slowly*, while the patient *is standing*.

2. A flap is formed by a curved incision along the whole length of the leg; after a careful dissection of this, all dilated veins are exposed (Fig. 504). In most cases this is very difficult, since the thin wall of the veins is easily nicked, resulting in the collapse of the veins through loss of blood. In making the dissection, the blade of the knife should always be directed somewhat toward the skin, and each vein wound should be closed at once with hemostatic forceps.

3. After the trunks have been doubly ligated in the upper portion of the wound, the varicose veins are enucleated, in part bluntly, in part with the knife; and after ligation of the lower ends of all lateral branches, they are excised.

4. The large wound of the skin is closed by careful suturing.

INJURIES OF THE WALLS OF THE BLOOD VESSELS

If a vessel is divided in its whole circumference or to a large extent by a transverse wound, it must be grasped with hemostatic forceps on *both sides* of the wound and ligated.

But if the injury involves only *one side* of the wall of the vessel, the opening can be closed without obliterating the permeability of the vessel. Smaller openings in the *venous wall* are grasped with the hemostatic forceps and a ligature is placed around it, which constricts the small cone of the wall of the vessel (**lateral ligature of the veins**). Since the latter, however, can be applied only in small wounds, and since, moreover, there is some danger of slipping of the ligature, for instance, on the jugular vein, during vomiting and coughing, it is better to close such openings in the vessels by the **continuous suture** (*Schede* 1882) (Fig. 505). In difficult extirpations of tumors of the neck, in the axilla, etc., an injury of the great veins often cannot be avoided, especially when the tumor is firmly attached to the wall of the vessel.

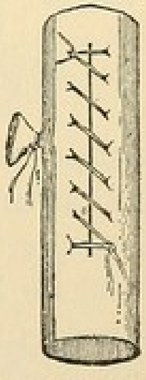


FIG. 505. LATERAL LIGATURE AND SUTURE OF BLOOD VESSEL.

While the vein is held compressed by the finger ligature loop, or hemostatic forceps above and below the wound, the longitudinal incision is united with fine catgut, or, still better, with the finest silk (*Tichow*), by a close continuous suture. The closure is safe; it is indifferent whether the wall of the vein is grasped in its whole thickness or whether the tunica is not perforated; hemorrhage from the needle punctures in consequence of the rapid swelling of the catgut does not occur, and the lumen of the vein remains permeable. In this manner, often the internal jugular vein, the subclavian vein, and recently even the inferior vena cava (*Schede*) have been sutured with the best success. Small wounds of large arteries can also be successfully closed by suturing. *Jassimowski* sutures them according to *Lembert's* method by protecting the tunica intima.

OPERATIONS ON THE TENDONS

(TENOTOMY)

Shortened tendons can be *elongated* by a transverse section, since the extravasated blood between the two retracted ends is changed in the course of healing into tough fibrous connective tissue.

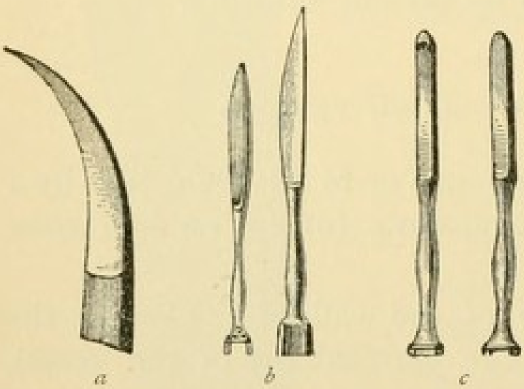


Fig. 506 Fig. 507 Fig. 508
TENOTOMES. *a*, Dieffenbach's; *b*, Stromeyer's pointed; *c*, blunt-pointed

(The extravasated blood is not converted into connective tissues, but serves the useful purpose of a temporary scaffolding for the granulations which project into it from the adjacent wound surfaces.)

The dangers of open wounds of tendons, which were very much feared in former times, were eliminated by **subcutaneous tenotomy**, which *Stromeyer* introduced in the year 1833. He used for this operation small narrow-pointed or blunt-pointed **tenotomes** (Figs. 506–508), which are inserted underneath the skin either above or below the tendon to be divided, with the blade lying flat, and are pushed forward until the point can be felt at the opposite margin of the tendon. While the assistant draws the tendon *as rigidly as possible*, the blade of the knife is raised perpendicularly to the tendon, and the latter is divided with easy, sawing movements, or by simple pressure with the tenotome (Fig. 509).

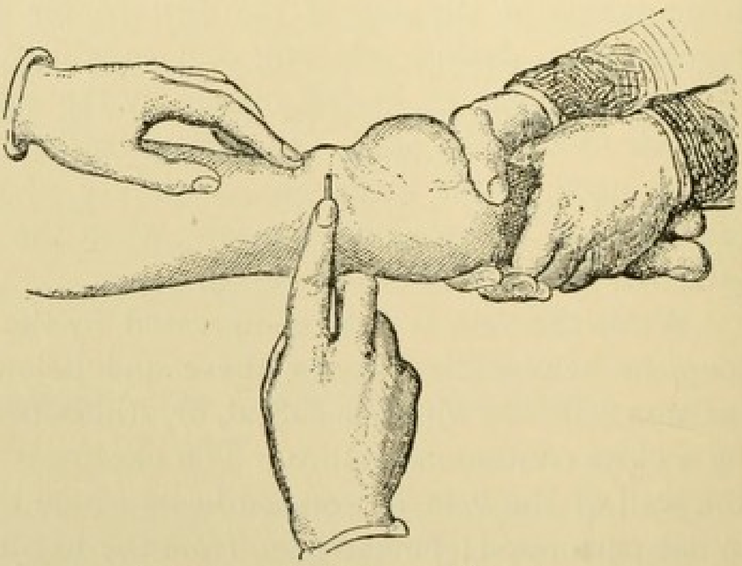


Fig. 509. SUBCUTANEOUS TENOTOMY

Since, however, in this "operation in the dark," the tendon is sometimes divided only incompletely and a few fibres remain in connection, which interfere with the intended elongation of the tendon, and since, moreover, by an unintentional injury of large vessels in the immediate neighborhood, a considerable hemorrhage may occur, in spite of all the advantages and rapidity of subcutaneous tenotomy, still, at the present time, under the protection of asepsis, it has become customary to make **open tenotomy** *after exposing the tendon or tendons* by a free incision.

The open operation is performed as follows: —

TENOTOMY OF THE TENDO ACHILLIS FOR CLUBFOOT

1. The foot is held in strong dorsal flexion; an external *incision* 2 centimeters in length is made *over the posterior side of the tendon*, and extended down to the white, shining tendinous tissue.

2. A strabismus hook or a curved probe is inserted from the side transversely underneath the tendon (Fig. 510); the instrument is carried through

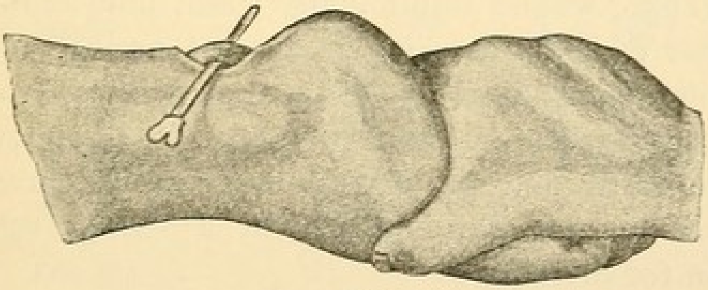


FIG. 510

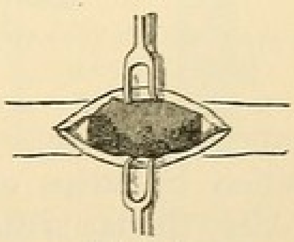


FIG. 511

OPEN TENOTOMY OF THE TENDON OF ACHILLES

as closely to the tendon as possible until it appears on the opposite side; all tissues lying on the probe are divided by slow sawing movements of the knife, after which the tendon ends retract considerably, and the foot can be flexed more freely in the dorsal direction (Fig. 511).

3. The little wound is closed by interrupted sutures. In applying the dressing, it is above all important that over the place of operation no harmful pressure should be made, — as, for instance, by the margin of a small bandage too firmly applied, — because the formation of an adequate coagulum would be impaired thereby. The foot must be bandaged with a *broad* bandage. After the healing of the wound, methodic passive movements to extend the foot may be begun gradually. Concerning the

extension of the tendon of Achilles (*Bayer*) in paralytic talibes equinus, see p. 296.

Phelps obtained in suitable cases the same result by dividing all tense resisting structures (tendons and soft parts) at the internal border *of the plantar side of the foot.*

1. After a previous tenotomy of the tendon of Achilles a transverse incision is made at the internal border of the foot, parallel to the astragalo-navicular articulation.

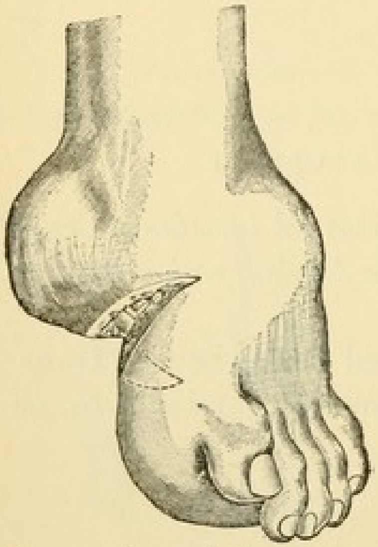


FIG. 512. PHELPS'S OPERATION FOR CLUBFOOT

2. Division of the plantar fascia, of the tendons of the flexor longus digitorum, of the flexor longus hallucis, of the abductor hallucis, and, if necessary, of the flexor brevis digitorum communis. These are drawn forward one after the other with a strabismus hook and divided (Fig. 512).

3. Sometimes the division of the deltoid ligament and the chiselling through of the neck of the astragalus are necessary.

4. The foot is placed in its normal position; the wide gaping wound is tamponed; and immediately a plaster of paris dressing is applied under which the wound must heal by granulation with a broad cicatrix. During the after treatment passive movements and massage are made daily, and the foot is kept in its correct position by strips of galvanum plaster, subsequently by a rubber tube.

Very similar is the operation for dividing contracted fascias (**fasciotomy**), for instance, of the plantar fascia on the inner side of the plantar surface of the foot or of the *palmar fascia* (*Dupuytren, contraction of fingers*, Fig. 513). Since, in the latter case, a recurrence after a simple division is the rule, it is better to expose the whole portion by a longitudinal incision, and to separate and excise the contracted fascia with all its processes from the skin and the underlying tissue (*Kocher*).

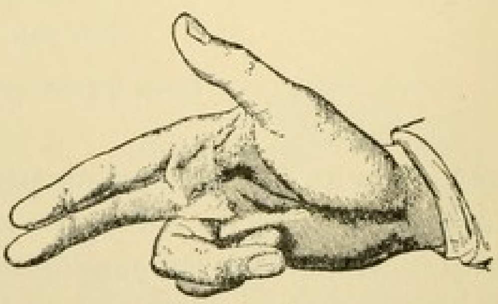


FIG. 513

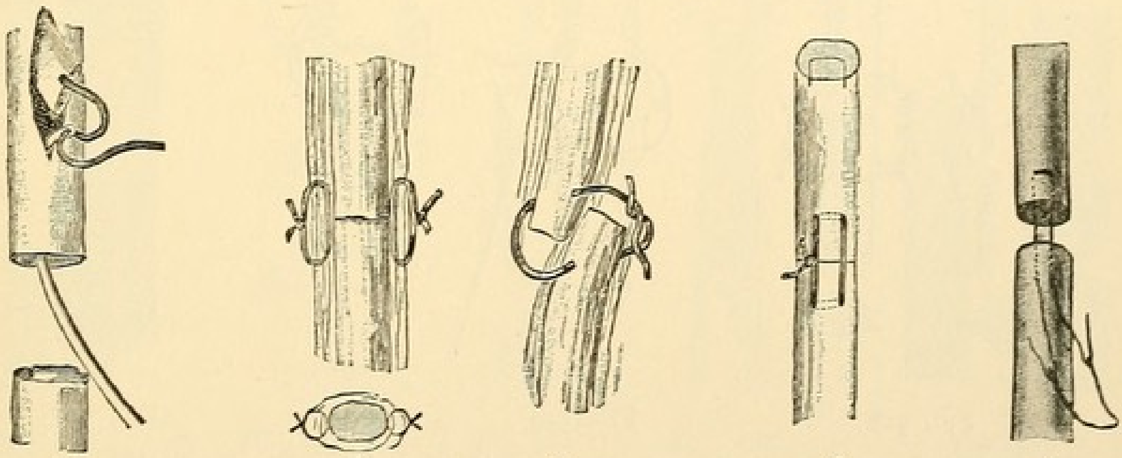
TENDINORRHAPHY

If a tendon has been divided transversely by an injury, its ends must be united again as soon as possible, or else the function of the corresponding muscle becomes seriously impaired, if not completely destroyed.

In recent wounds, the peripheral end can be easily found. The central muscular end, in most cases, however, has retracted into its sheath. It can be drawn forward by grasping it in its sheath with tenaculum forceps or a fine tenaculum; if this does not succeed after a faithful trial, the sheath must be carefully divided longitudinally, but not farther than is absolutely necessary.

To prevent unpleasant coalescence *Sédillot* recommended to make the necessary external incisions not directly over the tendon, but in a lateral direction from it.

Sometimes it is also beneficial to lengthen the contracted muscle by vigorous rubbing toward its periphery, or to force it out of its sheath by bandaging it with an elastic band from above. But if this, too, is not successful, the division of the sheath of the tendon may still be avoided by cutting a



a *b* *c* *d* *e*

FIG. 514 FIG. 515 FIG. 516 FIG. 517

TENDINORRAPHY. *a*, according to Madelung; *b*, *c*, Hueter's paratendinous suture; *d*, quilt suture; *e*, according to Kocher

buttonhole in the place where the tendinous stump can be felt; the tendon is then drawn forward, provided with a ligature, and drawn out of the transverse wound of the sheath by an eyed probe, introduced from the transverse wound. An aneurism needle can also be used for this purpose (*Madelung*, Fig. 514). If the two ends have been grasped in this way, they must be approximated as much as possible, and thus united by a suitable position of the limb (dorsal flexion in wounds on the extensor side, volar flexion in wounds on the flexor side).

If the tendon ends can be easily *pushed into lateral apposition* it is advisable to fasten them by their *lateral surfaces* (which are richer in vessels than the cut surfaces) (**paratendinous suture,** Fig. 515). In most cases, however, the surgeon must be content with approximating the *cut surfaces* by a few sutures which grasp the tendon itself.

The suturing should be done with strongly curved round or flat needles, bent at an angle (according to *Wolberg* and *Hagedorn*), which are carried through longitudinally to the tendon and parallel to its axis and fibres, to avoid injury to the fibres of the tendon. If the sutures cause great tension, a *tearing out* is to be feared in consequence of the parallel arrangement of the fibres. Hence, it is safer to unite the tendon ends with **quilt sutures** instead of the usual interrupted sutures (Fig. 516), or by passing the sutures several times transversely through the tendinous end. *Kocher* inserts a ligature with a needle at each end; the needles are inserted on both

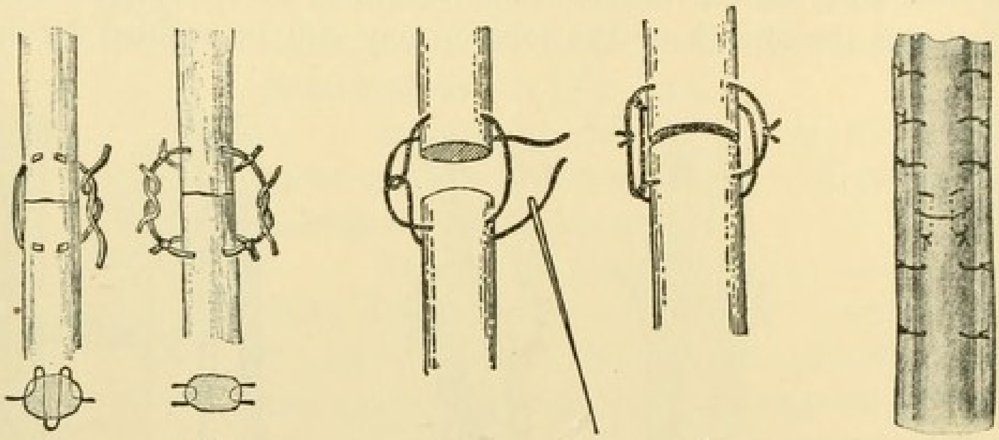


FIG. 518 FIG. 519 FIG. 520 FIG. 521

TENDINORRHAPHY. *a*, *b*, according to Wölfler; *c*, *d*, according to Trnka; *e*, according to Nebinger

sides of the tendon stumps, and are brought out parallel to the tendon fibres at the cut surface, inserted in the other stump in a reversed manner, and then tied together. Thereby a kind of quilt suture is formed similar to Fig. 517, the transverse suture of which lies superficially, the longitudinal buried. *Wölfler* applies an interrupted suture transversely on each tendinous end, and ties the ends of the knots on the corresponding sides (Fig. 518, *a*, *b*). In a similar manner proceeds *Witzel*. *Trnka's* suture can be seen from Figs. 519, 520. In order to *relieve* as much as possible the *tension* of the tendon suture, *marginal sutures* are applied according to *Nebinger*; these fasten the sutured tendon to the surrounding tissue. The interrupted as well as the continuous sutures may be used for this purpose (Fig. 521).

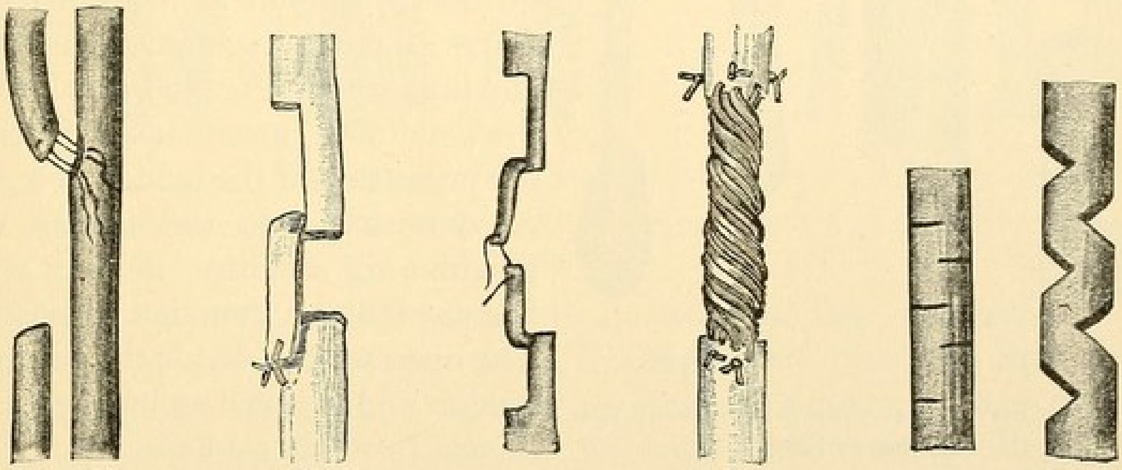
If the union of the tendinous stumps for some reason does not succeed, sometimes an indirect union of the ends by coalescence with the skin (of the forearm) can occur. The cicatrix of the skin must then be made very movable by massage and movement exercises.

Löbker resected a corresponding portion from both bones of the forearm in order to make the union of the tendons and nerves possible by shortening the limb.

TENDINOPLASTY

If the wound is already in a state of healing or cicatrized, it generally presents great difficulties to expose the tendon ends, which are far apart, and to approximate them with each other, owing to the marked muscular contraction.

In such cases, it is desirable to find the proximal end by incising the sheath of the tendon, to vivify it laterally, and to fasten it at the correspond-



a FIG. 522 b FIG. 523 c FIG. 524 d FIG. 525 e FIG. 526

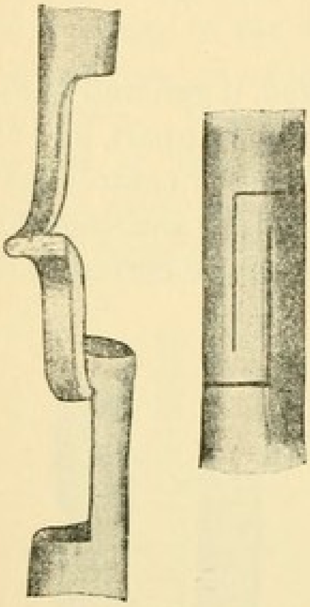
TENDINOPLASTY. *a*, according to Tillaux; *b*, *c*, according to Hueter; *d*, according to Gluck; *e*, according to Bardenheuer

ing place to a neighboring tendon, which is likewise vivified laterally (*Tillaux*, Fig. 522); or else a tongue-shaped flap with a lower base is cut out at one side from the tendinous stump; it is turned down and sutured to the other stump (*Hueter*, Fig. 523). This can also be done on both sides (Fig. 524). Finally, the deficiency can be filled by a *twisted catgut suture à distance*, which is fastened to the tendon ends (*Gluck*, Fig. 525). The growing tendon then extends its new fibres between the catgut threads in opposite directions, and the continuity of the tendon is restored by new tissue which takes the place of the temporary catgut bridge. The implantation of tendons of animals, or of excised portions of healthy tendons of the same person, is unsafe.

During the first weeks after the union of the tendon, the limb must be placed in a splint in such a manner that the sutured place is exposed as *little as possible* to tension (see Fig. 168). Only gradually the limb is replaced in its normal position.

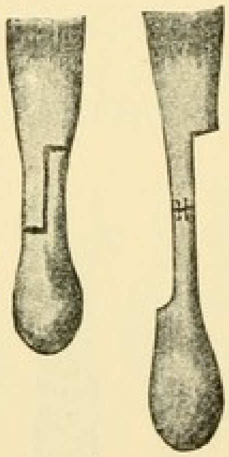
An **extension of shortened tendons** in contractures (after injuries, paralysis, etc.) can be effected by means of several superficial lateral transverse incisions (*Bardenheuer*, Fig. 526); or by means of *Sporon's* method of making the incision through the whole tendinous substance from which an extension is effected corresponding to the length of the two longitudinal incisions (Fig. 527). If it is desirable to divide the tendon at the same time, *Bayer's* incision, recommended by him and indicated in Fig. 528, may be used.

Tendinous anastomosis is called the ingrafting of the tendon of a *paralyzed* muscle into the tendon of a neighboring healthy muscle which has as similar a function as possible. The operator can divide the paralyzed tendon and proceed as in Fig. 522, or he can form lateral flaps.



a

Fig. 527



b

Fig. 528

Tendinoplasty. *a*, according to Sporon; *b*, according to Bayer

OPERATIONS ON NERVES

Divided trunks of nerves must be united again as soon as possible, or else paralysis and anæsthesia occur in the part supplied by the injured nerve. After the union of the ends, the power of transmission of the nerve is restored rather rapidly, even if the union is not completed until several months after the injury. Of course in such a case the stumps must first be carefully vivified.

NEURORRHAPHY (*Nélaton*, 1863)

This operation is performed essentially according to the principles which govern tendinorrhaphy. It is best to unite the cut surfaces of the nerves with fine *Hagedorn's* needles and catgut — **direct neurorrhaphy** (Fig. 529). The suturing of the tissues surrounding the nerve (indirect or **perineurotic suture**, Fig. 530) sometimes may be added for the purpose of safety; nerve junction by lateral apposition or angular union is less effective (**paraneurotic suture**, *Rawa*, Figs. 531–532). If joining the two ends does not prove successful, an extension of one or of both stumps can be effected by *stretching* (as much as 4 centimeters, *Schüller*). **Neuroplasty** can be made in the manner suggested by *von Hueter* for the tendons

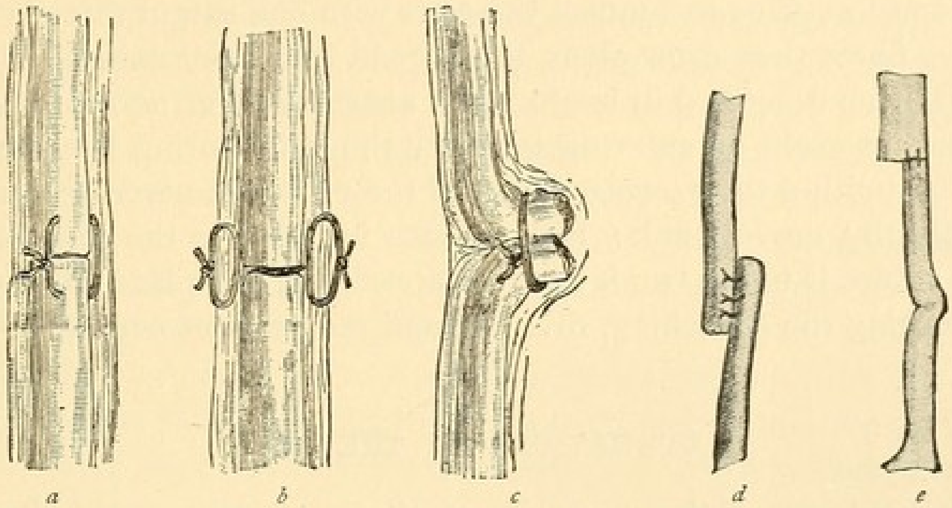


FIG. 529 FIG. 530 FIG. 531 FIG. 532 FIG. 533

NEURORRHAPHY. *a*, direct; *b*, indirect; *c*, paraneurotic; *d*, *e*, Hueter's neuroplasty

by turning over a small lateral tongue-shaped flap on one or both stumps (*Letiévant*) (Fig. 533). With thicker nerves, *two* little flaps can be formed for each stump and sutured together (Fig. 534). Since the ends of the nerves very rapidly produce proliferations which unite with the fibres

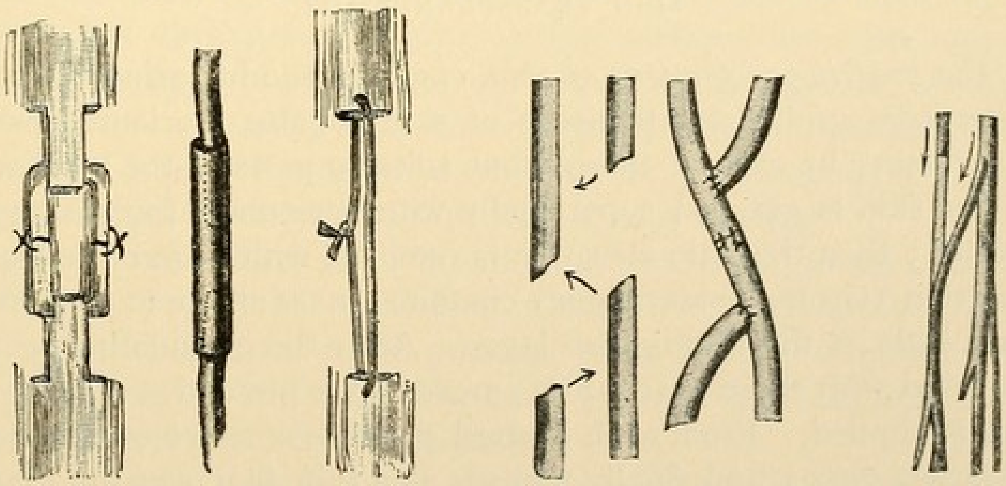


FIG. 534 FIG. 535 FIG. 536 FIG. 537 FIG. 538

NEUROPLASTY ANASTOMOSIS OF NERVES

of the other end growing toward them, on the whole it is only essential to give to the growing fibres the right direction and to prevent that no *connec-nective tissue comes to lie between*, whereby the success is impaired, if not prevented. *Vanlair* and *Gluck* did this by placing the two stumps into a decalcified bone tube (tubular suture, Fig. 535); they also succeeded in restoring the continuity of nerves in animals by interposing between the ends a bridge of catgut threads (suture à distance, *Assaky*). For nerves of medium size it seems to suffice to connect the ends with one catgut thread (Fig. 536). The nerve fibres then grow along this thread until they unite.

Similarly as described in tendons the **anastomosis of nerves** in very large deficiencies is made by suturing together the neighboring nerve ends (Fig. 537), or by uniting the *peripheral* end of the defective nerve with the neighboring healthy nerve trunk: Either place it between the separated nerve fibres or suture it to the trunk vivified laterally at one place (Fig. 538).

Concerning the stretching, division, and resection of nerves, see

OPERATIONS ON THE SKIN

Extensive losses of the substance of the soft parts, caused by accidental injuries or by operative removal of diseased parts, can heal after a long time by granulation, but they leave such large cicatrices that it is better, if possible, to close the defect by skin grafting, whereby the time of healing is considerably shortened, the deformity diminished, and the functional result improved. This is done either by skin transplantation or by plastic operations.

SKIN TRANSPLANTATION,

that is, the *grafting of portions of skin*, can be made in various ways.

J. Reverdin applied small pieces of skin the size of a lentil upon *granulating* surfaces; he excised these from suitable parts of the body with scissors. The skin is grasped superficially with tenaculum forceps, and somewhat raised; then the little elevation is removed with *Cooper's* scissors. The little portion (Greffe épidermique) contains, in addition to epidermis and corium, a little of the Malpighian layer. After the granulating surface has been covered with these grafts, it is covered with protective silk, and a light dressing is applied. From each grafted piece as a centre of epidermization the epidermis grows, and finally spreads as a thin film over the granulating surface, upon which the grafted pieces can be distinguished like raised islets of skin. Many of these grafts die before they can form vascular connections with the underlying wound surface.

(The best method of performing *Reverdin's* skin grafting is to transfix the superficial layers of the skin with an ordinary sewing needle, and after elevating it in the form of a small cone remove it with a razor and transfer it with the needle at once upon the granulating surface, where it is carefully spread out and embedded with the point of one or two needles.)

Wolfe grafted larger pieces of skin than *Reverdin* by excising with the knife from some portion of the body a piece of skin corresponding in shape to the defect, but somewhat larger; he very carefully detached every vestige of fat tissue with a razor or a pair of scissors until it had the appearance and the thickness of fine white glove leather. He then fastened it with a few sutures into the skin defect. The place from which it is taken is closed by sutures like a recent wound. This procedure gives very beautiful results *when successful*. It is especially adapted for covering defects without a floor of adipose tissue (forehead, nose).

Still, the flaps are inclined to contract subsequently.

Recently, even without detaching the subcutaneous adipose tissue, large non-pedunculated flaps have healed successfully (*Krause*); their contraction is considerably less.

But the best results are obtained by

SKIN GRAFTING ACCORDING TO THIERSCH

in which *very thin strips of skin* taken from other parts of the body are used for covering even large wound surfaces of all kinds of tissue. The large skin grafts unite with fresh wound surfaces or with such as have been tamponed for a few days, and with granulating surfaces after the superficial loose *granulation layer* has been *removed* with the sharp spoon. It is essential for a satisfactory healing that *hemorrhage* should be *completely arrested* before grafting, which is accomplished either by pressure, or, if necessary, by torsion. Catgut ligatures interfere with speedy healing.

It also appears desirable, and in most cases possible, to take the pieces of skin *from the patient*, for these heal in regularly. Attempts at grafting pieces of skin taken from other persons, from freshly amputated limbs, from fresh corpses, or from animals, have often proved failures.

The operation is performed as follows: —

1. In the case of fresh wound surfaces hemorrhage is arrested by pressing upon them a gauze compress or a sponge for several minutes. Granulation surfaces are scraped with the sharp spoon; on bones by means of flat, level-like chiselling, the spongy tissue must first be exposed.

2. From the skin of the external side of the arm, thoroughly disinfected beforehand, or from the anterior surface of the thigh or trochanteric region,

strips about 8 to 10 centimeters in length are removed by sawing movements with a sharp razor. The left hand during this procedure encircles the limb from below and draws the skin tense; it is also necessary to have the skin drawn upward by an assistant at the place where the incision is to begin. Next, a large moistened razor, ground flat at its posterior surface but hollow on its anterior surface (microtome blade), is applied as flat as possible, and drawn in rapid sawing movements toward itself, whereby the uppermost cut-off layer of skin is folded in transverse folds upon the blade of the razor (Fig. 539). The length, breadth, and thickness of these grafts depend alto-

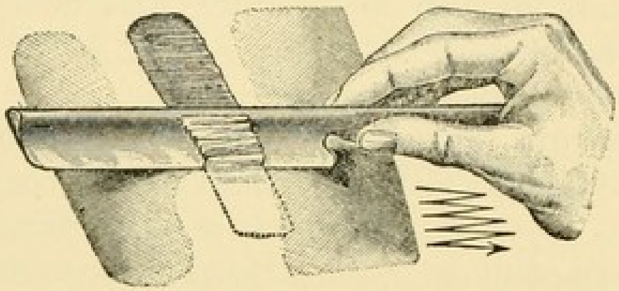


Fig. 539

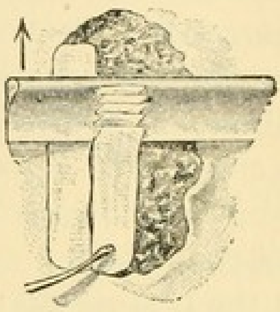


Fig. 540

Skin Grafting according to Thiersch

gether upon the dexterity and practice of the surgeon. According to *Thiersch*, epidermis, Malpighian layer, and papillary layer should be included in the graft, together with a smooth layer of stroma; still, even thinner grafts heal just as readily. These contain, in addition to the epidermis, only the points of the papillary layer (*Hübscher*). The strips can be 2 to 5 centimeters broad and 10 to 20 centimeters long.

3. The blade of the knife with the folded strip of skin is applied flat to the margin of the surface to be covered; the end of the strip is drawn down with a probe or a dissecting needle and held in position (Fig. 540), while the knife is drawn slowly across the surface of the wound, the strip is spread out flat, and smoothed with a probe and a brush if necessary. In this manner strip after strip is applied until the whole surface is grafted. Nowhere should a defect remain, and it is even well that the strips overlap each other at their margins like the tiles of a roof, and they should at the same time cover the margins of the wound.

4. Either dusting with iodoform powder, or an application of moist iodoform gauze, or little pieces of lint with boric vaseline, which are gently pressed upon the surface by loose "kruell" gauze or a compress, are serviceable for a *dressing*. Sometimes it is necessary to immobilize the limb

with splints. The dry dressing remains in position from 8 to 10 days, until the healing is completed; the salve dressing must be changed between the third and the fifth day. The wounds between the grafts heal under *one* dry dressing, leaving very little scar tissue.

The dressings in transplantations are made in a very different manner. *Thiersch* recommended during the whole after treatment the use of the *physiological solution of sodium chloride*, and covered the grafted portion with salt water compresses, which were changed daily. The application of antiseptics, however, seems not only harmless, but even necessary in practice, since the practising physician can make use of strict aseptic measures only in rare cases. To cover the grafts with impermeable materials (protective silk, gutta-percha) prevents, it is true, the adhesion of the grafts to the dressing, but it necessitates a more frequent change of dressings, since the secretions cannot be absorbed readily by the dressings. (This difficulty can be overcome by leaving linear spaces between the protective strips.) *Socin* uses strips of tinfoil with 2% of salicylic oil for a covering. The dry iodoform dressing is just as safe as it is convenient and simple.

Large defects of the skin, which are either congenital or caused by injuries, burns, ulcerative processes, and removal of neoplasms, are closed by

PLASTIC OPERATIONS

by using the neighboring skin for covering defects of the same in the most various ways.

In general, the following kinds of plastic operations are distinguished: —

1. By **stretching the margins of the skin,** which, if necessary, have been dissected from the underlying tissues, and have been made movable. Lancet-shaped and rhomboid-shaped defects can be sutured in a straight line; triangular and square defects are sutured from the corners, so that finally the long sides touch each other (Figs. 541–

Fig. 541

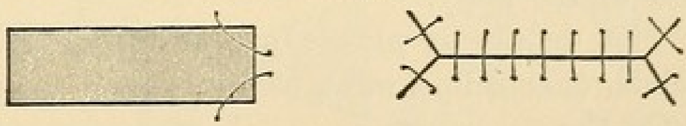


Fig. 542

Fig. 543

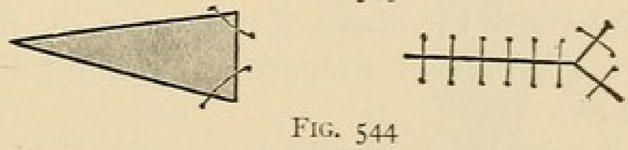


Fig. 544

Plastic Operations. Covering defects by stretching the margins of skin

544). If necessary, a square defect is changed into a lancet-shaped one by excision of two triangles on its small sides, or else, on one or both sides, deep incisions are made to relieve tension (Figs. 545, 546).

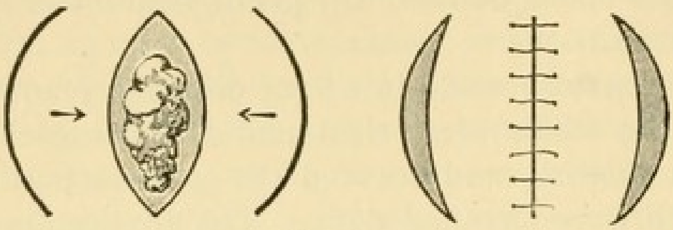


FIG. 545

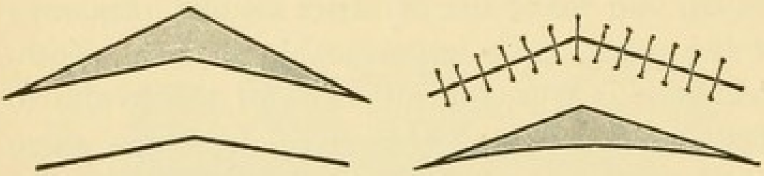


FIG. 546

PLASTIC OPERATIONS. Incisions to relieve tension

2. By **the sliding of flaps** (*Celsus*): by *straight* or *curved* incisions, one or several flaps are formed, which, after having been detached and mobilized, are sutured over the defect (Figs. 547–551).

Burow formed movable flaps by excising corresponding *triangles*, whereby very fine results can be obtained; unfortunately, however, too much healthy skin is sacrificed, so that this method is very rarely used (Figs. 552, 553).

The sliding is finally made

3. By **twisting**, after the flaps have been cut in such a manner that they remain in connection with the vascular supply only on one side as a *pedicle* with the wound surface (*pedunculated flaps*, Figs. 554, 555).

According to *Thiersch*, pedunculated flaps can be lined over the wound surface with mucous membrane or skin; large flaps can also be doubled by turning over their margins, and thus be used for covering defects in the walls of the body.

The details of plastic operations on the face to cover defects of the eyelids, cheek, lips, nose, etc., are given on pp. 514 *et seq*.

Of the

OPERATIONS ON NAILS

the most important and frequent treatment is for **ingrown nail** of the great toe. Since this very painful affection recurs often, it is all-important not only to remove the diseased portion of the nail, but also to resort to suitable measures to prevent a recurrence. The following operation yields the best results: —

1. Under local anæsthesia or under the influence of a general anæsthetic, the pointed blade of a pair of strong, straight scissors is inserted under the

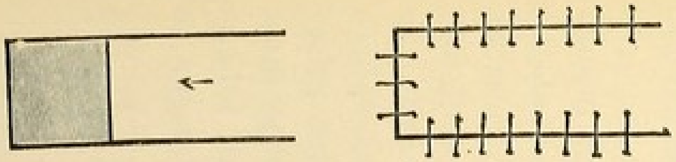


FIG. 547. according to Celsus

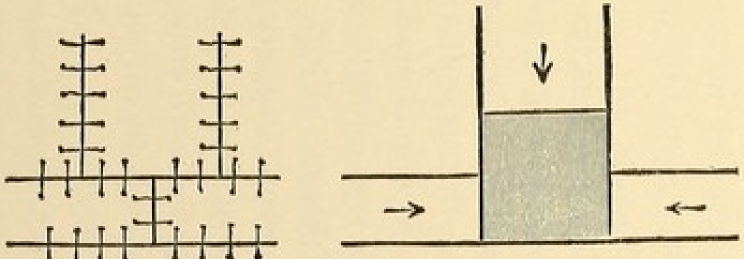


FIG. 548

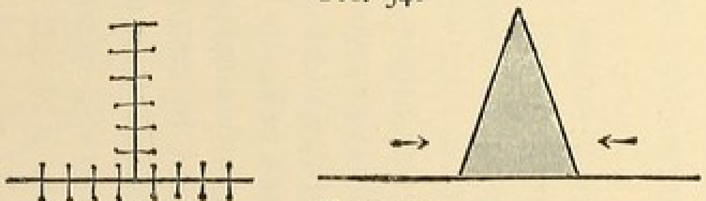


FIG. 549

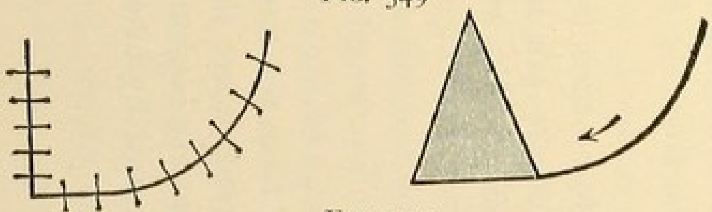


FIG. 550

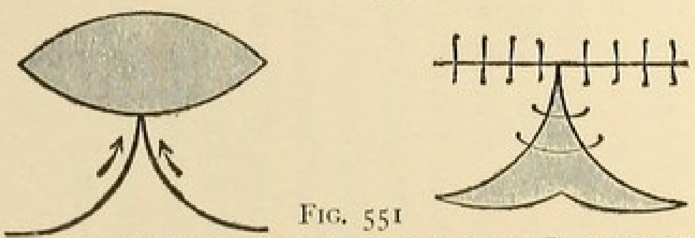


FIG. 551
PLASTIC OPERATION BY SLIDING AND STRETCHING OF FLAPS

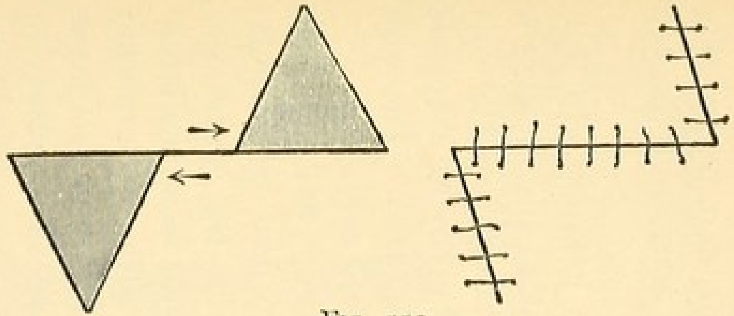


FIG. 552

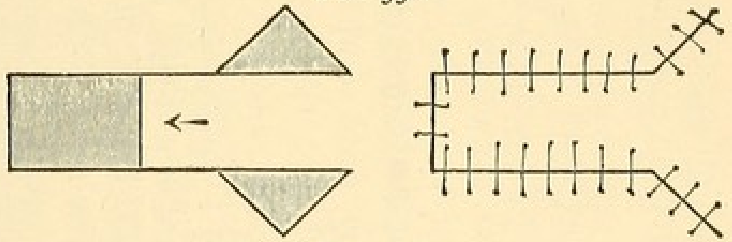


FIG. 553

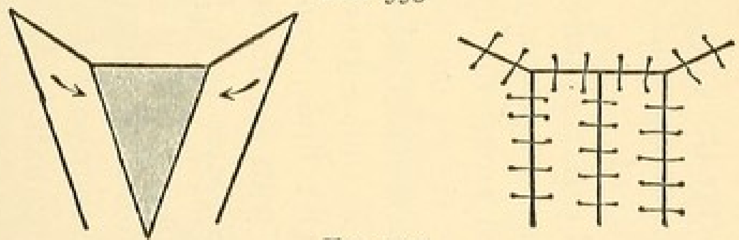


FIG. 554

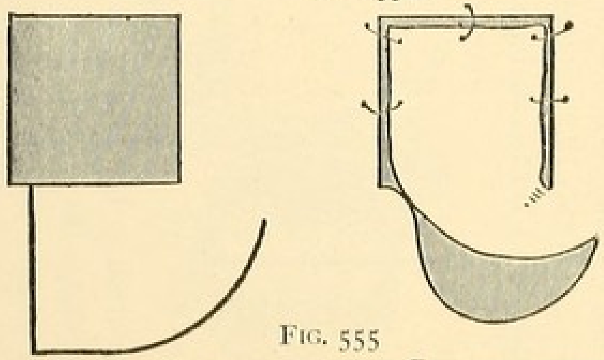


FIG. 555
PLASTIC OPERATIONS WITH PEDUNCULATED FLAPS

middle of the free anterior edge of the nail, pushed forward as far as its posterior margin, and the nail divided with one stroke (Fig. 556). The two halves are grasped one after the other with strong forceps, and, by twisting them around their axis, in an outward direction over the margin of the bed of the nail, they are extracted.

2. Next, the diseased (internal) edge of the matrix is grasped with forceps, and removed by sawing movements with a sharp knife; the incision is extended along the inner granulating margin of the soft parts as far as the point of the toe, whereby all diseased tissue is removed at the same time (Fig. 556). The wall of the nail fold is thereby made completely even.

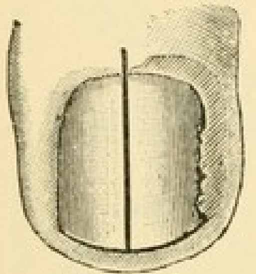


FIG. 556

3. The little wound and the exposed nail bed are covered with iodoform gauze, and left to heal by granulation. Or, after vivifying the nail bed with the knife conducted in a flat manner, skin grafting is made immediately according to *Thiersch* (from the thigh). Healing by primary intention occurs. In subsequent dressings it is advisable to allow the lowermost layer of gauze which covers the nail bed to remain in position as a protective dressing. Subsequently it falls off of its own accord. The patient can walk without pain after three to four days. *Hägeler* obtained an eminence of the toe covered only by skin in this manner: He extracted the nail, and removed by a deep *cuneiform* incision on both sides the lateral nail folds. Having excised the transverse fold and scraped off the nail bed, he united by sutures the movable *lateral flaps* upon the middle of the dorsum of the toe.

This procedure, to be sure, is very radical; but it yields the best permanent results. All others are likely to fail. The *simple removal* of the whole nail or its diseased half, without removing the corresponding matrix segment, the *insertion of foreign bodies* between the granulating nail fold and the sharp edge of the nail pressing upon it, recommended for ages, the scraping out of a shallow longitudinal groove in the middle of the nail to render it more elastic, and the application of an elastic clamp, which raises the edge of the nail from the tissues beneath it, prove unsuccessful in most cases. In milder cases, where the inflammation of the lateral nail fold is not far advanced, success is obtained by *cutting the nail* either *straight* or in a *concave manner*, and by inserting cotton under both corners.

OPERATIONS ON BONES

Osteoclasis, that is, **the subcutaneous fracturing of bones,** is made for vicious union after fractures; if not too much time has elapsed since the injury, in most cases (especially in children) the still soft callus yields to extension and manual redressment. Under some circumstances, it is necessary to infract the bone like a green stick across the knee or the edge of

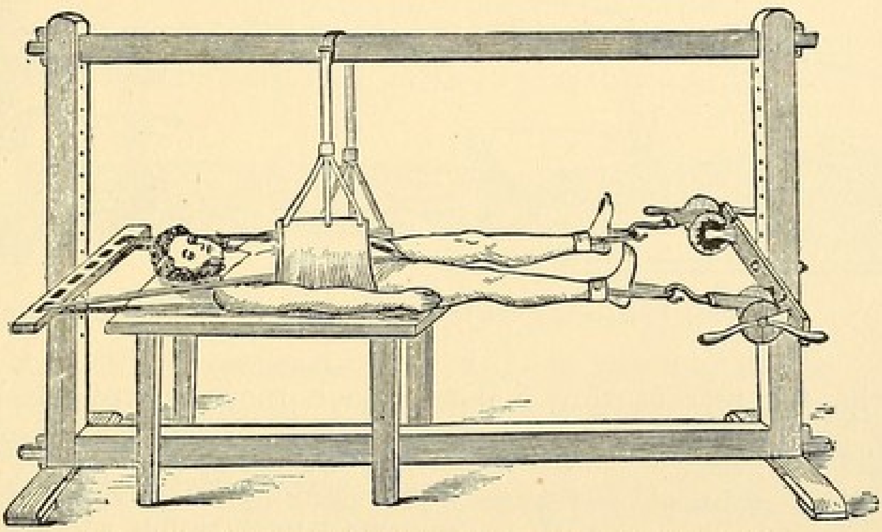


FIG. 557. SCHNEIDER-MENNEL'S EXTENSION APPARATUS

a table to effect correction of the deformity. In some cases of badly united and not too old fractures, especially of the femur, *Wagner* has again recommended the *extension apparatus* of *Schneider-Mennel*, which was originally mentioned for setting old irreducible luxations, to correct the shortening and irregularity. In this apparatus the patient is securely fixed, and the fragments are brought in proper position by cog-wheel extension (Fig. 557).

But if the fractured ends are *firmly united by bony callus*, in most cases this method of treatment is inadequate, and greater force must be employed. *Von Bardeleben* extended the lever arms formed by the ends of the bones by fastening *long laths* to the ends of the fracture by a strong plaster of paris dressing; for instance, in a fracture near the ankle joint, a wooden splint 2 feet long was fastened to the foot and leg, below the fracture, whereby the ankle joint was immobilized, while the seat of fracture remained free. While an assistant held the upper portion of the leg immovable, pressure was exerted upon the free end of the splint, and the callus was easily fractured by manual force.

Simple and very effective also is *von Esmarch's* **osteoclast** (Fig. 558), a one-armed long *wooden lever*, which is pressed forcibly upon the limb placed between two firm cushions.

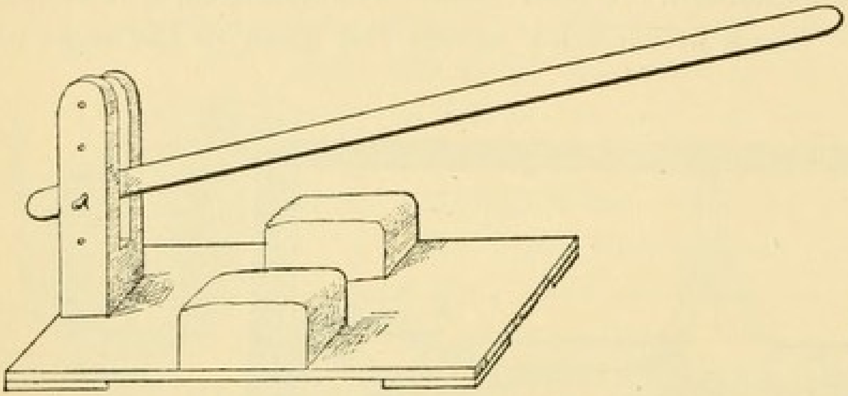


FIG. 558. VON ESMARCH'S OSTEOCLAST

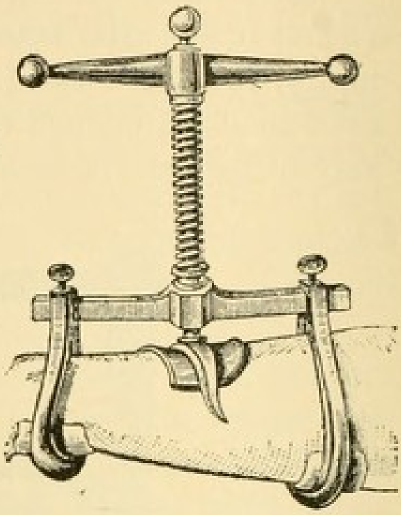


FIG. 559. RIZZOLI'S OSTEOCLAST

Formerly, for refracturing a bone, much more complicated appliances were used. For instance, the **dysmorphosteopalinclast**, *Bosch and Österlein's* screw-press. *Rizzoli's* **osteoclast** operates in a much more simple manner, according to the same principle (Fig. 559); this instrument infracts the bone with the limb immobilized between two rings (Fig. 560).

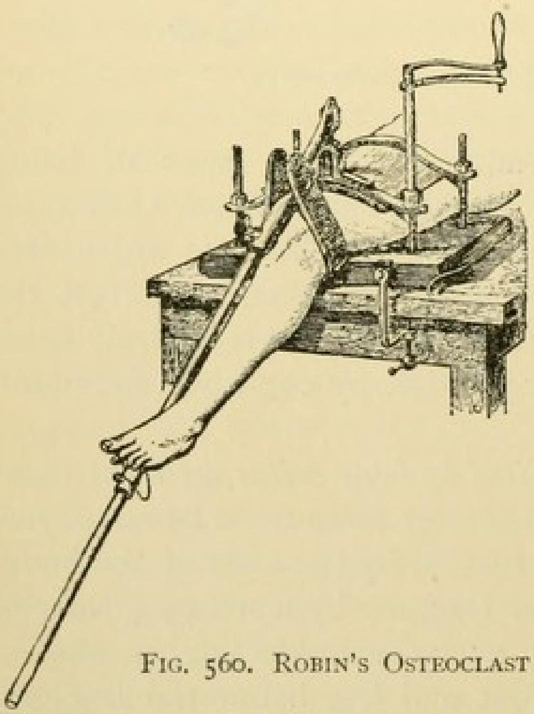


FIG. 560. ROBIN'S OSTEOCLAST

Robin's excellent *osteoclast* (Fig. 560) is extensively used in France. Of a similar construction is the apparatus of *Lorenz*.

Even if good success may eventually be obtained with these machines, still at the present time in most cases **osteotomy** *aseptically performed* is the operation of choice, especially since the place of the intentional artificial fracture can be determined with accuracy, and the great *contusion* of the soft parts is avoided, which in the application of all osteoclasts is unavoidable.

OSTEOTOMY

Bone section is made for the purpose of straightening deformities caused by vicious union of fractures, in curvatures of bones, the result of disease, and in deformities of the leg caused by the body weight ("Belastungsdeformitäten").

The operation is performed as follows: —

1. The limb is made bloodless by elastic constriction, and a small longitudinal incision is made with a strong knife down to the periosteum at a place where as few important soft parts as possible will be injured.

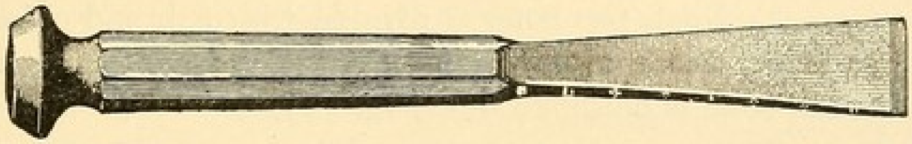


Fig. 561. Macewen's Osteotome

2. A strong chisel (**osteotome**, Fig. 561) is inserted in the little wound down to the bone, then placed at a right angle to the axis of the bone, and driven into it with strong blows of the hammer. In large bones, after half of the thickness of the bone has been chiselled through, a thinner chisel should be used in order to have more room in the bony groove. After the bone has been divided, except a small bridge, it can be fractured by manual force. During the hammering, the limb is placed upon a firm support (moist sandbag), which yields but little.

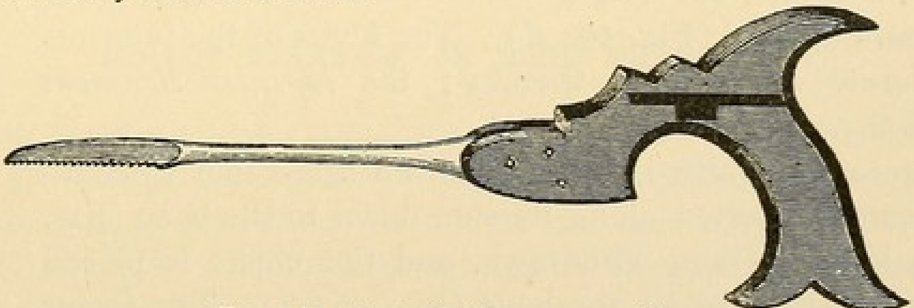


Fig. 562. Adams's Metacarpal Saw

3. Instead of the chisel, the *metacarpal saw* is also used (*von Langenbeck, Adams* — Fig. 562). The bone dust produced by the sawing does not interfere with the healing of the wound as long as asepsis is maintained. Still, on the whole, the chisel is preferable.

4. After the chisel has been removed from the bony groove — which often requires some strength — the little wound is either sutured or left to heal by granulation. The constrictor is removed, and the limb immobilized

in the corrected position by plastic dressing, which is applied at once. The healing usually takes place under the first dressing; if necessary, after a few weeks, a new dressing must be applied, more especially if the deformity has not been entirely corrected in applying the first one. Any defects are then corrected.

The typical osteotomies are: —

Subtrochanteric osteotomy (*osteotomia subtrochanterica, von Volkmann*).

In contractions of the thigh: —

1. External incision across the posterior outer side of the trochanter.

2. The periosteum is reflected with the raspatory and the elevator as far as one-third of the circumference of the bone.

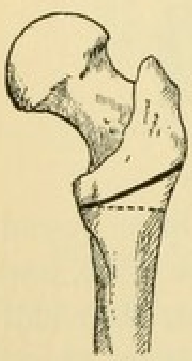


Fig. 563 Subtrochanteric Osteotomy

3. Next, the bone is divided with a broad chisel; in more serious cases, a corresponding wedge from the external half of the bone is chiselled out (Fig. 563).

Supracondylic osteotomy of the femur (*Osteotomia supracondylica femoris Macewen*).

In genu valgum (and varum): —

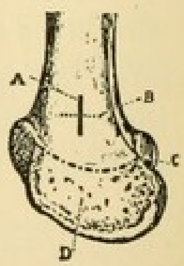


Fig. 564. Supracondylic Osteotomy. *A*, external incision; *B*, bone incision; *C*, line of epiphyses; *D*, condyles

1. On the *inner side* of the thigh, at the point of crossing of two lines, of which one is drawn a finger's breadth above the superior extremity of the outer condyle transversely across the thigh, the other passing downward 2 centimeters in front of the tendon of the adductor magnus muscle, a pointed knife is inserted down to the bone, and the insertion is enlarged 4 to 5 centimeters upward (Fig. 564 *A*). The fibres of the internus vastus muscle are divided thereby; the *capsular ligament remains intact.*

2. Before the knife is withdrawn, an osteotome $1\frac{1}{2}$ centimeters broad is inserted along its side down to the bone (Fig. 561); the knife is then withdrawn, and the chisel is placed *transversely* to the axis of the bone (Fig. 564 *B*). The femur is chiselled through transversely from within backward, forward, and outward (for fear of injuring any blood vessels). After the bone has been sufficiently weakened the fracture is made by manual force (Fig. 565). Hahn completes the bone section more rapidly by using the chisel on the same line from the outer and inner sides through two separate incisions.

3. In some cases, the tibia must also be divided by osteotomy at once or subsequently closely below its tuberosity, from a lateral longitudinal inci-

sion. In curvatures of a high degree, it may become necessary to take out a corresponding wedge from the femur or the tibia.

4. The openings of the wound are covered with iodoform gauze, and the leg in a straight position is immobilized in a plaster of paris dressing. The little wounds heal quickly, otherwise a fenestra must be made in the dressing.

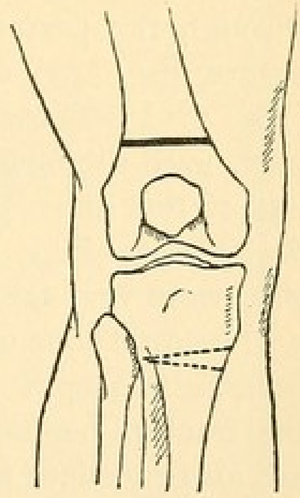


FIG. 565. SUPRACONDYLIC OSTEOTOMY

Supramalleolar osteotomy (*osteotomia supramalleolaris, Trendelenburg*).

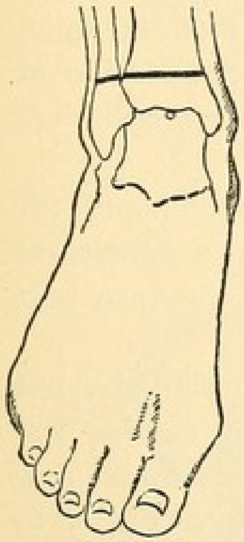


FIG. 566 SUPRAMALLEOLAR OSTEOTOMY

In flat foot and angular deformity after fractures of the malleoli, whereby the foot has been displaced outward and has assumed a pronation position:—

1. A small skin-incision 1 centimeter long is made on both sides across the malleoli.

2. The tibia and the fibula are divided transversely with a small chisel closely above the malleoli, so that the foot becomes completely movable (Fig. 566).

3. Having been restored to its normal position, a plaster of paris dressing is applied with the foot in the corrected position; after about 12 days, a new dressing is applied.

DIRECT FIXATION OF BONE FRAGMENTS

for effecting bony *union* in pseudoarthroses and after some resections and sometimes in complicated fractures can be made in various ways. If the ends of the bone can be placed in a firm and secure position, it is mostly sufficient to unite the surrounding periosteum all around by catgut sutures (**Periosteal suture**); but if greater security is desired, the *bone itself* can be

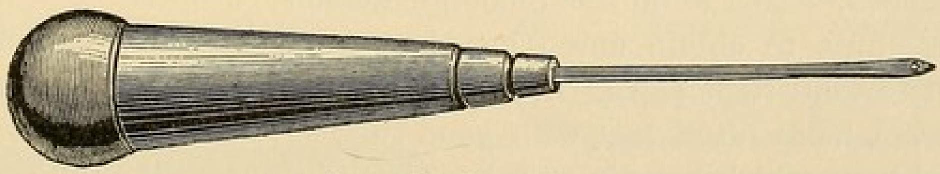


FIG. 567. BONE DRILL

sutured by drilling it obliquely at both ends with a simple bone drill (Fig. 567), or with a *special drill;* the instruments may be conducted with the hand. The work is done more rapidly if the fly-wheel of a dental bur (Fig. 568) or an electromotor (Fig. 569) is at one's disposal, and by applying through the perforations silk, or silver wire, aluminum bronze wire (**bone suture**, Fig. 570), or *the bones are* firmly *nailed together* with long **steel nails** (Fig. 571). These remain in the bone from 3 to 4 weeks without causing pain, until the bone is firmly united, and they can be easily extracted at the end of that time. In a similar manner is the procedure with *Gussenbauer's bone-clamps* (Figs. 572, 573). Instead of nails, formerly *ivory nails or ivory pins* were very frequently used.

(Aseptic bone or ivory nails should be used in preference to metallic nails, because in aseptic wounds they are always absorbed after consolidation of the fracture has taken place. Bone rings and interosseous hollow cylinders are also excellent means of direct fixation.)

For a more accurate coaptation of the fragments of bones and for increasing the bone surfaces, the bone ends can be vivified in a cuneiform (Fig. 574) or scalariform manner. With the latter procedure, they are best united by driving in transversely nails, pegs, or screws.

Wille perforates the bone for applying the wire suture not obliquely, but *transversely*. With a drill of special construction, he then carries the wire through the perforation, and finally ties it together. *Hausmann* screws to one or both sides of the bone small aluminum splints (Fig. 576) which heal in. Fractured ends which are very oblique can be simply tied together in the form of a ring with wire applied in a shallow groove, made with a saw or a chisel, on both sides, to prevent the slipping of the wire ligature (Fig. 575).

Likewise good results are obtained with : —

The procedure of *Bircher*, who fastens the bone ends with an ivory cylinder (Fig. 577) *inserted into* the medullary canal of both fragments; the procedure of *Senn*, who uses intra- and extra-osseous absorbable *bone splints*. The procedure of *Davy*, who *wedges* the cone-shaped pointed end of one bone into the medullary cavity of the other, whereby a considerable shortening is produced, seems to be less recommendable.

The attempts to obtain union by plastic operations by detaching and suturing periosteal flaps (*Rydygier*), and pedunculated skin-periosteal bone flaps (*Müller*), have often met with good success; the *implantation* of periosteum and bone which have been taken from distant portions of the body or from animals is uncertain in its results.

If the operator does not succeed in this manner in forming *solid osseous* callus, sometimes success is obtained by the use of **irritants**. To these be-

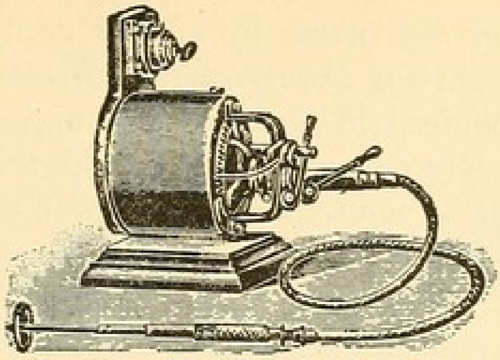


Fig. 569. Electromotor

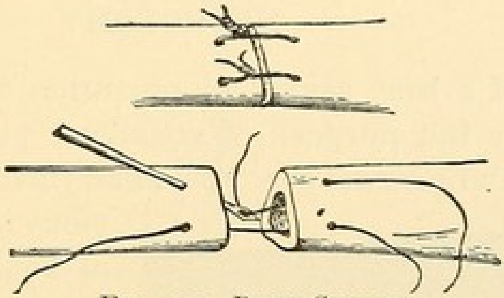


Fig. 570. Bone Suture

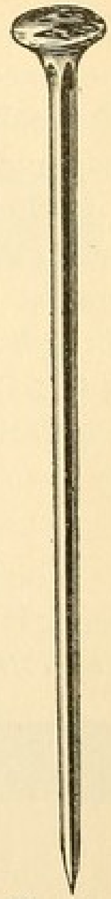


Fig. 571 Steel Nail

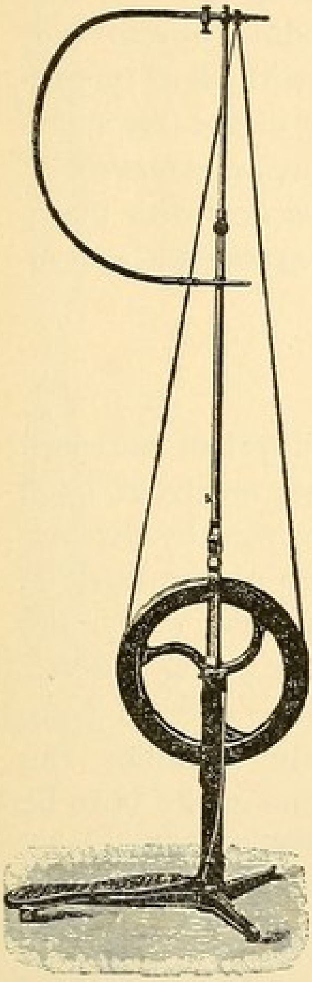
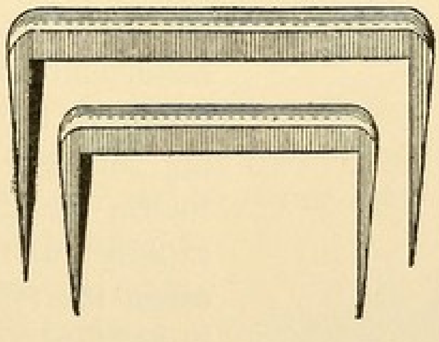


Fig. 568. Dental Bur



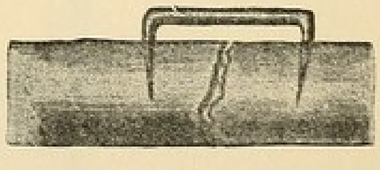


Fig. 572. Gussenbauer's Bone Clamps. Fig. 573

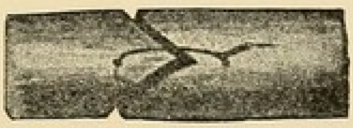


Fig. 574. Cuneiform Vivifying

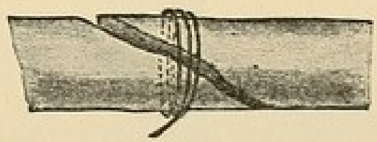


Fig. 575. Bone Union with Silver Wire

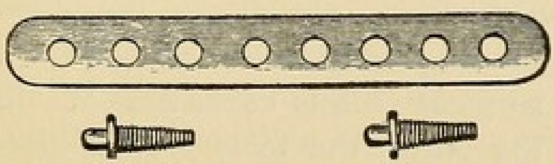


Fig. 576. Aluminum Splints for Bone Union

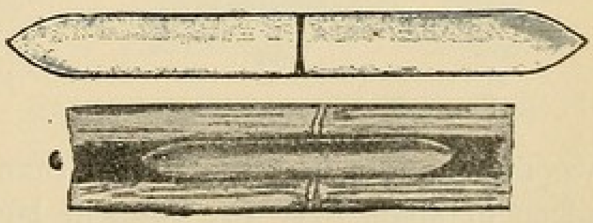


Fig. 577. Ivory Cylinders

long: *congestion or hyperæmia* by merely applying an elastic band above the place of fracture (*von Dumreicher, Helferich*), "healing" by active use of the limb immobilized in a well-fitting apparatus (*Hessing* and others), massage; furthermore *painting* the skin with tincture of iodine, *injections* of a 10% chloride of zinc solution (*Lannelongue*), tamponade with oil of turpentine (*Banks, Miculicz*); in open fractures, vigorous rubbing of the fragments against each other (*Celsus*) under anæsthesia; finally, the *introduction of foreign bodies:* driving in nails, ivory pegs, needles, *acupuncture* with many (5 to 20) needles, which remain in position for weeks (*Nicolaysen*), and *electropuncture* (*le Fort*).

NECROTOMY

The **opening of a bone cavity**, or operation for the removal of necrosed bone, is made for the purpose of removing pus, dead fragments of bone (*sequestra*), which are incased by new bone (involucrum) formed by the previous inflammation of the medulla of bone (osteomyelitis), or for the extraction of other *foreign bodies* (bullets) which have entered from without. If only a bullet embedded in the bone cavity is to be removed, the fistulous canal, leading through the wall of the bone to the foreign body, can be most rapidly enlarged with *Marshall's* **osteotribe** (Fig. 578). In operations for *necrosis*, however, this procedure is not sufficient; on the contrary, the involucrum must be opened in its *whole extent*, so that its contents can be removed *thoroughly* and with ease. This can be done most rapidly and conveniently with a *chisel* and a *hammer* (Figs. 579–582); the common *large carpenter's chisel* with a wooden handle is more useful than the surgical chisels consisting of one piece of steel. At any rate, in lack of the latter, the tools may be borrowed from the next best carpenter or joiner shop. In the clinic at Kiel,

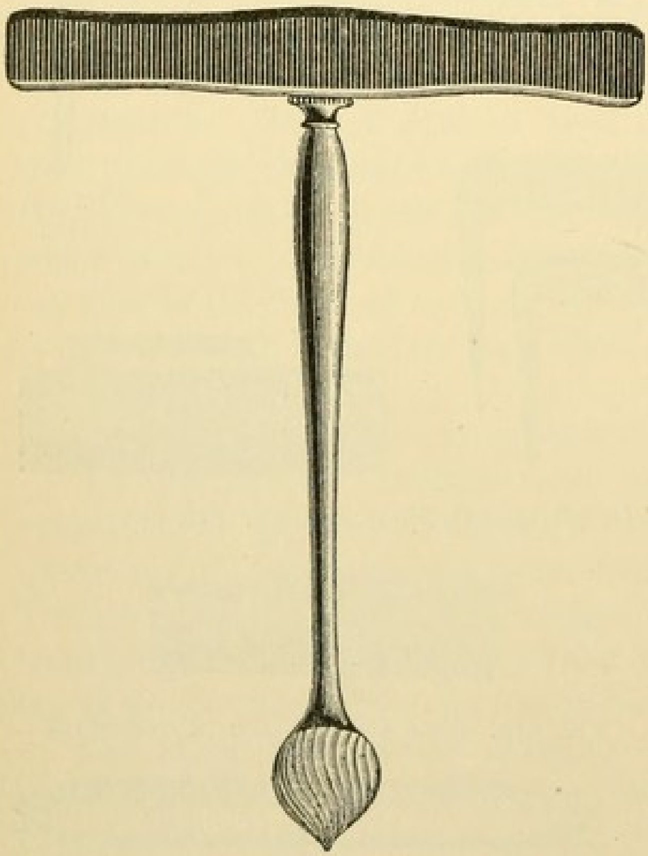


FIG. 578. MARSHALL'S OSTEOTRIBE

chisels are used for these purposes, the cutting surface or bevelled edge of which is 5 centimeters in width (Fig. 584).

Fig. 579

Fig. 580

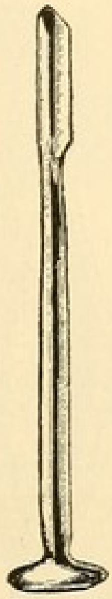


Fig. 581

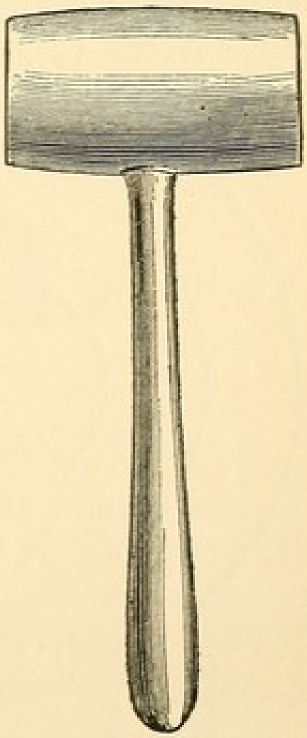


Fig. 582

Chisels and Hammer for Necrotomy

1. Under elastic constriction the affected bone is freely exposed over the seat of the disease by a *longitudinal incision;* the divided periosteum is reflected with the raspatory on both sides (Fig. 586), and the involucrum opened with chisel and hammer to such an extent that the dead bone is freely exposed; in order to advance more *rapidly*, much benefit is derived from the use of *very large* gouges (Figs. 580, 584).

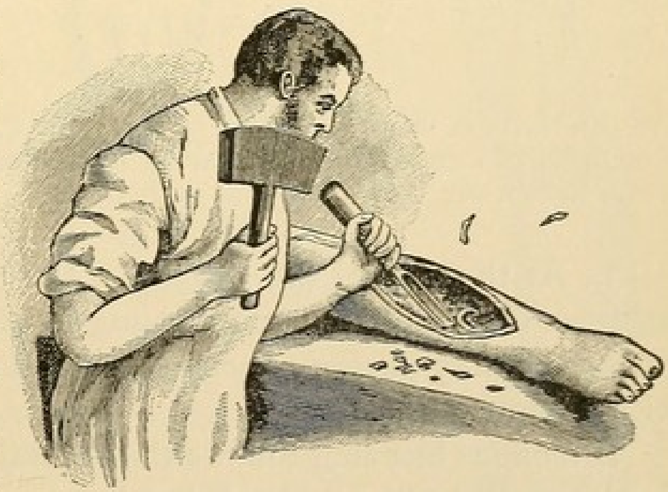


Fig. 583. Opening an Involucrum of the Tibia with Chisel and Hammer

2. With the *sequestrum forceps* (Fig. 587) the dead bone is now extracted; and all granulations surrounding it are thoroughly scraped out with the sharp spoon. Since the surgeon can never be sure whether still smaller or larger portions of sequestra have remained in the angles and sinuses of the opened involucrum, or whether the *granulating*

canals extend deep into the bone, it is necessary to remove enough from the lateral edges of the involucrum *to change* the *cavity of the bone* into an **open shallow cavity** (alveolus), in which no accessory cavities can remain undiscovered (Fig. 585). The surface of this shallow cavity is finally smoothed with a chisel and the sharp spoon.

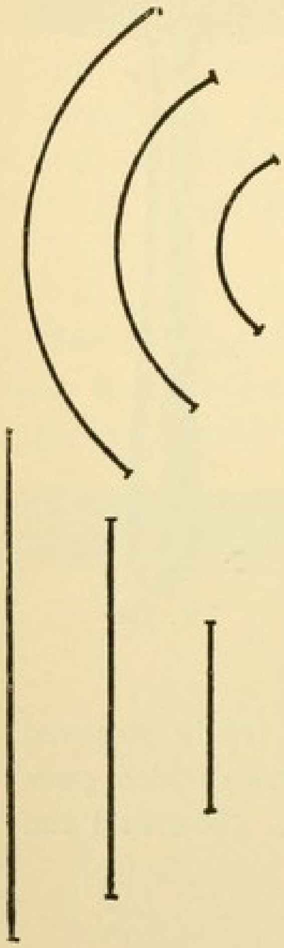


Fig. 584. Natural Size of Bevel of Chisels for Necrotomy

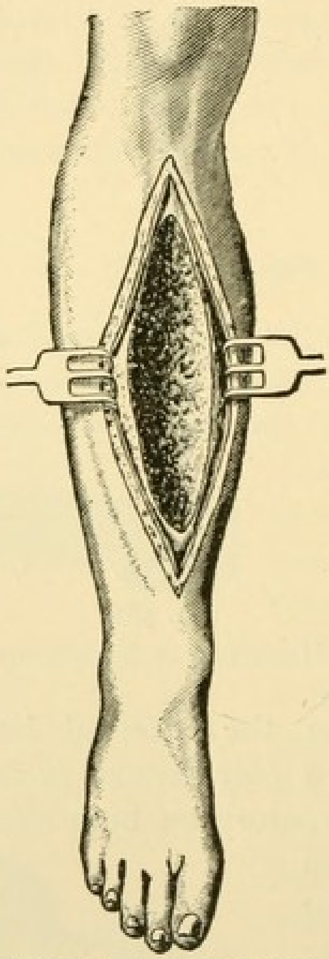


Fig. 585. Shallow Cavity after Necrotomy

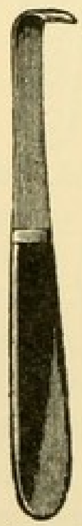


Fig. 586 Raspatory

Fig. 587 Sequestrum Forceps

3. At the end of the operation, the margins of the wound are sutured together if possible to effect healing by aid of a moist blood clot, or the bony cavity is firmly *packed;* a copious dressing is applied over it and fastened with a bandage.

If copious bleeding follows the operation, the whole dressing can be more firmly applied with an elastic bandage. *Then* only the elastic constriction is *rapidly* removed.

(Most of the surgeons prefer to remove the elastic constrictor before the dressing is applied, as in doing so many of the bleeding vessels can be tied, leaving only the parenchymatous hemorrhage to be arrested by tampon and dressing. The limb should always be immobilized and kept in an elevated position for at least 24 hours.)

The wound heals by forming granulation, which, moreover, with large and deep cavities, takes a very long time.

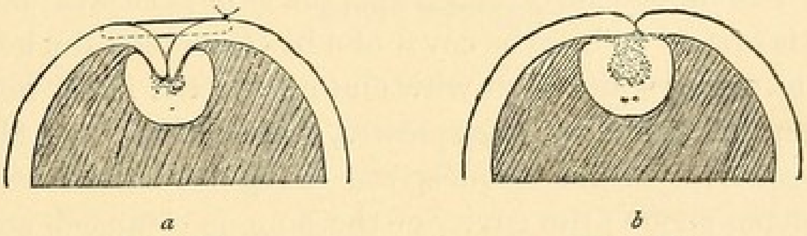


FIG. 588 FIG. 589

NEUBER'S INVERSION SUTURE. *a*, after the operation; *b*, after healing

To *promote the healing process*, the skin can be *detached* on both sides of the wound from the fascia and drawn over the surface of the bone, where it is fastened with small steel nails or with a suture (*inversion suture* — *Neuber*, Fig. 588). The healing then takes place by adhesion; the flaps of skin, at first pressed deep into the bone, gradually rise to their normal position by the mass of bone forming underneath it (Fig. 589).

Attempts have also been made to fill the gap immediately after the operation with *bone chips* made by the chiselling, and to sew the skin over them. *Senn* used in a similar manner *decalcified* chips of the tibia or femur of an ox; these decalcified chips are preserved in alcohol or iodoform ether. Still, aside from some good successes, many failures have occurred from the fact that some chips did not heal in and were eliminated by suppuration. (Failures after packing bone cavities with decalcified bone chips are due entirely to imperfect disinfection of the cavity or the use of fine material which has not been thoroughly sterilized. Extrusion of bone chips never takes place from perfectly aseptic cavities.) It is much better, after a complete suturing of the margins of skin, to allow the cavity to be filled with blood and to let it heal by the aid of a *moist blood clot* (*Schede*).

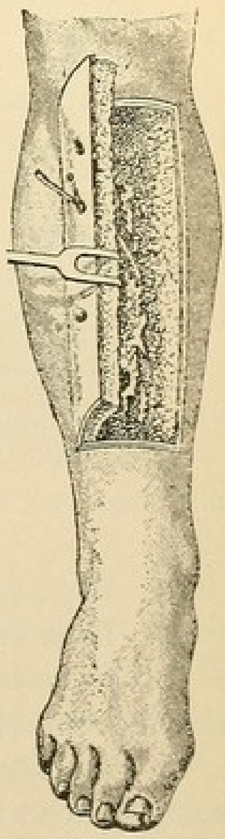


FIG. 590
OSTEOPLASTIC NECROTOMY

With *Lücke and Bier's* **osteoplastic necrotomy**, aside from great rapidity and ease of inspection, sometimes even a considerably more rapid and better healing of the wound is obtained and with a minimum amount of scar tissue.

If the tibia is the seat of necrosis, as is most often the case, an incision is made around the thickened part on three sides down to the bone (Fig. 248).

In line with the short transverse incisions, the thickened bone wall is divided at its anterior circumference with a *metacarpal saw*. The longitudinal incision is chiselled deep with a broad straight *chisel*. With the last strokes of the hammer, by forced leverage, the skin-periosteal-bone flap of the diseased bone is turned up like the cover of a box (whereby the bone at the base of the flap is infracted), and then with one glance the large bone cavity can be inspected and examined as to sequestra, granulations, and abscesses (Fig. 590). After removal of the sequestrum the granulations are scraped out with a large sharp spoon; the cavity of the bone is cleansed, and the portion of bone turned up with the soft parts is replaced in its former position and fastened by a few sutures.

Complete healing has set in, in some cases even where the necrosis was extensive, in 3 or 4 weeks. In other cases after a long interval fistulae occurred again, so that the broad opening with an alveolar formation is indeed more tedious, but surer of success.

AMPUTATIONS AND DISARTICULATIONS

Amputation of a limb in general *should be made only* when by this mutilation the prospect of *saving the life* of the patient appears to be essentially better than without it in attempts to save the limb.

A portion of the limb is amputated: —

1. In extensive *comminution of the bone* and laceration of the large blood vessels and nerves.

2. In lacerations of the *whole musculature*, even when the bone is involved only to a small extent.

3. In very extensive *destruction of the skin* (ulceration), when the limb has become thereby useless, and a formation of skin grafting is impossible.

4. In *gangrene* of a part of a limb (frost-bites, burns, senile gangrene).

5. In *malignant tumors*, to prevent general infection.

6. In serious *septic* or *pyæmic infections*, if the surgeon by other methods fails in removing the source of infection.

7. In *suppurations* of long duration, when the strength of the patient has been reduced to such a degree that apparently he can *not* resist the *prolonged* drain, and when by an amputation of the limb health can be restored in a *shorter* time; finally, as a favor.

8. In atrophied paralytic limbs, when the patient desires of his own accord the removal of such portions of his body as have become not only entirely useless, but an incumbrance.

GENERAL RULES

PREPARATIONS

1. The patient is placed in such a position that he can be well anæsthetized, and that the surgeon and his assistants have sufficient room. The cut surface of the limb to be amputated must be turned toward the full light.

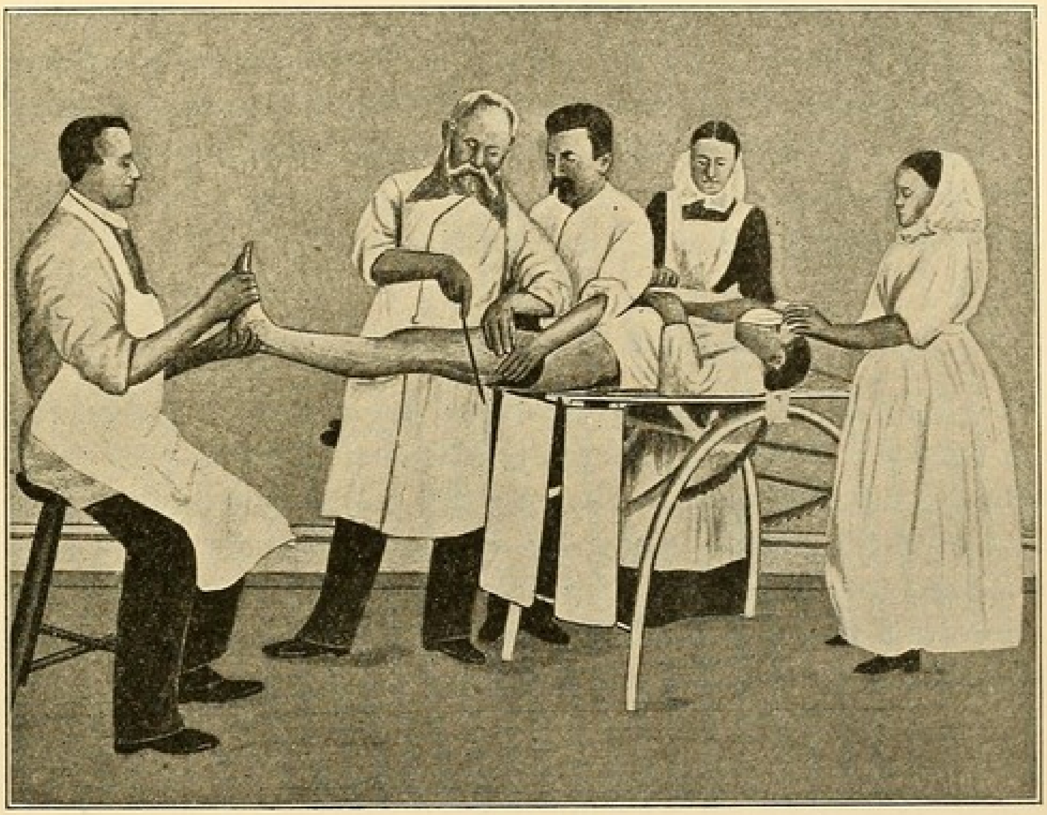


FIG. 591

2. Each assistant receives a certain position and a certain work to perform. The assistant who takes care of the wound stands opposite to the operator. The assistant handling the instruments stands close to him without hindering his movements or interfering with the light. A third assistant holds the part of the limb to be amputated with outstretched arms. The anæsthetizer stands at the head of the patient. If a sufficient number of assistants are not present, the operator must be content with fewer or even with only one. In such a case, the surgeon himself takes the instruments

from the basin, while the assistant holds the limb and subsequently the stump.

3. It is best for the operator to take such a position that the amputated limb falls *to his right side*.

4. Previous to the operation, the skin is *shaved* extensively in the region of the field of operation, *cleansed* with soap and brush, and thoroughly *disinfected* as described on pages 13–16. As soon as anæsthesia has set in, the limb is constricted above the place of amputation, and after removal of the bandage is once more disinfected. In inflammations and tumors it suffices to hold the limb for some time in a vertical position, so that the circulation of the blood becomes decreased. The constrictor is then applied, but always so far in an upward position, that it can be easily removed *after* application of the dressings. Fistulous openings and suppurating or gangrenous surfaces are covered with compresses dipped in antiseptic solutions to prevent any possible infection of the instruments and hands from carelessness. Of course, during the amputation, all rules of antisepsis and asepsis must be strictly observed.

DIVISION OF THE SOFT PARTS

The *soft parts* must be so divided that they will **cover** the sawed-off bone **without tension**. The muscles are divided **vertically** to the axis of the limb; the incision must not be made by pressure, but by see-saw motions of the knife, as in cutting roast beef. By an *oblique* section of the muscles the blood vessels are also divided obliquely, rendering their ligation more difficult. For this reason, of all methods most to be recommended are the **circular incisions** of the **skin and muscles.**

CIRCULAR AMPUTATION

(BY ONE INCISION — *Celsus*)

While an assistant holds the limb encircled with both hands over the place of amputation, and thereby fixes skin and muscles, all soft parts are divided by one **circular sweep** of the *amputating knife* (Fig. 592) down to the bone; the length of the knife depends on the thickness of the limb (Fig. 593); the bone is then sawed through *at once*. The surgeon should hold the long amputating knife with his whole hand, in order to reach around the whole circumference of the limb; the point of the knife is applied upon the anterior side of the limb turned toward him, vertically and transversely to its axis; next it is pushed with a slight pressure toward his own breast, whereby the blade, dividing all soft parts down to the bone, enters as far

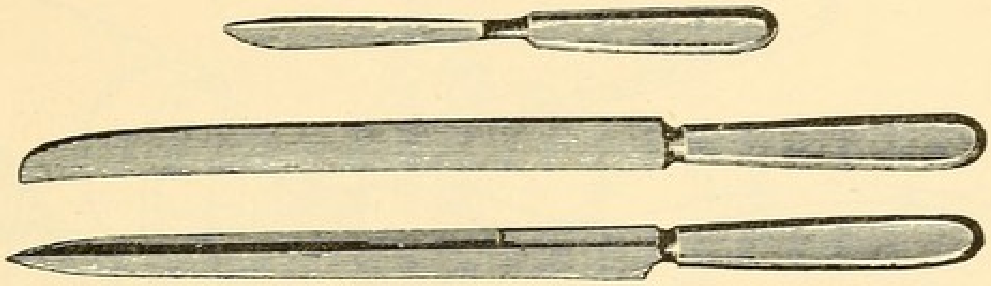


FIG. 592. AMPUTATING KNIVES

as the handle, when it is carried by short *sawing* movements around the bone and back to where the incision was commenced. Others divide with the knife, applied near the handle, in a long sweep, first the soft parts of the

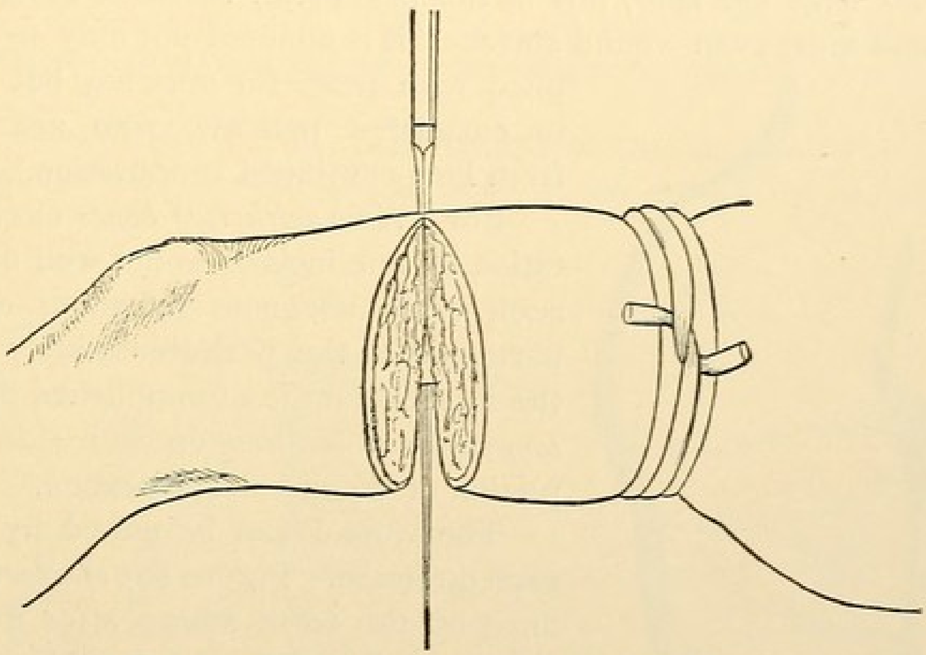


FIG. 593. CIRCULAR AMPUTATION BY ONE INCISION

limb on the side opposite to the operator, then apply the knife in an opposite direction at the beginning of the incision, and divide the soft parts on the operator's side.

The bone is then sawed through at once. In order that the soft parts may be united *without tension* over the bone, the end of the bone must be *again* sawed off to the extent of half of the diameter of the limb. For this purpose, the bone stump is grasped with *lion-jawed forceps*, and while the soft parts are well retracted, the *periosteum* is reflected with a gouge-shaped raspatory (Fig. 594), until the bone is sufficiently exposed (*von Esmarch*).

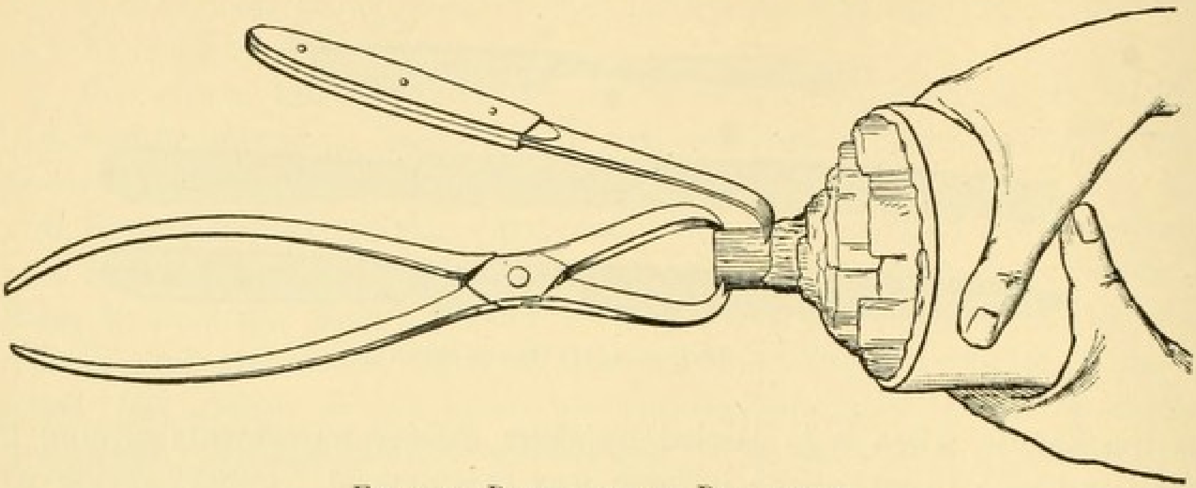


Fig. 594. Reflection of Periosteum

In *limbs with one bone*, this is the best of all methods in creating the smallest and most even wound surface; it is adapted not only to limbs supplied with powerful muscles, but especially to emaciated patients, who are exhausted from long-continued suppuration.

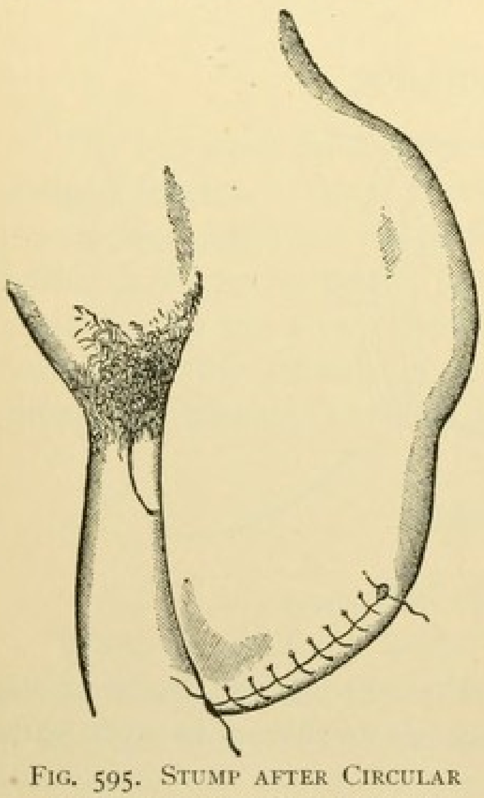


Fig. 595. Stump after Circular Amputation by One Incision

For *a limb with two bones* circular amputation by one incision is not well adapted; in such cases adequate reflection of the soft parts and of the periosteum after division of the interosseum is accomplished by a *lateral longitudinal incision* on each side after completion of the circular operation.

The wound can be united by sutures in each direction. Figure 595 shows the appearance of the fresh stump after a transverse suturing; Fig. 624, after a vertical closure of the wound.

A modification of this operation is **circular amputation (by two incisions**—*Petit*, 1718), by which the skin and the muscles are divided in *two* planes by separate circular incisions.

By a circular incision the skin is divided down to the fascia (Fig. 596); next, the skin is loosened all around, while an assistant retracts the skin upward by repeated incisions made perpendicularly to the axis of the limb down to the fascia (Fig. 597, *not* as in Fig. 598). The skin is freed to such an extent that its margin can be grasped with the fingers of the left hand and

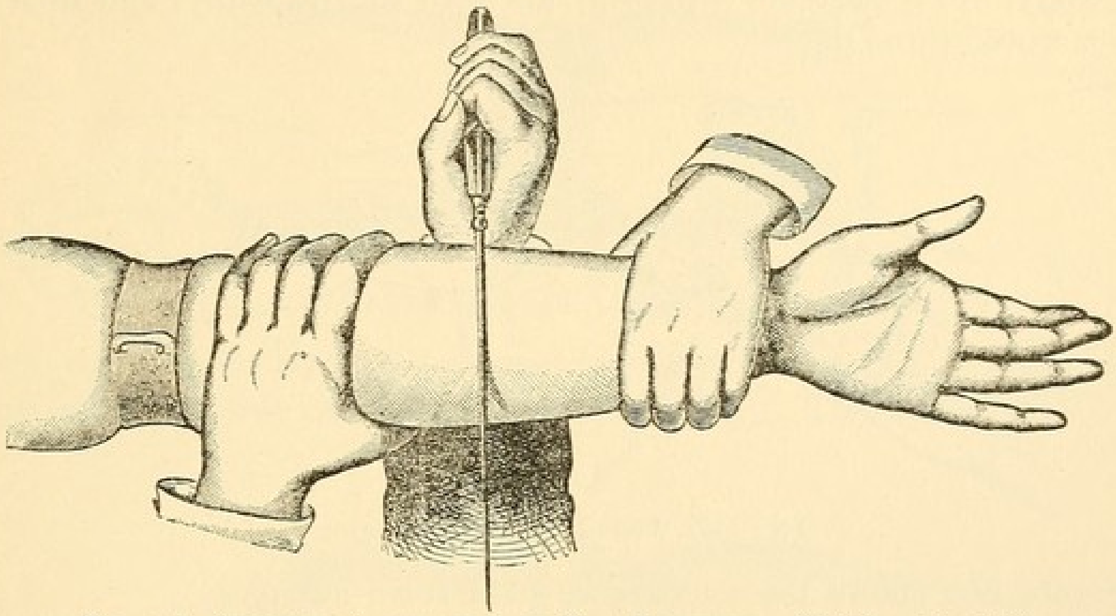


FIG. 596. CIRCULAR AMPUTATION BY TWO INCISIONS. (Dividing the skin)

be turned upward like a cuff. The length of the manchette or cuff *must equal nearly half the diameter of the limb.* If the margin of the incision of

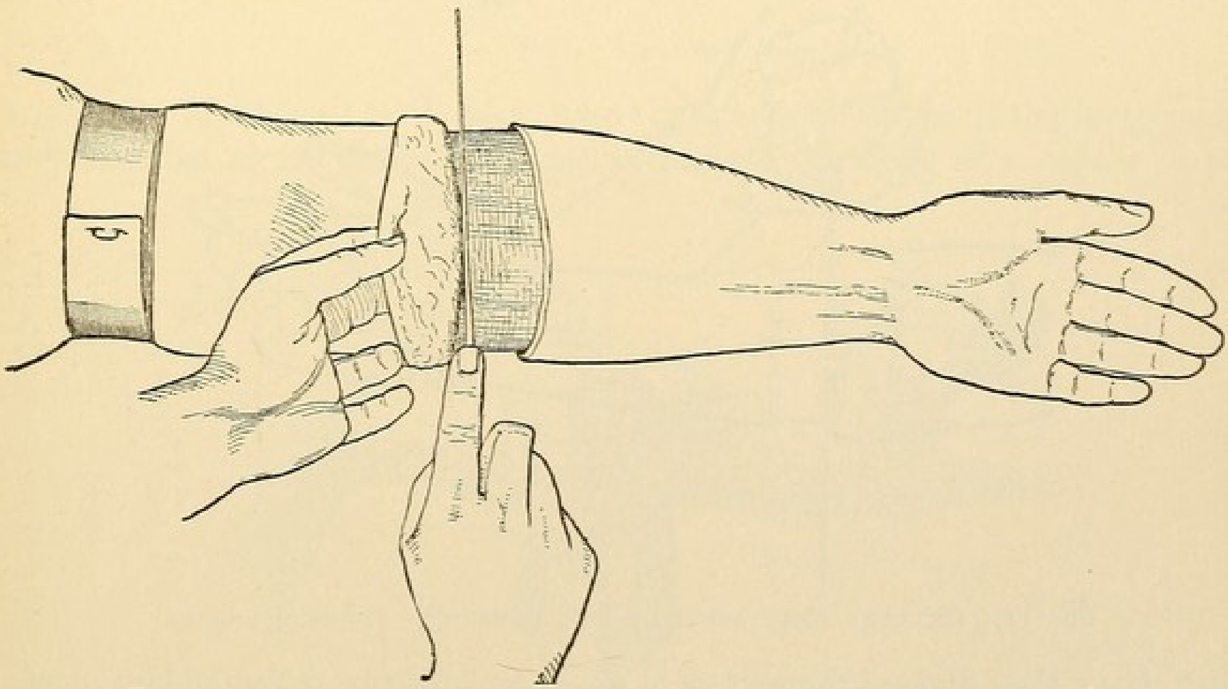


FIG. 597. CIRCULAR AMPUTATION BY TWO INCISIONS. (Loosening the skin)

the skin is too narrow, because the limb increases in circumference above the place, the skin can be divided by a *short longitudinal incision* at one or two opposite places. Close to the place of reflection of the skin cuff, by a second circular incision, all muscles are divided down to the bone (Fig. 599); the periosteum is *pushed back* with the raspatory, and then the bone is sawed through.

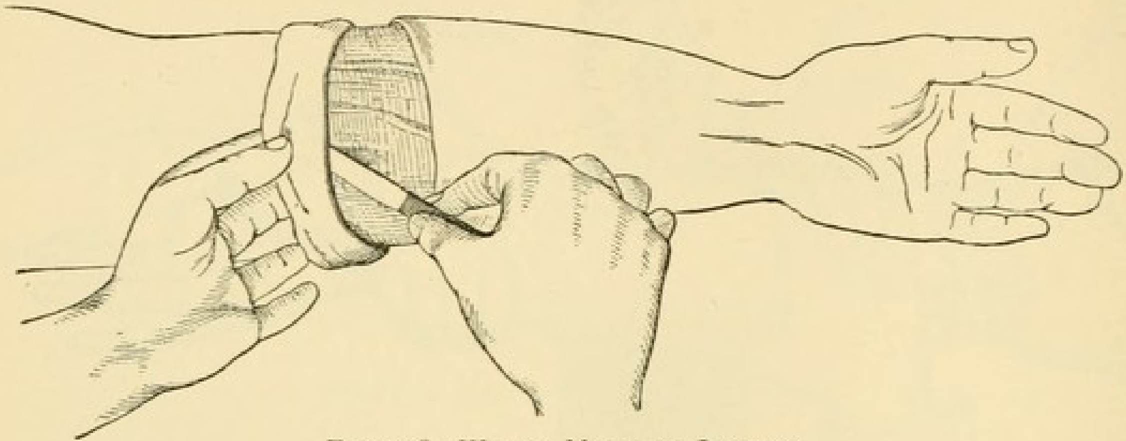


Fig. 598. Wrong Mode of Incision

Figure 600 shows the appearance of a fresh stump.

Amputation made by two circular incisions has been described in various modifications. *Petit and Cheselden* first divided only the skin in a circular manner; next, while all the soft parts were *drawn forcibly upward*

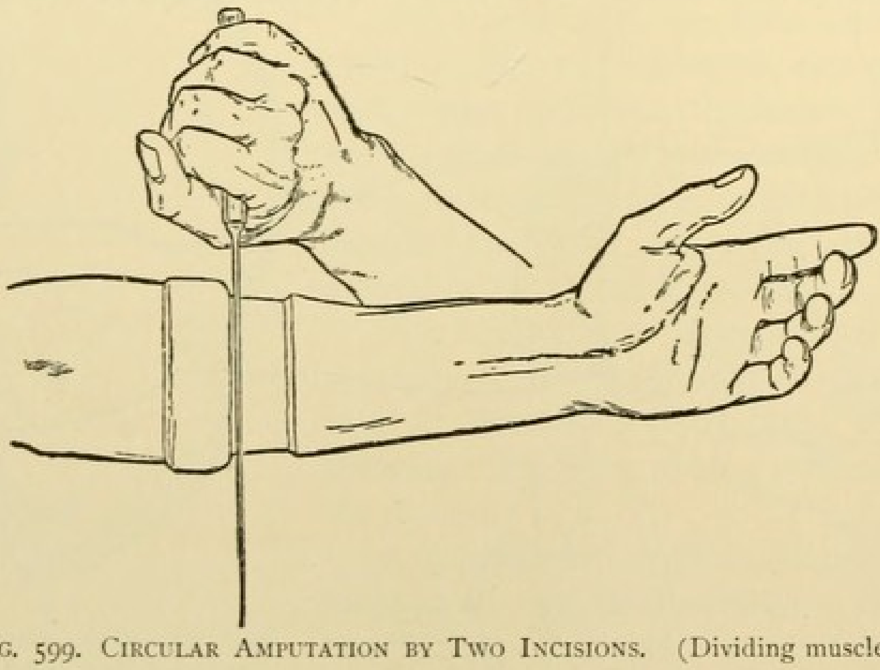


Fig. 599. Circular Amputation by Two Incisions. (Dividing muscles)

(Fig. 601), they divided them *close to the margin* of the retracted skin down to the bone in one sweep. *Louis* divided all soft parts in one cut down to the bone, but detached from the bone by a second circular incision the small *muscular cone*, which after the retraction of the superficial muscles is formed by the deep muscles more firmly attached to the bone. *Desault* went farther by dividing in layers first the skin, next the superficial muscular layer, and

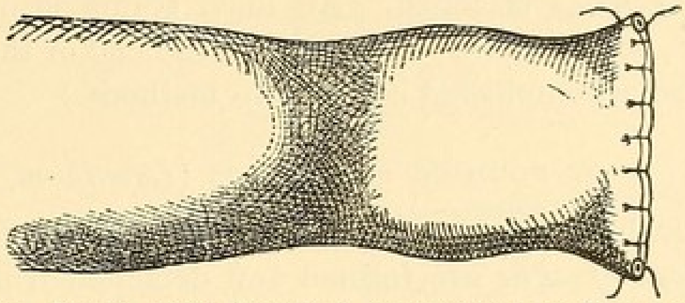


FIG. 600. STUMP AFTER CIRCULAR AMPUTATION BY TWO INCISIONS

finally the deeper layer, on a level to which the former had retracted (**amputation by three circular incisions**) (Fig. 602). The wound then forms

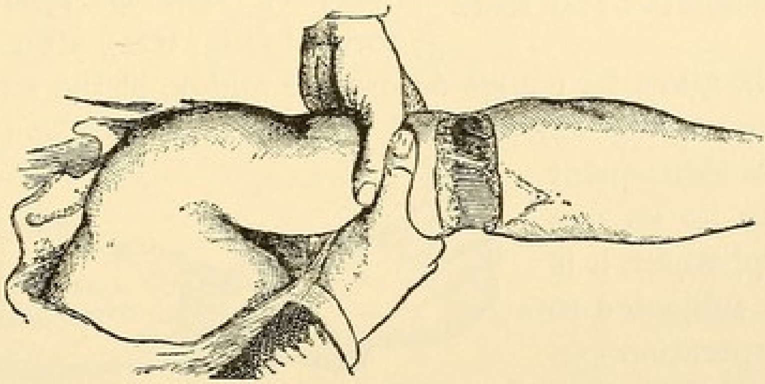


FIG. 601. PETIT'S CIRCULAR INCISION

a funnel. Much better, however, than the several divisions of the muscles, is the **reflection of the periosteum** and sawing off the bone *at a higher plane*

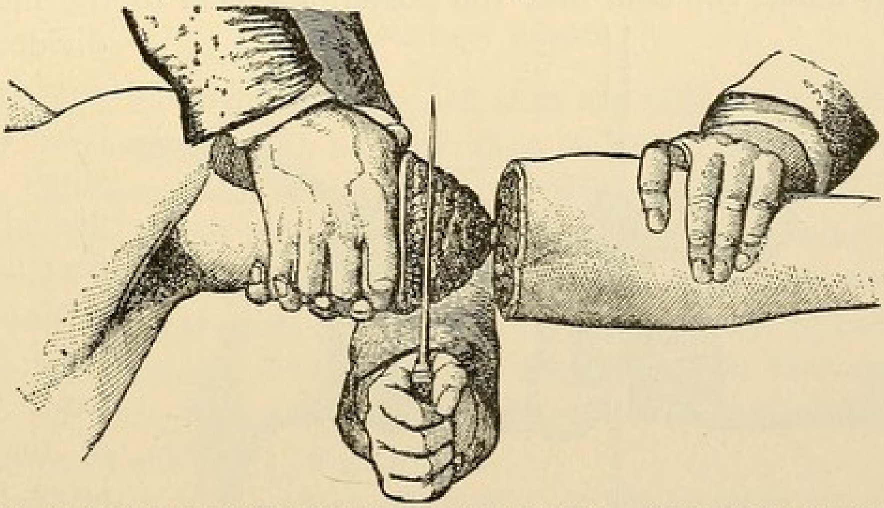


FIG. 602. AMPUTATION BY THREE CIRCULAR INCISIONS. (Detaching muscular cone)

(*von Esmarch*), whereby abundant soft parts are secured for covering the stump.

(All methods of circular amputation have become unpopular owing to the scar which always forms in the centre of the stump over the end of the bone to which it becomes attached. An ideal stump is only obtained by suturing the wound, not over, but to one side, of the end of the bone or bones, and this can only be accomplished by the flap methods.)

AMPUTATION BY FORMING SKIN FLAPS (*Lowdham*, 1679)

With a broad scalpel or a *flap knife*, according to *von Langenbeck* (Fig. 603), *semilunar flaps of skin* are formed and detached from the fascia by incisions directed vertically to their surface as far as their base, when they are reflected. Either *two lateral flaps of skin of equal length* are formed (Fig. 604), after the union of which the cicatrix takes its course across the middle of the stump, or, what is more preferable, a *long anterior* and a *short posterior flap* (Fig. 605) are made, so that the subsequent cicatrix comes to lie on one side of the stump, where it is less liable to be subjected to pressure. The operation can also be modified so that, in the wearing of an artificial limb, after a *long anterior skin flap* has been made, the skin over the posterior aspect of the limb can be divided by a *semicircular incision* (Fig. 606), when it is detached and reflected in the form of a short flap. In this case, the base of the anterior large flap must be *a little smaller* than half the circumference

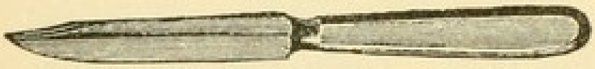


FIG. 603. VON LANGENBECK'S FLAP KNIFE

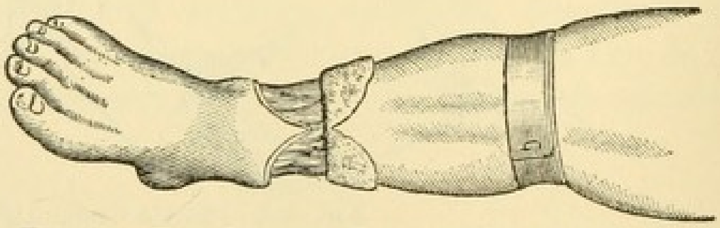


FIG. 604. TWO LATERAL FLAPS OF SKIN OF EQUAL LENGTH

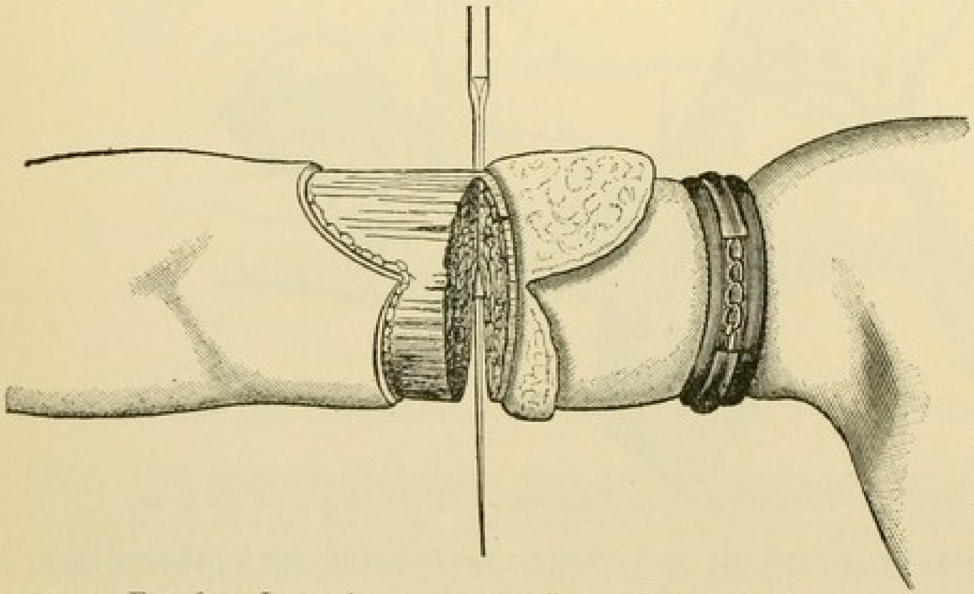


FIG. 605. LONG ANTERIOR AND SHORT POSTERIOR FLAP

of the limb; its length, however, must be equal to the sagittal diameter of the same. Close to the place of reflection of the flaps of skin all muscles are divided by a circular incision down to the bone, and the latter is sawed

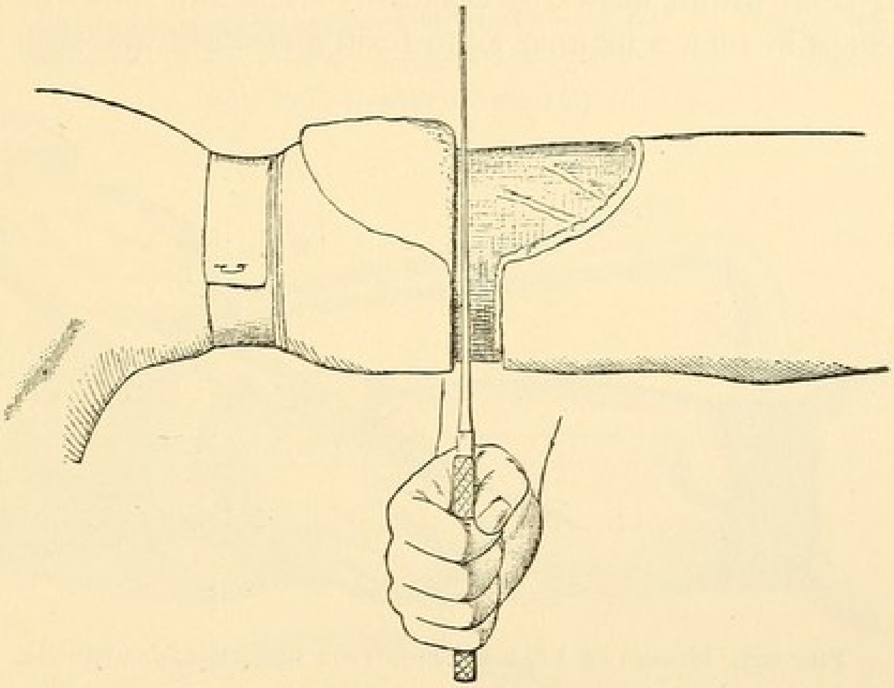


FIG. 606. ANTERIOR SKIN FLAP WITH SEMICIRCULAR POSTERIOR INCISION

off. The anterior flap hangs then like a curtain over the surface of the wound, and permits good drainage for the secretions, as well as a favorable lateral position for the subsequent scar.

MUSCULAR FLAPS

The methods by which **muscles and skin are utilized** in making the flaps are not to be recommended, because they result in *larger* wound surfaces, and above all, on account of the *oblique* section of the arteries.

The flaps can be cut either **from without inward** (*Langenbeck*—Fig. 607), for which very sharp flap knives are used, or **from within outward** (*Verduin*), by *transfixing* the soft parts at the base of the flap close to the bone with a long two-edged knife, and carrying the same obliquely downward and outward from the bone with long sawing movements toward the surface. (See disarticulation of the thigh, Fig. 760.)

The latter method is seldom resorted to at the present time; in amputations for gunshot fractures, it is especially to be avoided, because the knife is easily arrested by bullets concealed in the soft parts or by splinters of bone. Moreover, two-edged knives are not safe, because the edge of the back, if the knife is carried unsteadily, may nick the blood vessels in the flap at several places. Moreover, two-edged knives are more difficult to grind than a one-edged knife, with which the formation of flaps can be made just as well from within outward, especially when the point of the knife is always directed in such a manner as to form a straight line with the back of the knife.

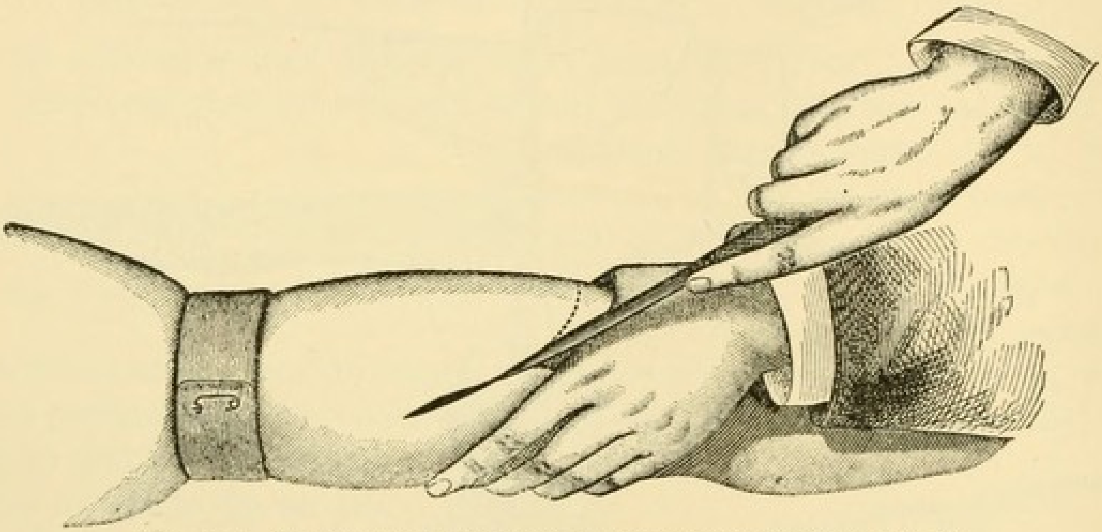


FIG. 607. MUSCULAR FLAP INCISION (von Langenbeck's method)

A modification of amputation by the muscular flap incision is the **oval incision** (*Langenbeck*).

In the operation by this method two flaps join posteriorly in a *transverse incision* so that the wound has the form of a heart (Fig. 643). It is especially adapted for disarticulating smaller joints (fingers and toes). In other localities, aside from the rapidity of its execution, which, with the use of chloroform and the "bloodless method," is of little consideration, it has no advantage over other methods. For an exact execution of the operation, much practice and very sharp flap knives are required.

SAWING OFF OF THE BONES

After division of all soft parts, the operator changes the knife for an *amputation saw* (Figs. 608–610), applies the nail of his left thumb upon the bone to steady the blade of the saw (Fig. 611), and saws along it with long, very light movements, making first a guiding furrow; then with long, vigorous movements, he saws through the bone with moderate rapidity, *without exerting any pressure*.

During the sawing, the soft parts are retracted by the first assistant using his hands or by means of a sterilized divided compress (Figs. 612, 613),

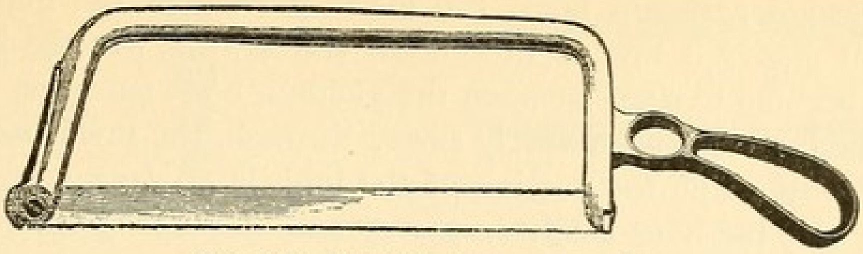


FIG. 608. REINER'S AMPUTATION SAW

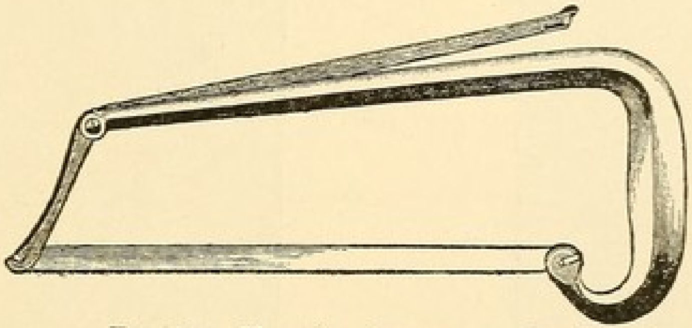


FIG. 609. NYROP'S AMPUTATION SAW

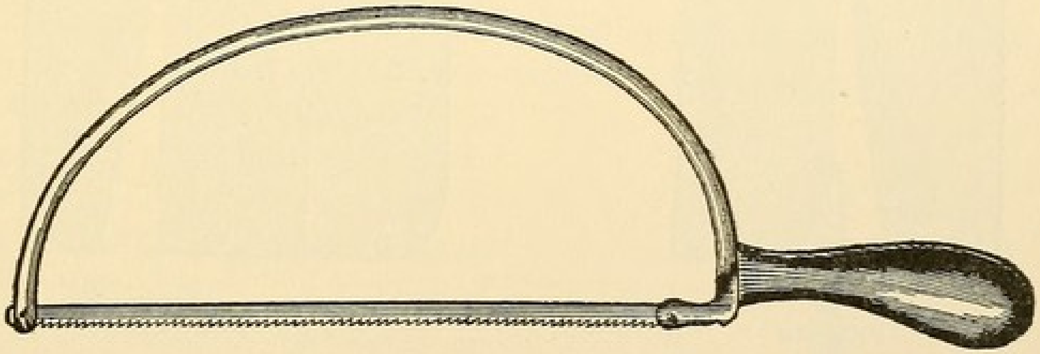


FIG. 610. HELFERICH'S AMPUTATION SAW

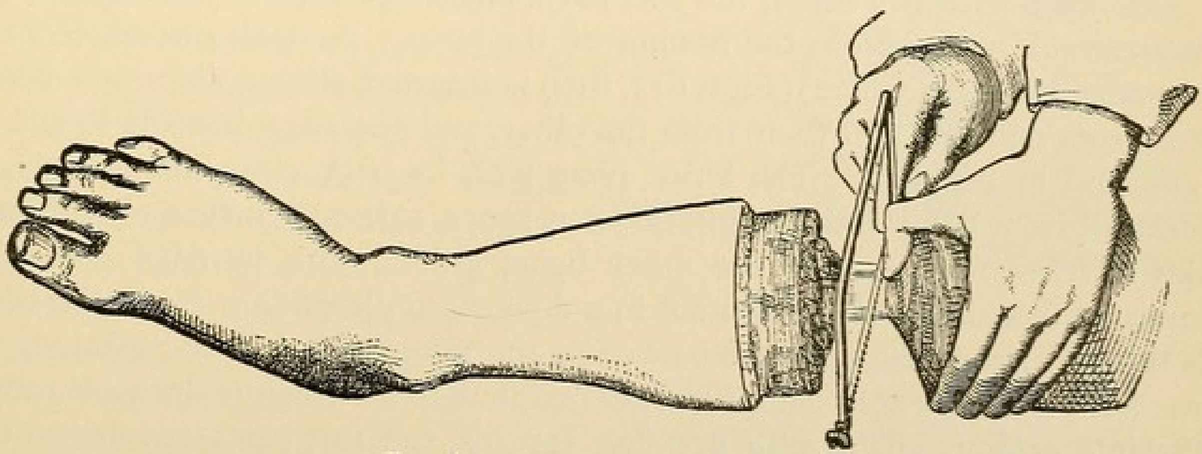
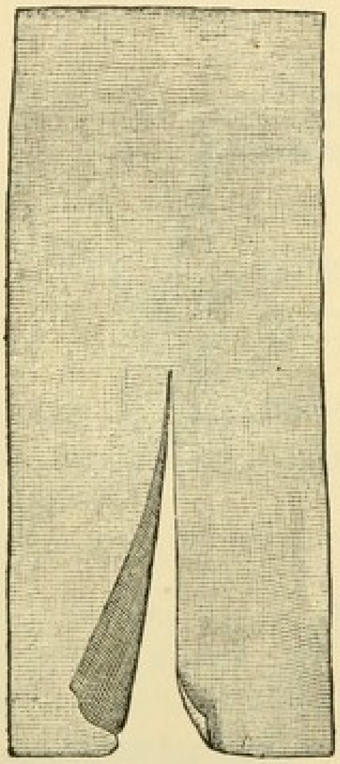


FIG. 611. SAWING OFF THE BONE

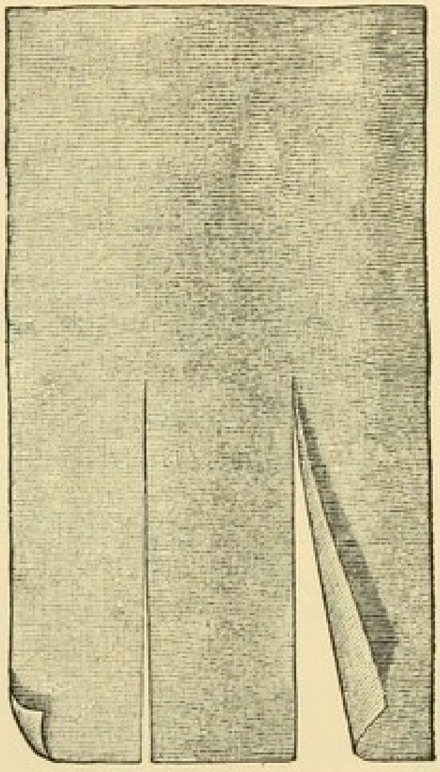
while the second assistant holds the lower portion of the limb firmly and securely, but *lowers* it toward the end of the sawing, *lest* the blade of the saw should become *wedged* between the yielding bone surfaces.

When the bone has been nearly sawed through, the saw is used carefully and more slowly, while the section of the limb is *no longer* lowered by the assistant, or else the bone easily *breaks off* and becomes splintered.



a

FIG. 612



b

FIG. 613

DIVIDED COMPRESSES. *a*, for limbs with one bone; *b*, for limbs with two bones

In limbs with two bones, the soft parts must be completely divided in the *interosseous space* before the sawing of the bone. A small one-edged or a two-edged knife (Catline) (Figs. 615, 616) is inserted, sliding along one bone, first from one side and then from the other, and the edge is made to cut as indicated in Fig. 617. The knife, lying with its back close to one bone, is inserted from below into the interosseous space, carried transversely through the interosseous space to the other bone, guided with its edge along its inner surface, and then drawn out in a downward direction. Next, the edge is turned against the opposite bone, and the same procedure is repeated.

With a doubly split compress, the middle flap of which is drawn through the interosseous space with dressing forceps, the soft parts are drawn up-

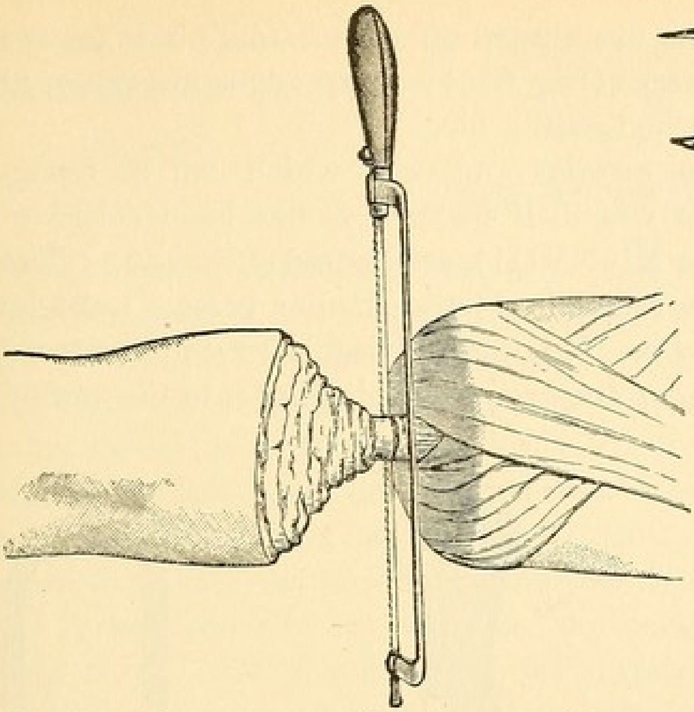


Fig. 614. Retraction of Soft Parts by Means of Divided Compress

Fig. 615

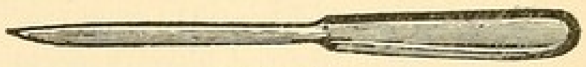


Fig. 616

Knives for dividing Soft Parts in the Interosseous Space (Catline)

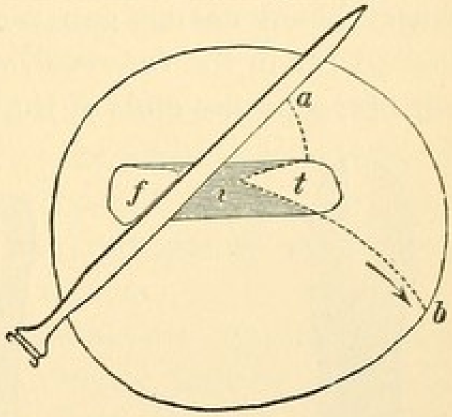


Fig. 617. Method of carrying Knife in the Interosseus Space (*i*)

ward (Fig. 618), and both bones are divided *at the same time.* If, as on the leg, one bone is considerably thinner than the other, the saw is so conducted as first to make a guiding groove in the tibia to prevent the splintering of the fibula; next, the fibula is divided, and then with the last movements the tibia also.

(In amputations of the lower extremity above the ankle joint it is exceedingly important to perform the operation with a view of obtaining, besides satisfactory wound healing, an ideal, painless conical stump well adapted to the wearing of an artificial limb. These conditions must be complied with to obtain such a result: 1. Lateral position of scar. 2. Cover end of bones with periosteum. 3. Saw through the fibula at least an inch higher than the tibia.)

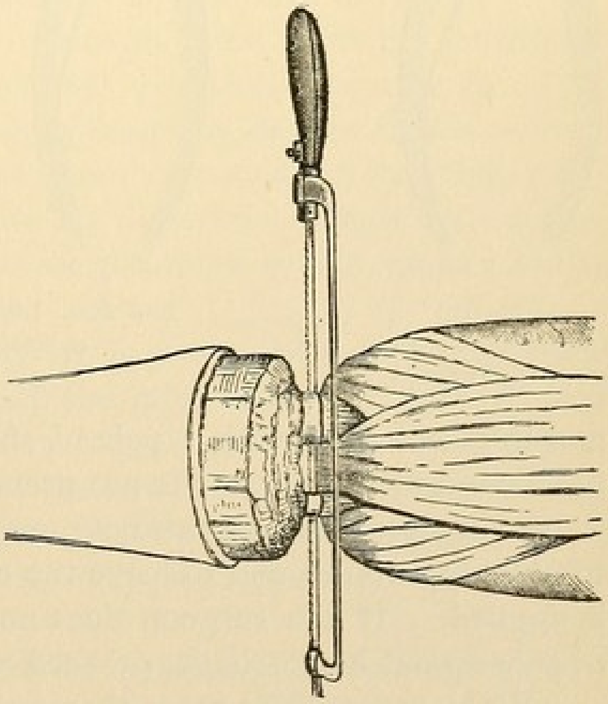


Fig. 618. Sawing off both Bones. Retraction of soft parts by means of divided compress for limbs with two bones

After the bone has been sawed

off, any projecting portions of bone are nipped off with *Liston's* **bone forceps** (Fig. 619), or with *Lüer's* **gouge forceps** (Fig. 620); sharp edges are removed with a fine saw (Fig. 621) or smoothed with a file.

Next, *all divided* **blood vessels**, arteries and veins which can be recognized as such, and the position of which, if necessary, has been called to mind by sectional drawings (Plates XI–XVIII), **are ligated** (Fig. 440). The larger blood vessels can easily be recognized; the smaller vessels must be looked for in the *intermuscular septa*. It is also advisable to *draw forward* with forceps the ends of the *trunks of large nerves* projecting into the wound

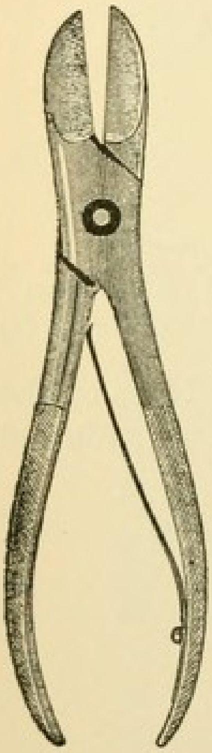


FIG. 619
LISTON'S BONE-CUTTING FORCEPS

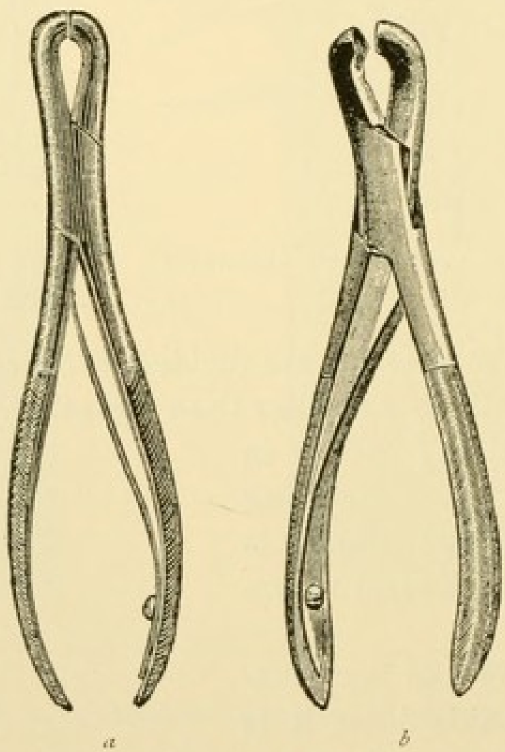


FIG. 620. LÜER'S GOUGE FORCEPS
a, straight; *b*, curved

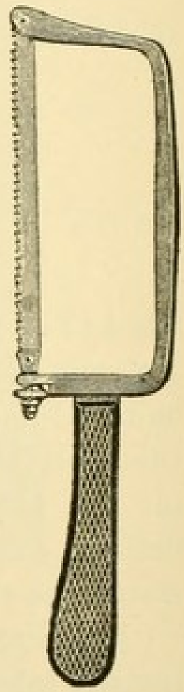


FIG. 621
AMPUTATION SAW

and to resect them with a pair of sharp scissors; by doing so, the pains in the wound or in the cicatrix are prevented, or at least alleviated.

A surgeon who has the necessary practice in ligating can then proceed to unite the wound, and to leave the constrictor in position until the dressing is applied. If the surgeon does not dare to pursue such a course for fear of subsequent hemorrhage, proceed as indicated on page 233.

(We now recognize more than ever the importance of careful hemostasis as an essential element in the satisfactory healing of wounds. Hence it is under all circumstances necessary to remove the constrictor before suturing the wound, and resort to the most pedantic measures in arresting the bleeding before the wound surfaces are brought in contact by sutures.)

UNION OF THE WOUND

This must be made in such a manner that blood and serum cannot collect in it, but must at once appear at the surface, where they are quickly absorbed by the antiseptic or aseptic compressive dressing.

With careful hemostasis and perfect asepsis, it is sufficient to unite the margins of the skin over the soft parts by suture; the angles of the wound should be left open, or supplied with drainage tubes, and a firm, compressive bandage should be applied, which presses the surfaces of the wound upon each other, and prevents the collection of secretions.

If drainage is to be made, the drainage tubes should be supplied with a long thread which is brought out through the dressing, and by means of which the tube can be extracted on the second or third day without changing the dressing. These *drainage tubes, provided with threads* (*Kocher*), have the advantage of securing the drainage of the secretions as any other drainage tube, while their canals, after the tubes have been withdrawn, at once become closed by the apposition of their walls, so that, in spite of the drainage, complete healing can take place in ten to twelve days.

If it is not desirable to insert any drainage tubes, then the lowermost angle of the wound is left open in order that any secretions may drain off, or the several layers are stitched together *in layers* by *deep or buried sutures*, whereby all sinuses in the surface of the wound are avoided, and the collection of secretions prevented. The following illustrations show the application of the sutures after an amputation of the thigh with a single circular incision:—

First, the retracted periosteum is drawn forward and united with a few catgut sutures over the sawed surface of the bone (Fig. 622). Next, with long, slightly curved needles and heavy catgut sutures, first the deeper (Fig. 622), then the superficial, layers of the muscles (Fig. 623) are sutured, and finally the margins of the skin are carefully stitched together with a double glover's suture (Fig. 624), whereby only the lowermost angle of the wound is left slightly gaping.

(In suturing this amputation wound the periosteal flap should be first fastened over the end of the bone by two or three fine catgut sutures. Next a few strong catgut sutures must be used to supply the end of the muscles with a temporary point of anchorage to prevent undue retraction, and finally the flaps are sutured with silk or silkworm gut and horsehair. Drainage should be established where it is most needed, at the most dependent part of the wound, preferably through a separate buttonhole at the base of the posterior flap.)

Only after a permanent dressing, as described on page 43, and illustrated in Fig. 41, has been applied, is the constriction band removed.

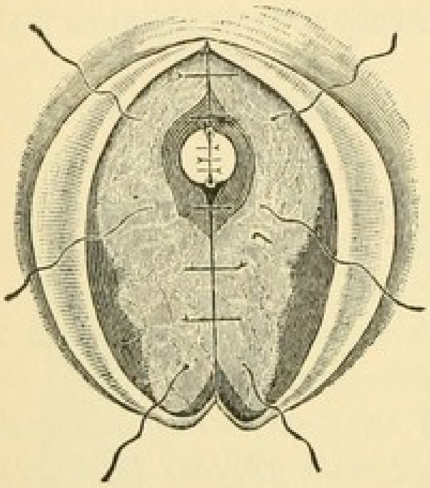


FIG. 622. SUTURING PERIOSTEUM AND DEEP MUSCULAR LAYERS

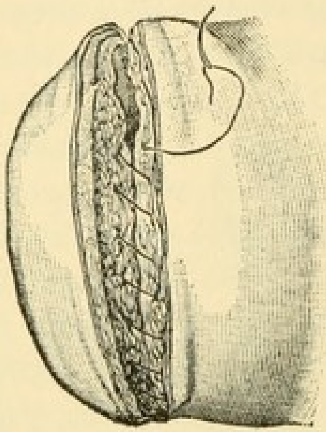


FIG. 623. BURIED MUSCULAR SUTURE

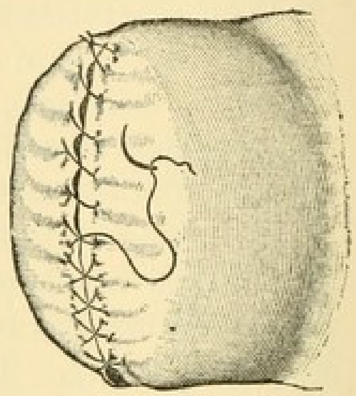


FIG. 624. SUTURE OF SKIN MARGINS

As a rule the dressings can remain in place for *several weeks*, until complete healing by primary intention has taken place; and finally all blood that the patient has lost since the amputation is found in the form of a small, dry, odorless crust on the inner surface of the dressing.

(The stump, after amputation, should be immobilized upon a hollow, well-fitting and well-padded splint, and kept in an elevated position at an angle of 40° for at least twelve to twenty-four hours.)

GENERAL RULES FOR DISARTICULATION

1. In most cases of **disarticulation** it is best for the operator to take a position with his face turned toward the patient, and to seize with his left hand the limb to be removed.

2. For division of the soft parts the *circular incision* is not as well adapted as the *flap incision*. Since in this operation it is generally necessary to cover a *large surface of bone*, comparatively large flaps must be formed either from the skin alone, or consisting of skin and the underlying muscles. In many cases, an *anterior large flap* and a posterior small flap (knee, shoulder, hip) are most advantageous; in some cases (ankle joint, metatarsus) the *posterior* flap must be the longest to protect the cicatrix from pressure.

For small joints (fingers, toes) the *oval incision* is especially well adapted.

3. Having divided the covering soft parts, the *articulation is opened* by *forcibly stretching* the exposed *tendons* by suitable movements, and by dividing them with a flap knife.

4. By dividing the other tendons and the *capsular ligaments* all around, the disarticulation is completed, and if necessary a portion is sawed off from the opposite articular end of the bone. On the whole the procedure is the same as in an amputation.

REAMPUTATION

1. If in an amputation insufficient soft parts have been saved, or if they have retracted during the healing in consequence of osteitis, or have been lost by gangrene, a so-called **conical stump** (Fig. 625) is the result; that is, the end of the bone projects so far that a complete cicatrization cannot be effected (ulcus prominens); or, finally, the thin cicatrix produced breaks down again and again as soon as the patient wears an artificial limb. Similar difficulties arise in stumps which are the result of frost-bite, burns, or gangrene. The bone of every, even, well-formed stump becomes atrophied after some time from *inactivity*, and *conical*.

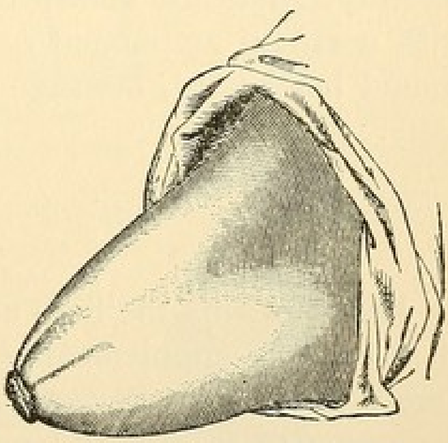


FIG. 625. CONICAL STUMP

2. In such cases, operators formerly performed another amputation higher up, or they sought to cover the cicatrix by the transplantation of skin flaps. The former procedure is in most cases unnecessary, and is just as dangerous as the first amputation; while the latter procedure only rarely yields a satisfactory result, because the skin on the extremities is not well adapted to plastic operations.

3. It is far better to make the **subperiosteal resection of the bone stump** — that is, the cicatrix or the ulcerated surface implicated is circumscribed with a strong knife, the soft parts of the stump are divided downward, or on two sides (avoiding the region where the large blood vessels and principal trunks of nerves are located) down to the bone, and the *periosteum is reflected upward* so far with a raspatory that a sufficiently large portion of the bone can be removed with a metacarpal saw or a chain saw. The hemorrhage, as a rule, is inconsiderable. The wound is united with

deep and superficial sutures after a drainage tube, if necessary, has been inserted as far as the end of the bone. The wound generally heals by primary intention, and the result is a good stump completely covered with healthy soft parts.

4. When the first amputation was made near a joint, the **subperiosteal disarticulation** may follow in the same manner under similar circumstances (compare Fig. 737).

In a perfect aseptic course the disadvantage just mentioned of the conic diaphysis stump will not occur. Still, the surface of the stump is always more or less sensitive to pressure. Hence, in making the prothesis attention should be paid that no pressure is exerted upon the stump. *Bier* has remedied this disadvantage by *osteoplastic amputation.* He closed the amputated bone surfaces by means of a bone cover (see p. 374) and thereby effected non-sensitive stumps, which were well able *to bear pressure.* More recently *Hirsch* has shown that the same success can be obtained likewise with a stump amputated *in the ordinary manner* if, immediately after the wound has healed, massage and pressure movements by walking are made daily.

PROTHESES

For rendering the limb mutilated by amputation somewhat useful again, or at least for supplementing its former shape, the patient wears an artificial limb, a **prothesis**. Protheses are made in various forms, from the simplest apparatus to artistic and most perfect machines. In general, for patients who must work with their protheses, the simplest apparatus is to be recommended. The artificial limbs, in form and power of motion often strikingly similar to the missing limb, are rather ornamental, and must be often repaired for injuries which easily occur.

An *amputated* **hand,** together with the arm, can be replaced by a **claw hand** (Figs. 626–628), a hook, clamp, plate, or something similar, attached to the end of a well-fitting leather case, with which the patient, after some practice and ingenuity, can perform a great deal of ordinary work most skilfully. A hand made of wood and covered with a glove can likewise be attached to the leather stump; it serves more for ornamentation than use. The artificial arms provided with movable fingers, in which the muscles are imitated by means of spiral springs and threads, are adapted only to lighter work. They are very expensive, and easily get out of order.

An **amputated leg** is replaced in the simplest and most durable manner by a **peg leg**; that is, a firm wooden stump fastened to a well-fitting case. When the leg has been amputated very high the patient *kneels* upon it (Fig. 631). When the thigh has been amputated very high he *sits* upon the well-padded margin of the support (Figs. 629, 630). The "artificial leg," made of light, firm wood, is movable at the knee and the ankle joint by a hinge joint (Fig. 632). As beautiful as it may appear, still, if the patient wishes to walk rapidly and for a long time, the simple support is mostly preferred, because it is more durable and can be repaired more easily and inexpensively than an artificial leg.

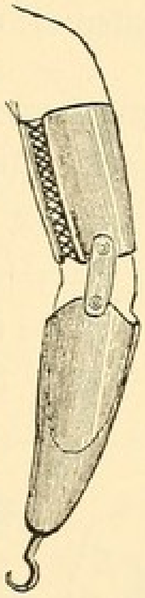


Fig. 626

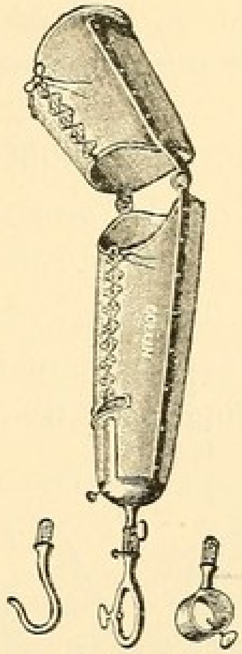


Fig. 627
Claw Hands

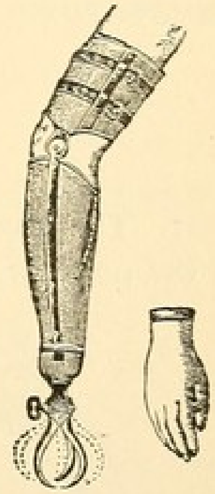
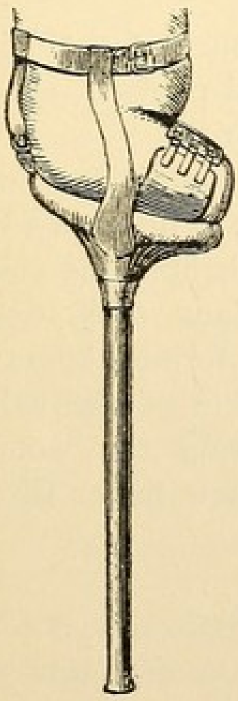


Fig. 628



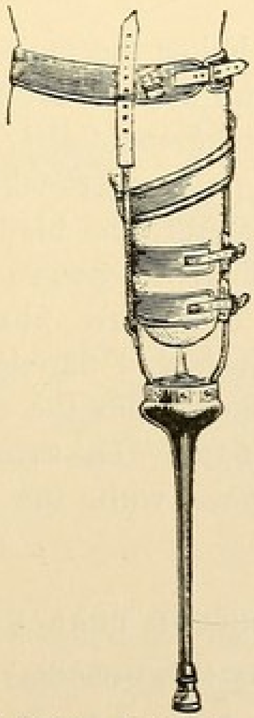
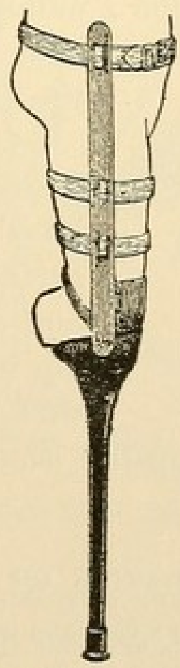


Fig. 629 Peg Legs Fig. 630
for amputated thigh



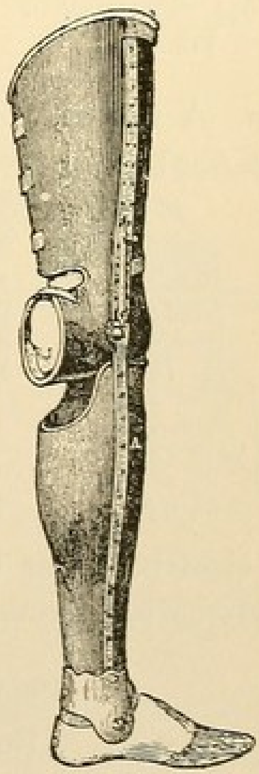


Fig. 631. Peg Leg Fig. 632. Artificial Leg
for amputated leg

(If, after an amputation of the leg or thigh, the patient can bear the expenses of an artificial limb, the stump must be properly prepared. Artificial atrophy should be induced by systematic bandaging, and the skin properly prepared by washing with diluted alcohol for at least three months.)

AMPUTATIONS AND DISARTICULATIONS OF THE UPPER EXTREMITIES

DISARTICULATIONS OF THE FINGERS — DISARTICULATION OF THE THIRD PHALANX

(By forming a volar flap from without inward)

1. The hand is held in pronation toward the operator. He takes hold of the point of the finger and flexes the third phalanx.

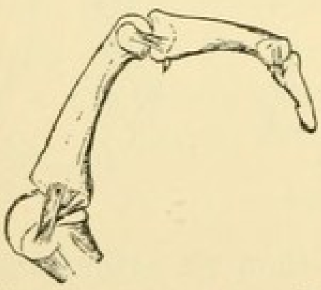


FIG. 633. SKELETON OF FINGER

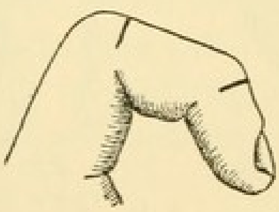


FIG. 634. POSITION OF LINES OF ARTICULATIONS OF THE FINGER

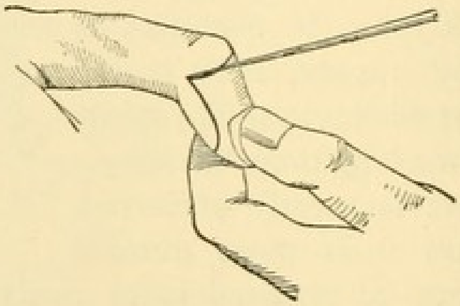


FIG. 635. DISARTICULATION OF FIRST PHALANX

2. A flat curved incision 2 millimeters below the eminence of the joint (Fig. 634), made transversely across the head of the second phalanx, opens the capsular ligament (Fig. 635).

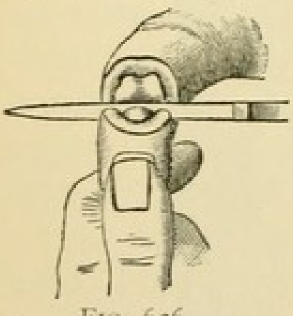


FIG. 636

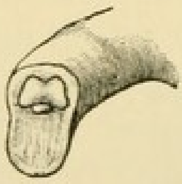


FIG. 637

3. The point of the knife divides both lateral ligaments; the blade is inserted with its edge turned downward behind the volar surface of the third phalanx (Fig. 636), and a well-rounded flap is formed by sawing movements from the skin of the volar side (Fig. 637). In suturing the wound the cicatrix comes to lie on the *dorsal surface*, while the new finger tip is covered with normal skin.

DISARTICULATION OF THE SECOND PHALANX

(By forming a flap from within outward by transfixion)

1. The hand is held in supination toward the operator; he takes hold of the extended point of the finger, inserts a small knife below the fold of the

joint from one side to the other between skin and joint, and carries the blade by sawing movements first toward himself, then upward, so that a well-rounded flap is formed (Fig. 638).

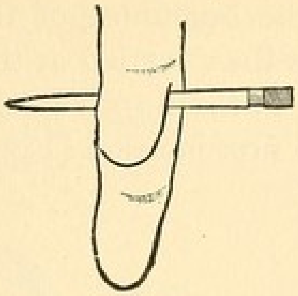


FIG. 638

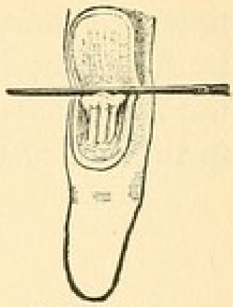


FIG. 639

2. The flap is turned upward, the joint is forcibly stretched, and from the wound the knife divides in one sweep the capsular ligament, the lateral ligaments, and the skin on the dorsal side of the joint in a transverse direction (Fig. 639).

DISARTICULATION AT THE METACARPOPHALANGEAL JOINT

(*a*) *Oval incision.*

1. The operator, standing on the left side of the limb, with his back toward the face of the patient, seizes, while an assistant draws aside with his left hand the two neighboring fingers, the diseased finger, hyperextends it so far that he can see the volar surface, carries a small knife from the

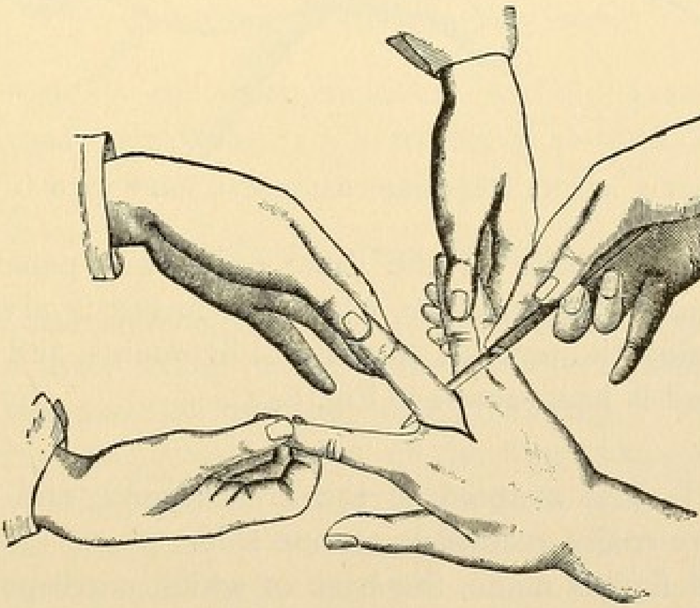


FIG. 640. DISARTICULATION AT THE METACARPOPHALANGEAL JOINT (oval incision)

right to the volar surface of the first phalanx, divides here at the level of the tense web the soft parts transversely, carries the knife around the right side of the phalanx to the dorsal side, and here in a curve upward as far as the head of the metacarpal bone (Fig. 640).

2. The knife is carried under the left hand around the left side of the finger as far as the beginning of the first incision; here it penetrates down to the bone; it is then carried at the level of the web around the left side of the first phalanx to the dorsal side, and here it is drawn upward in a curve to the end of the first incision (Fig. 641).

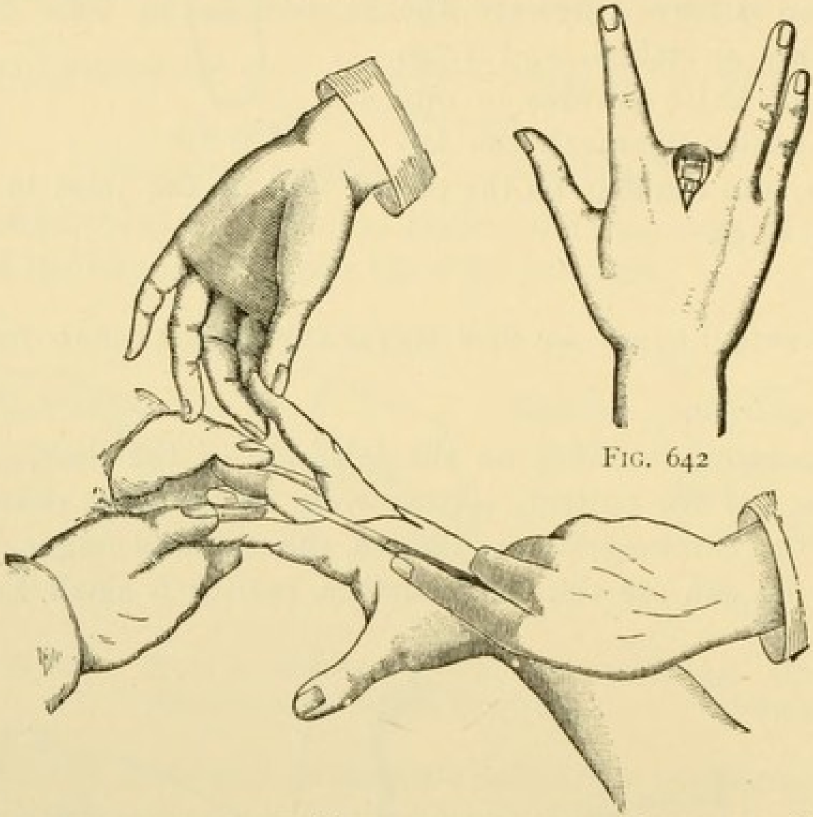


Fig. 642

Fig. 641. Disarticulation at the Metacarpophalangeal Joint with Oval Incision

3. Both incisions are made in the same order, but penetrating more deeply toward the joint. They divide, while the finger is always inclined toward the opposite side, the tendons, the lateral ligaments, and the capsular ligament. The wound is heart-shaped (Fig. 642).

(*b*) *Flap incision.*

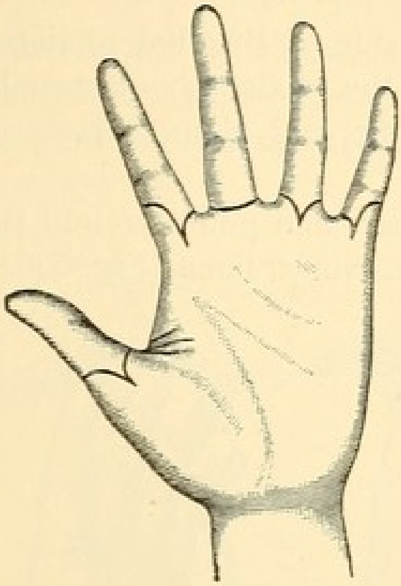
1. This incision is best adapted to the first, second, and fifth fingers, because they are more easily accessible on one side.

A large half-oval flap is made, the base of which corresponds with the level of the articulation from the volar, dorsal, or lateral skin of the first phalanx, and is reflected upward.

2. Next, a smaller skin flap is formed on the opposite side, and likewise turned up.

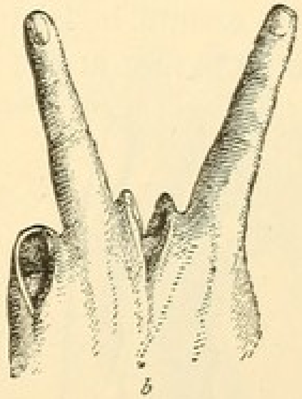
3. Finally, the tendons are divided at the level of the articulation, and the latter is completely disconnected (Fig. 643).

If the *metacarpus* of the finger involved must be removed at the same time, it is best to extend the *dorsal angle* of the wound to the carpus. The



a

FIG. 643



b

FIG. 644

DISARTICULATION OF THE METACARPOPHALANGEAL JOINT. *a*, of the thumb, second and fifth fingers. Formation of flaps of unequal size on the fourth finger; of two equal flaps on the third. Oval incision from the volar side. *b*, Wound from the oval incision and flap incision

metacarpal bone is then disarticulated without great difficulty from the carpometacarpal articulation. The wound is sutured completely.

DISARTICULATION OF ALL FINGERS

1. If the last four fingers must all be amputated, they may be singly disarticulated in the manner just described; more useful, however, is a dorsal *circular incision* and the formation of a volar flap.

2. Under strong volar flexion of the fingers a *transverse incision* is made through the skin and tendons across the base of the four fingers from one margin of the hand to the other.

3. Next, the knife cuts along the volar side (the fingers being flexed dorsally), in the fold of the joint, along the margin of the web a small flap, the ends of which meet the dorsal incision.

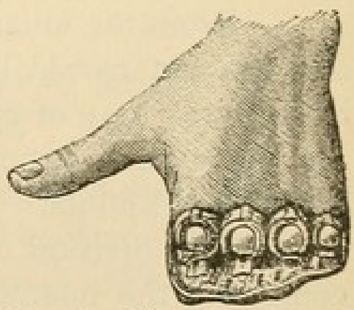


FIG. 645. DISARTICULATION OF ALL FINGERS

4. Each finger is then disarticulated singly, and next the margins of the wound are sutured (Fig. 645). The cicatrix occupies the dorsal side.

DISARTICULATION OF THE THUMB AT THE CARPAL JOINT

(*a*) *Oval incision.*

1. The first incision begins at the ulnar side of the first phalanx at the level of the web, is carried obliquely across the phalangometacarpal joint as far as the radial side of the metacarpal bone, and along this as far as its base.

2. The second incision, carried from the same point around the radial side, meets the first at the middle of the metacarpal bone (Fig. 646).

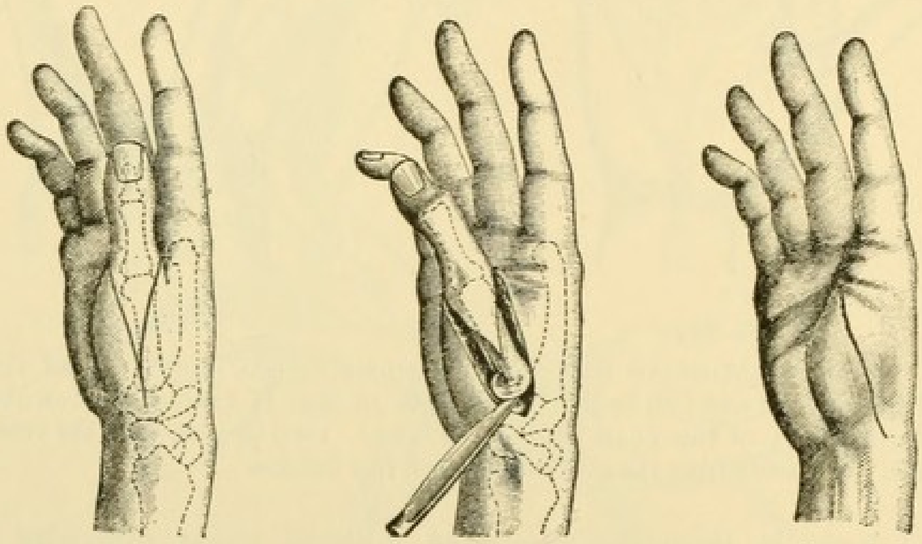


FIG. 646 FIG. 647 FIG. 648

DISARTICULATION OF THE THUMB (oval incision)

3. By repeated incisions in the same direction along the bone, the latter is freed from the muscles. It is of importance to preserve as much as possible of the muscles, and especially of the periosteum, in order to obtain a somewhat movable stump.

4. From the ulnar side, the articulation is opened between the trapezium and the metacarpal bone, whereby the edge of the knife must be carried close to the base of the latter for fear of opening the articulation between the metacarpal bone of the index and the trapezium, connected with the other carpal joints.

5. The division of the articular ligaments on the radial side (Fig. 647) completes the operation, which leaves a linear scar after the wound has been sutured (Fig. 648). Since a hand without a thumb is not very useful, a stump should be preserved on the metacarpus wherever it is possible, no matter how small. If it is impossible, according to *Lauenstein*, the metacarpus of the second and fifth fingers can be sawed through transversely by

dorsal longitudinal incisions. The two fingers are then turned 180° around their axis and healed in this position. They then stand in opposition to the third and fourth fingers (as in a parrot's foot).

(*b*) *Lateral flap incision according to von Walther.*

1. The thumb is held in abduction, the knife is applied over the middle of the web, and carried upward by sawing movements between the first and

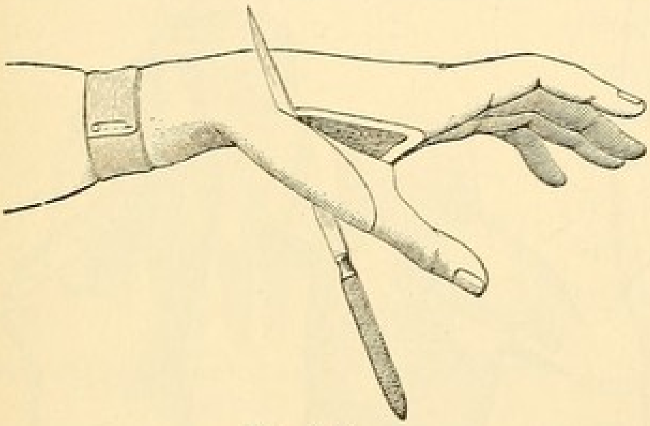


Fig. 649

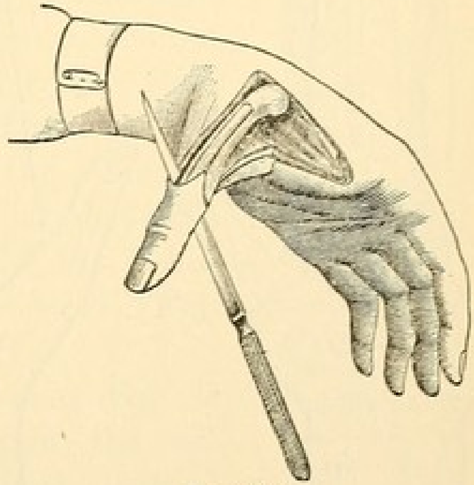


Fig. 650

Von Walther's Radial Flap Incision

second metacarpal bones until it reaches the ulnar margin of the base of the first metacarpal bone (Fig. 649).

2. By avoiding the joint between the metacarpal bone of the index and the trapezium, the point of the knife is carefully carried under the base of the bone, and thereby the carpometacarpal joint is opened.

3. The thumb can be abducted even more forcibly; the knife penetrates the joint to the radial side of the metacarpal bone, and is again carried on this downward, forming a radial flap, the rounded point of which ends at the level of the web (Fig. 650).

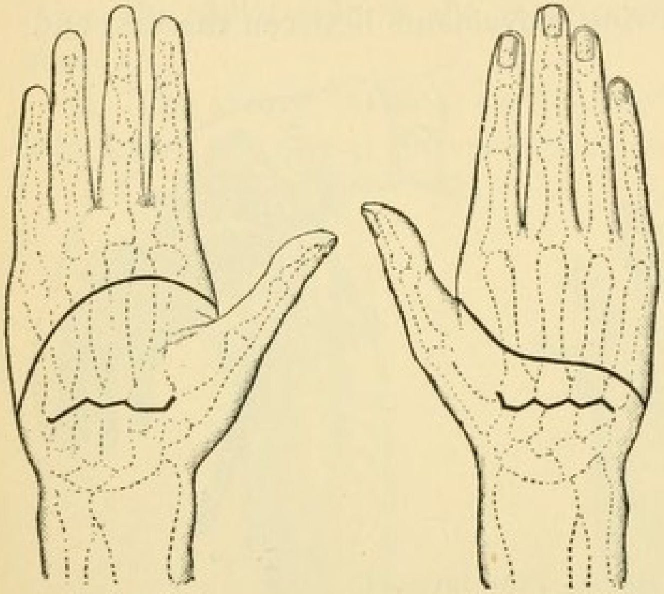
DISARTICULATION OF THE LAST FOUR METACARPAL BONES (WITH PRESERVATION OF THE THUMB)

1. On the palmar surface a semilunar flap is circumscribed by an oblique curved incision, beginning at the web of the thumb and ending at the ulnar margin of the base of the fifth metacarpal bone (Fig. 651). The flap can also be formed from within outward by transfixion at its base (Fig. 652).

2. An incision is made upon the dorsal side of the hand, beginning at the web of the thumb and extending obliquely upward as far as the upper third of the second metacarpal bone; thence it extends at the same level across

the last three metacarpal bones; at the ulnar margin of the hand, it meets the volar flap (Fig. 653).

3. After both flaps have been dissected back as far as the region of the carpometacarpal articulations, the latter are opened from the ulnar side under forcible abduction of the metacarpus, until also the connection of the second



a *b*

FIG. 651 FIG. 653
DISARTICULATION OF THE LAST FOUR METACARPAL BONES. *a*, volar incision; *b*, dorsal incision

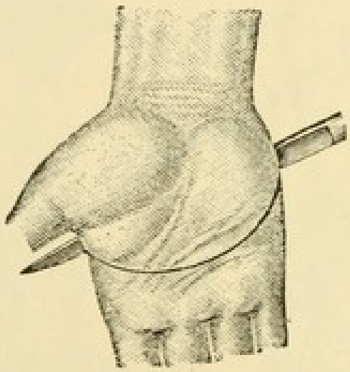


FIG. 652. VOLAR INCISION BY TRANSFIXION

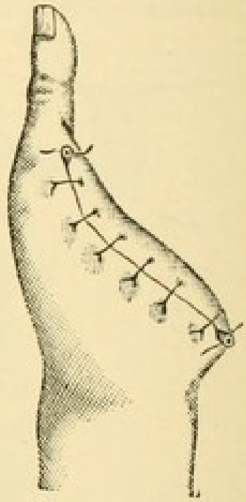


FIG. 654. STUMP AFTER DISARTICULATION OF THE LAST FOUR METACARPAL BONES

carpometacarpal bone with the trapezium is divided. During the last act, the incision must be made very carefully and always be directed toward these two bones in order to avoid injury of the articulation between the trapezium and the metacarpal bone of the thumb.

4. It is exceedingly advantageous to preserve the thumb for working purposes (Fig. 654).

DISARTICULATION OF THE WRIST

(*a*) *Circular incision.*

1. A circular incision circumscribes the hand upon the middle of the metacarpus 4 centimeters below the styloid processes.

2. The skin is separated all around by vertical incisions until it can be turned back like a cuff or manchette over the styloid processes.

3. The pronated hand is strongly flexed; a slightly curved incision with the convexity directed upward, across the wrist from one styloid process to the other, divides the extensor tendons and opens the wrist.

4. The lateral ligaments are divided under both styloid processes, and finally the anterior capsular wall and all flexor tendons are divided with one sweep of the knife (Figs. 655, 656).

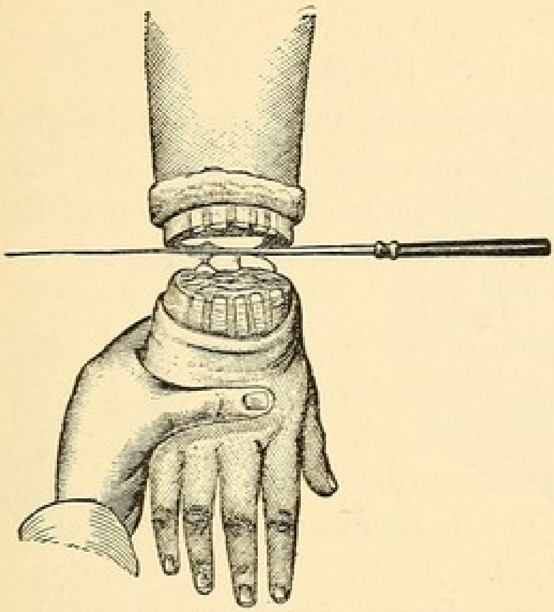


Fig. 655. Disarticulation of the Hand by Circular Incision

(*b*) *Flap incision.*

1. The operator takes hold of the lower portion of the hand in pronation, flexes it, and makes from the point of one styloid process to the other a semilunar incision across the middle of the dorsal side of the hand (Fig. 657).

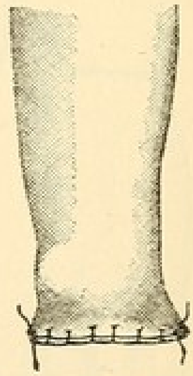


Fig. 656. Stump after Disarticulation of the Wrist by Circular Incision

2. The skin flap is detached from the extensor tendons, turned upward, and the joint is opened in the same manner as in the circular incision.

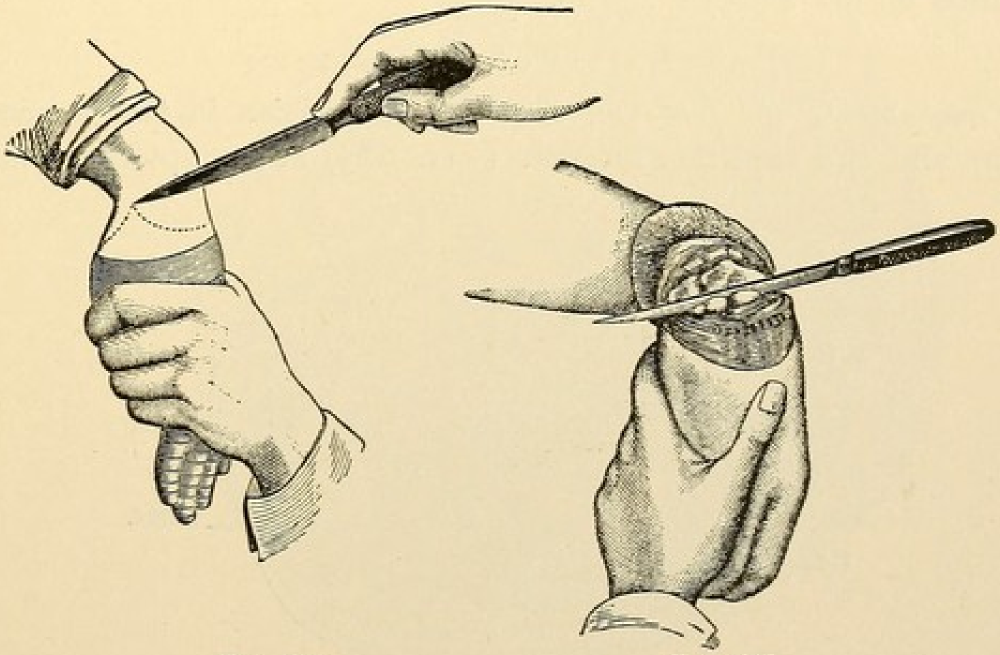


Fig. 657 Fig. 658

Disarticulation of the Hand with Two Flaps of Skin (Ruysch)

3. The fasciculus of the flexor tendons is forced forward with the point of the left forefinger into the wound from the volar surface, and carefully

divided by to and fro motions of the knife; next, a small skin flap is made on the volar side (Fig. 658). It is advisable by an incision to indicate the volar flap at the beginning of the operation.

(*c*) *Radial flap* (*von Walther*, 1810).

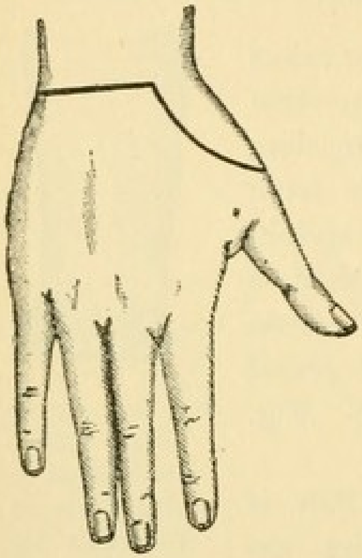


Fig. 659. Disarticulation of the Hand (von Walther's method)

1. From the skin covering the metacarpal region of the thumb, a semilunar flap is formed, the base of which comprises the radial third portion of the carpus, the point of which reaches the base of the first phalanx.

2. After the flap has been dissected off from the muscles of the thumb and turned upward, a half-circular incision circumscribes the two remaining thirds of the carpus at the ulnar side (Fig. 659).

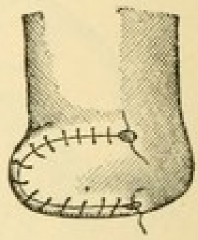


Fig. 660

Stump resulting from von Walther's Method

3. The skin is drawn forcibly upward, and the carpus, as described above, is separated from the bones of the forearm. Figure 660 shows the appearance of the sutured stump.

AMPUTATION OF THE FOREARM

For amputating the forearm, **the circular incision in two tempos** (Figs. 599–600) and the **skin flap incision** (Fig. 605) are adapted. During the

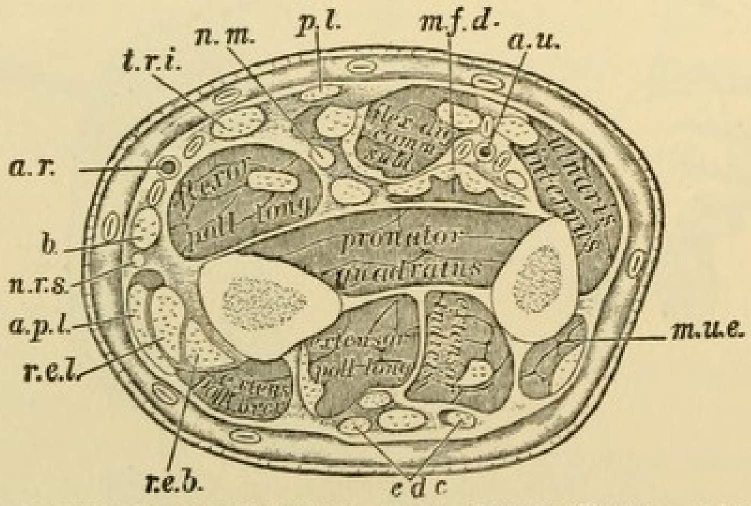
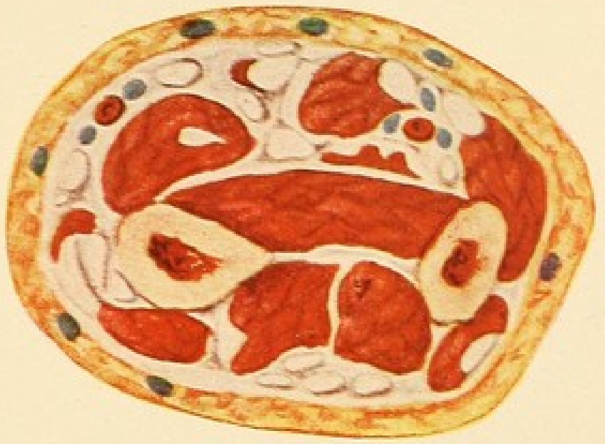


Fig. 661. Section of the Right Forearm at its Lower Third. *p.l.* palmar. long.; *n.m.* nerv. medianus; *t.r.i.* tendo rad. int.; *a.r.* art. radialis; *b.* brachioradialis; *n.r.s.* nerv. radial. superf.; *a.p.l.* abductor pollicis longus; *r.e.l.* radialis ext. longus; *r.e.b.* radialis ext. brevis; *e.d.c.* extensor dig. comm.; *m.u.e.* musc. ulnaris extern.; *a.u.* art. ulnaris; *m.f.d.* musc. flex. dig. comm. prof.

PLATE XI



At its lower third

At the middle of the right fore-arm

Sections of the right fore-arm

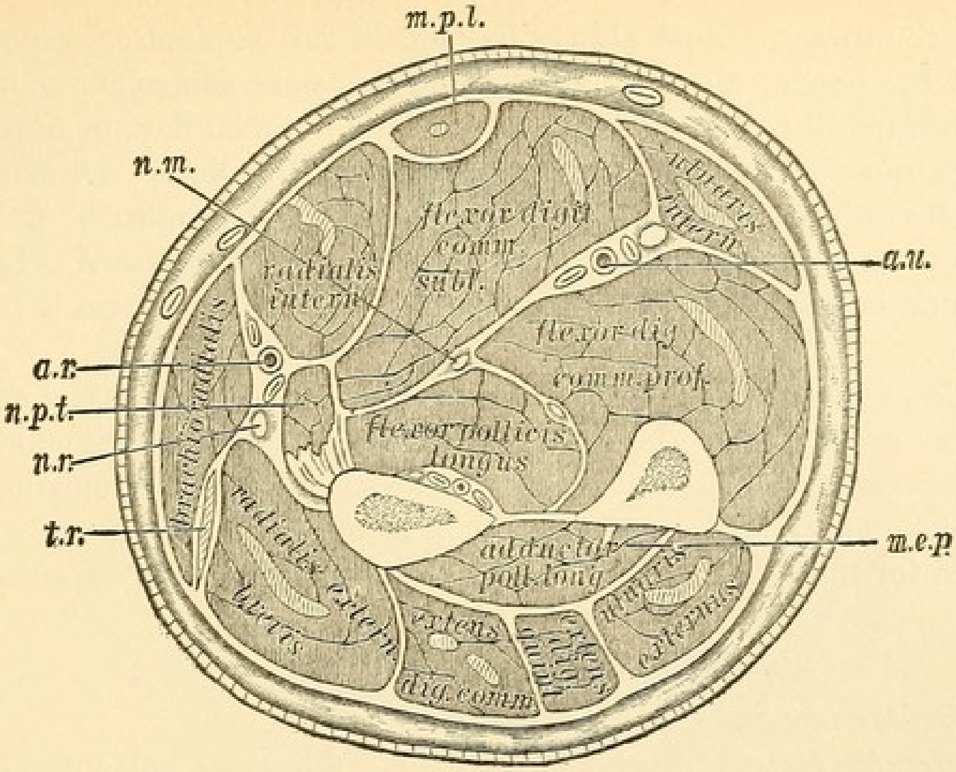


FIG. 662. SECTION OF THE RIGHT FOREARM AT ITS MIDDLE PART (see also Plate XI). *m.p.l.* musc. palmaris longus; *n.m.* nerv. medianus; *a.r.* art. radialis; *m.p.t.* musc. pronator teres; *n.r.* nerv. radialis; *t.r.* tendo radialis ext. long.; *m.e.p.* musc. extens. poll. long.; *a.u.* art. ulnaris

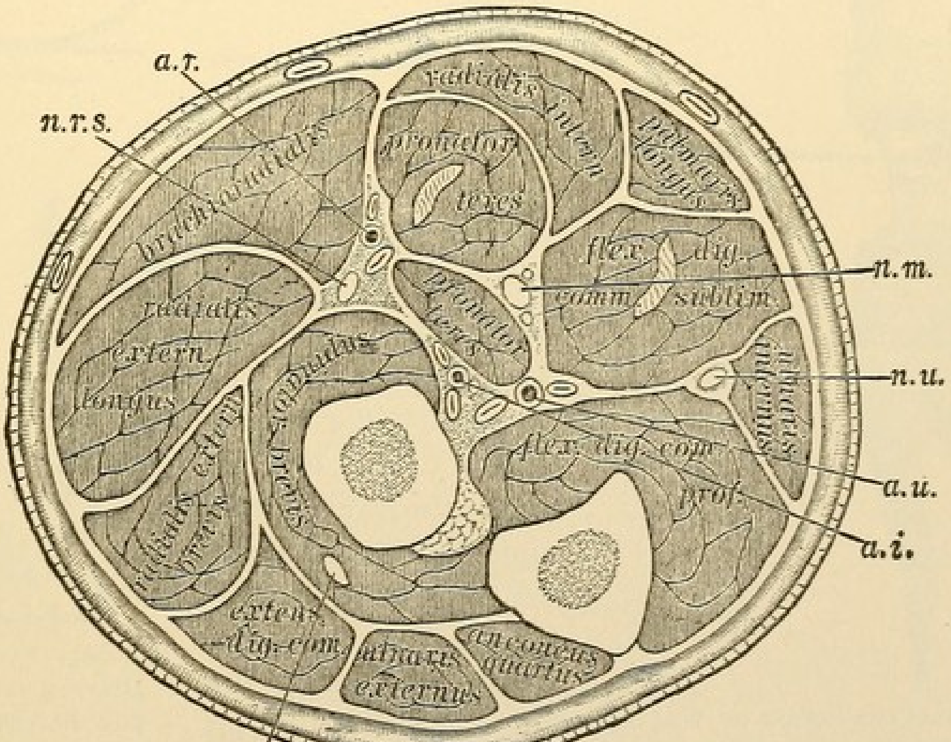


FIG. 663. SECTION OF THE RIGHT FOREARM AT ITS UPPER THIRD (see also Plate XII). *a.r.* art. radialis; *n.r.s.* nerv. radialis superf.; *n.r.p.* nerv. radialis profundus; *a.i.* art. interossea; *a.u.* art. ulnaris; *n.u.* nerv. ulnaris; *n.m.* nerv. medianus

operation, the forearm must always be held in full supination, especially in sawing off the bones; else the radial stump becomes somewhat shorter. If flaps are formed, it is best to select a volar and a dorsal flap, or only a volar flap, which must correspond to the diameter of the limb. Directly above the wrist, it is often difficult to divide the tendons; they must be drawn forward with tenaculum forceps, and cut off with a pair of scissors. The union of the wound is best made in a vertical direction, while the arm is placed in pronation.

As little as possible should be removed from the forearm, and especially when the amputation must be made very high and close to the elbow joint, a small forearm stump should always be preferred to disarticulation of the elbow, which can be made more easily. The stump is subsequently of great importance for the movement of any prothesis which may be applied.

DISARTICULATION OF THE ELBOW JOINT

(*a*) *Circular incision.*

1. A *circular incision* divides the skin 4 centimeters below the condyles of the humerus; the manchette is dissected back and reflected.

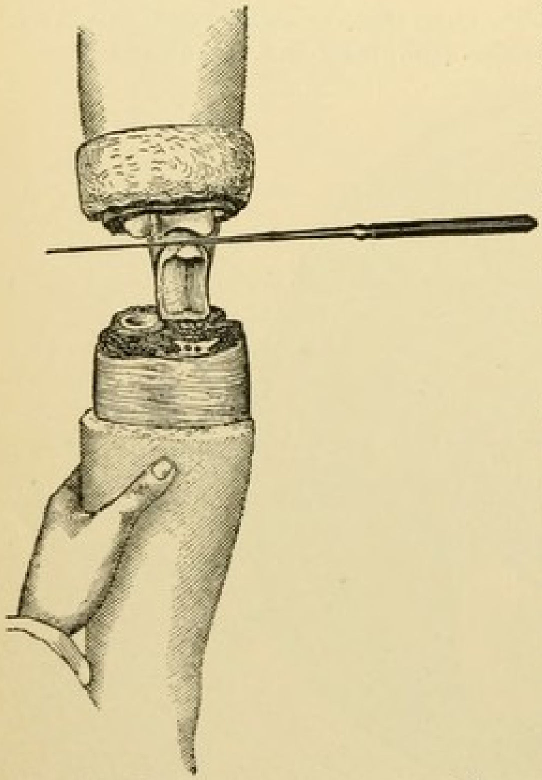


FIG. 664. DISARTICULATION OF THE ELBOW JOINT (circular incision)

2. A transverse incision across the volar side opens widely the hyper-extended articulation.

3. An incision above the *head of the radius* divides the external lateral ligament; an incision below the internal condyle divides the internal lateral ligament.

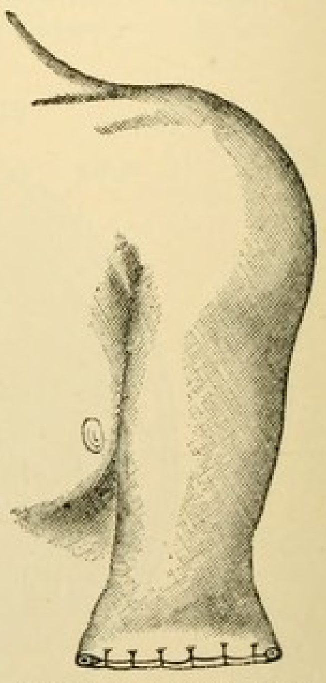
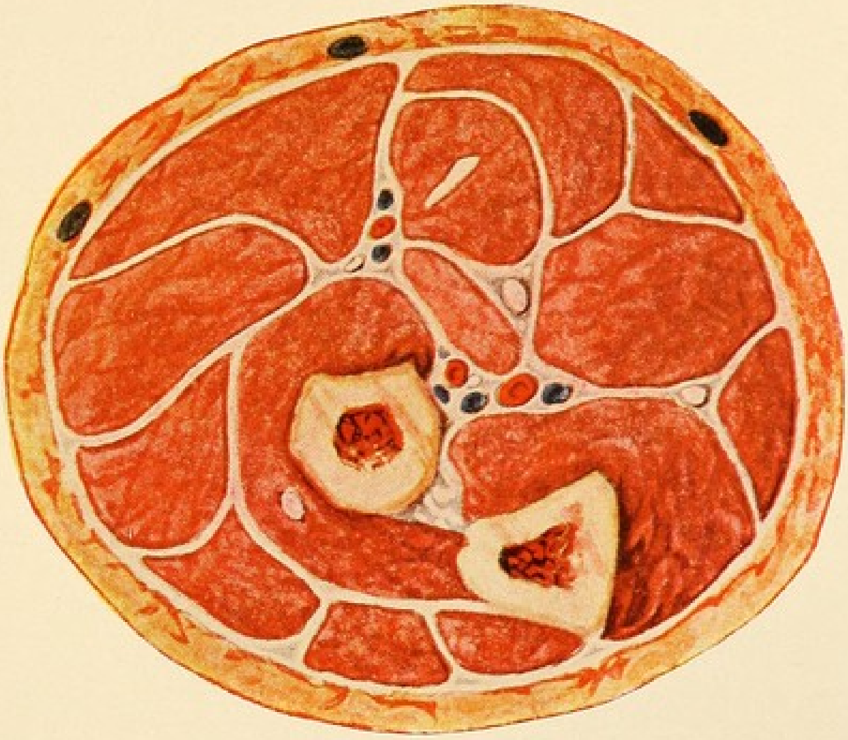


FIG. 665. STUMP AFTER DISARTICULATION OF THE ELBOW JOINT BY CIRCULAR INCISION

4. The articulation gapes widely; the olecranon is forced into the wound; an incision above its point separates the tendon of the triceps from it (Fig. 664). Figure 665 shows the form of the stump sutured transversely.

PLATE XII



At its upper third

Through the elbow joint in the line of Condyles

Sections of the Right Fore-arm

(*b*) *Flap incision.*

1. A curved incision, beginning 2 centimeters below one condyle and ending 2 centimeters below the other circumscribes on the volar side of the

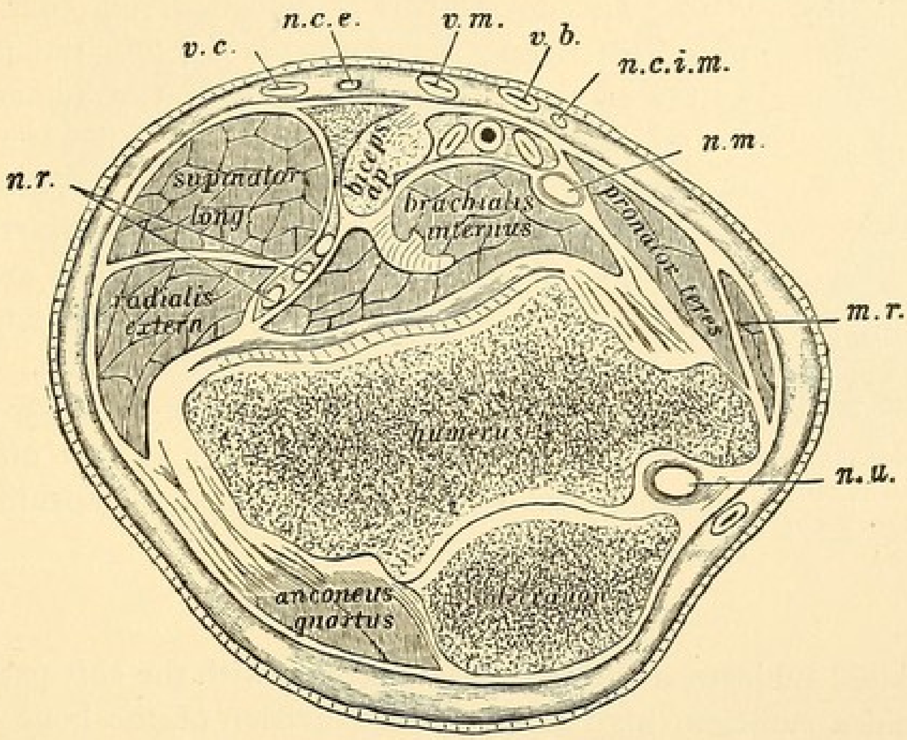


FIG. 666. SECTION OF THE RIGHT ELBOW JOINT IN THE LINE OF CONDYLES (see also Plate XII). *n.c.e.* nerv. cutaneus ext.; *v.c.* vena cephalica; *n.r.* nerv. radialis; *v.m.* vena mediana; *v.b.* vena basilica; *n.c.i.m.* nerv. cutaneus int. major; *n.m.* nerv. medianus; *m.r.* musc. radialis int.; *n.u.* nerv. ulnaris

forearm a large semilunar skin flap, which is detached from the fascia and turned upward.

2. The arm is strongly flexed and turned in such a way that the posterior side of the articulation faces anteriorly.

3. A shallow curved incision across the olecranon exposes its tip (Fig. 667).

4. A transverse incision from one condyle to the other divides the tendon of the triceps and the two lateral ligaments; a second, all the soft parts on the volar side of the articulation.

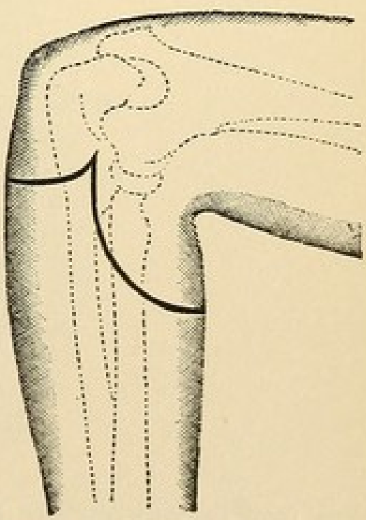


FIG. 667. DISARTICULATION OF THE ELBOW JOINT (flap incision)

(*c*) *Oblique incision.*

1. While the elbow joint is held flexed at an angle of about 135°, the incision penetrating immediately down to the bone extends from the line of articulation of the elbow (beginning over the head

of the radius) parallel to the axis of the arm and a hand's breadth below the tip of the olecranon along the dorsal side and around the limb back to the elbow.

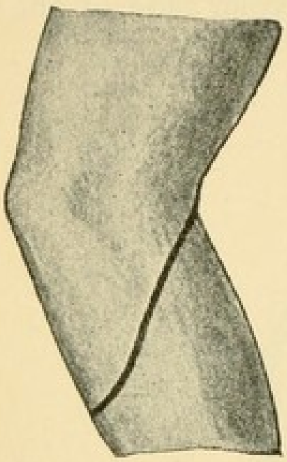


Fig. 668. Disarticulation of the Elbow Joint (Kocher's oblique incision)

2. The dorsal flap is detached, together with the muscles (triceps, anconeus tissue), and the periosteum as far as the posterior surface of the humerus.

3. After division of the external ligament follows the opening of the articulation, and finally, after division of the internal ligament, the forearm is disarticulated.

4. The flap is turned into the elbow and sutured in this position; the cicatrix comes to lie laterally and is protected from the pressure of the stump.

On account of the very uneven articular surface of the humerus, it is advisable also to saw off its lower extremity and extirpate the articular capsule (*transcondylary amputation, Pirogoff*).

AMPUTATION OF THE ARM

In emaciated subjects, **a single circular incision** with the soft parts forcibly reflected and a sufficient high subperiosteal division of the bone by sawing

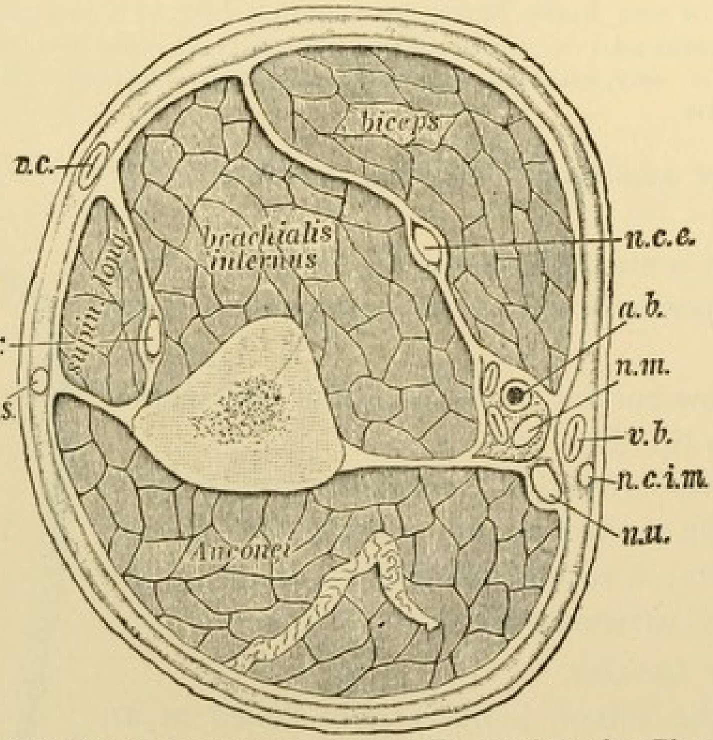
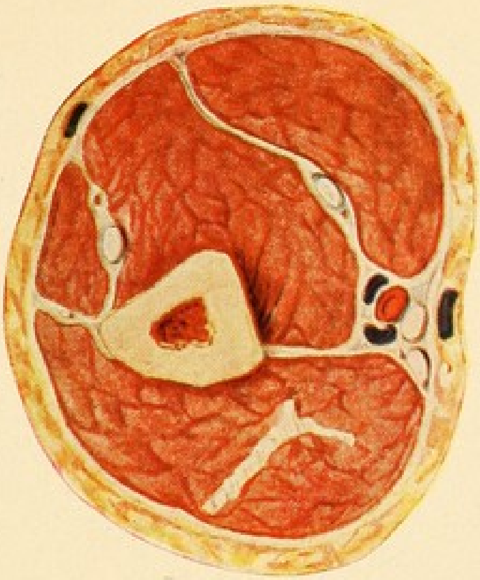
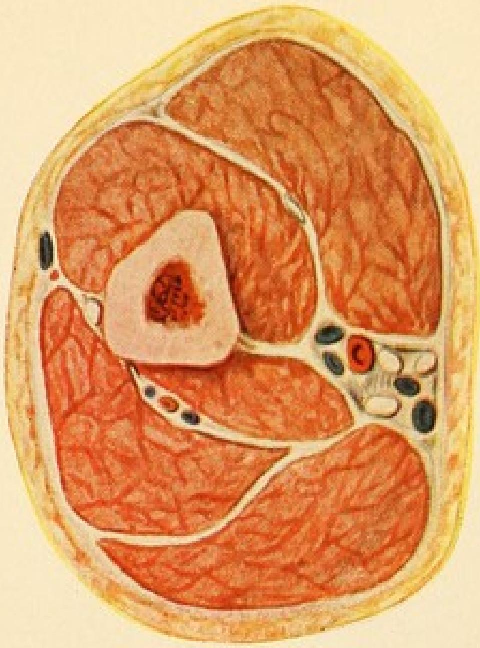


Fig. 669. Section of the Right Arm at its Lower Third (see also Plate XIII). *v.c.* vena cephalica; *n.r.* nerv. radialis; *n.c.e.s.* nerv. cutan. ext. superfic.; *n.c.e.* nerv. cutaneus ext.; *a.b.* art. brachialis; *n.m.* nerv. medianus; *v.b.* vena basilica; *n.c.i.m.* nerv. cutan. int. major; *n.u.* nerv. ulnaris

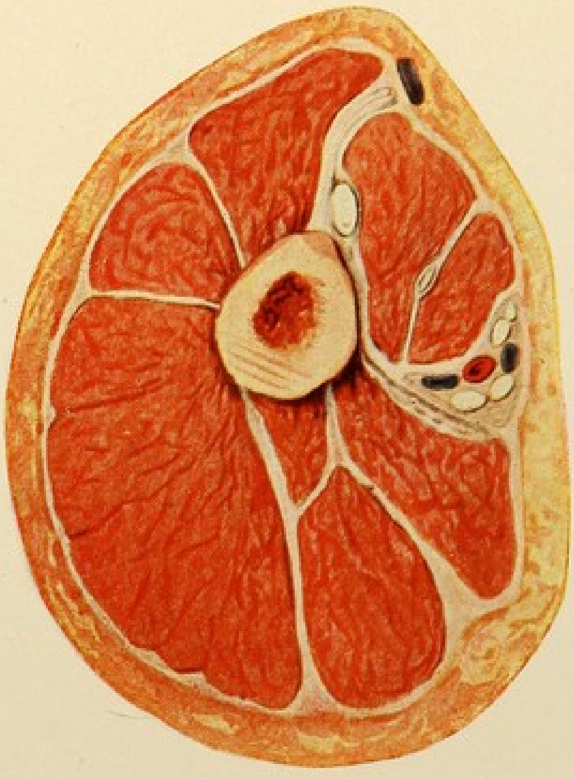
PLATE XIII



At its lower third



At its middle third



In front of the Axilla

Sections of the Right Arm

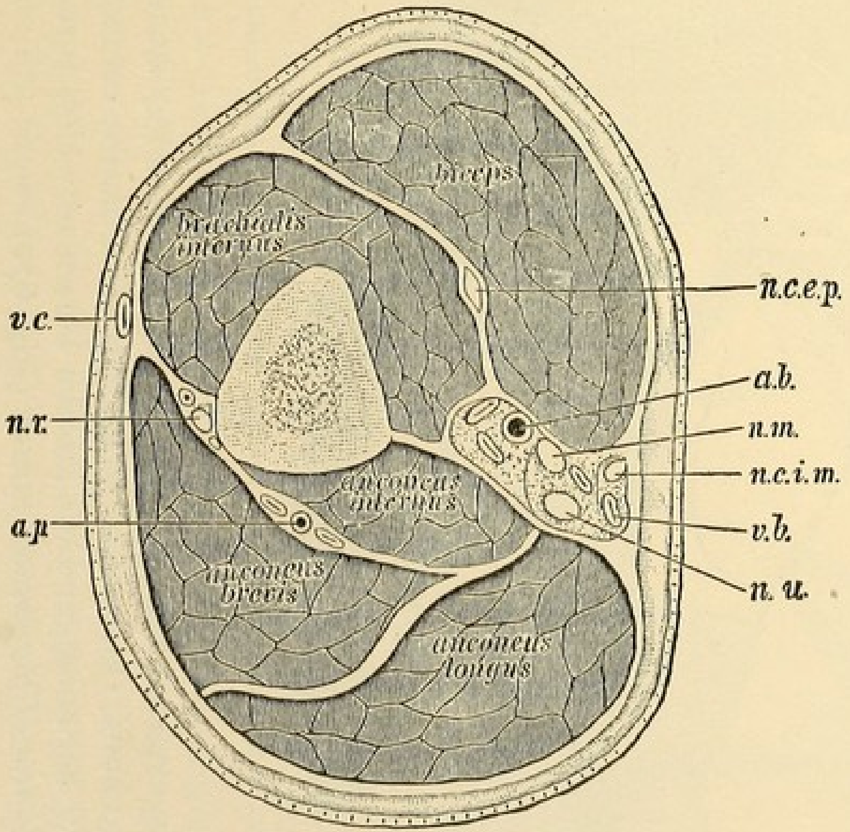


FIG. 670. SECTION OF THE RIGHT ARM AT ITS MIDDLE THIRD (see also Plate XIII). *v.c.* vena cephalica; *n.r.* nerv. radialis; *a.p.* art. profunda; *n.c.e.p.* nerv. cutaneus extern. perforans; *a.b.* art. brachialis; *n.m.* nerv. medianus; *n.c.i.m.* nerv. cutan. int. major; *v.b.* vena basilica; *n.u.* nerv. ulnaris

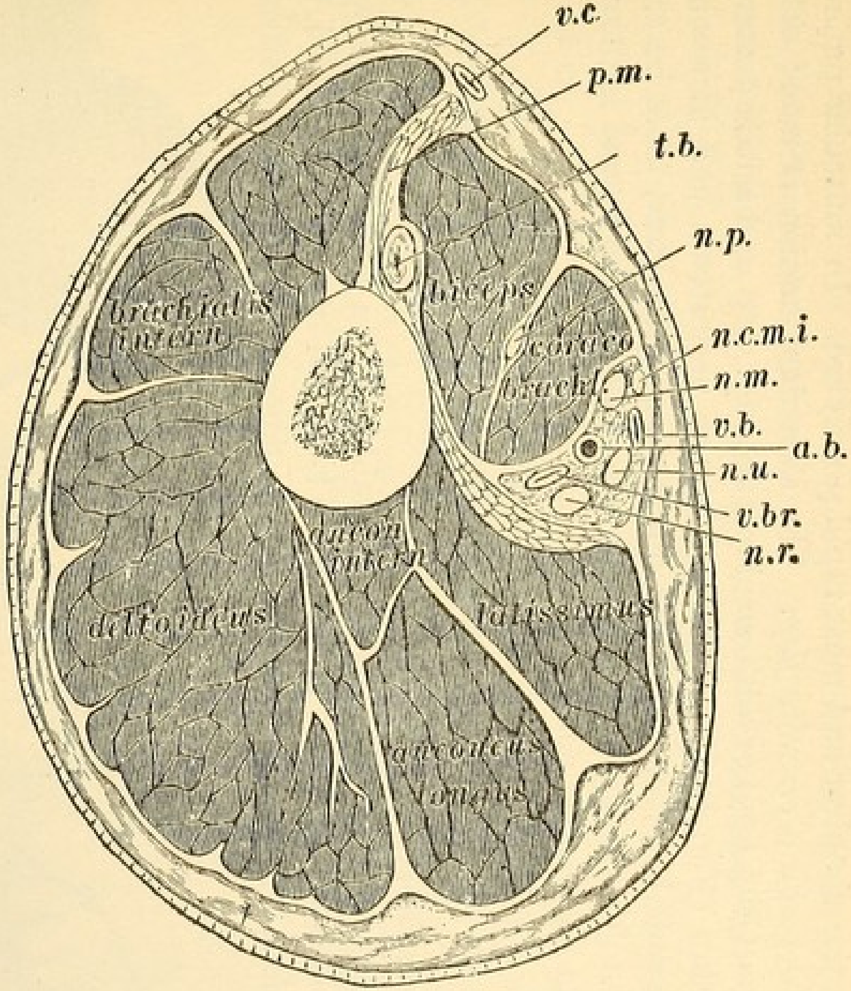


FIG. 671. SECTION OF THE RIGHT ARM IN FRONT OF THE AXILLA (see also Plate XIV). *v.c.* vena cephalica; *p.m.* pectoralis major; *t.b.* tendo bicipitis; *n.p.* nerv. perforans; *n.c.m.i.* nerv. cutan. major int.; *n.m.* nerv. medianus; *v.b.* vena basilica; *a.b.* art. brachialis; *n.u.* nerv. ulnaris; *v.br.* vena brachialis; *n.r.* nerv. radialis

(Fig. 594) is the simplest and most rapid procedure. In muscular patients it is better to make a *circular flap*. **The skin flap incision** is made either with *two* flaps (Fig. 605) or with *one* long anterior flap and a half posterior circular incision (Fig. 606). In reflecting the periosteum and in sawing, injury to the radial nerve, which lies directly upon the bone, must be carefully avoided. The same is forcibly drawn forth before the wound is sutured and cut off as high up as possible.

DISARTICULATION OF THE ARM AT THE SHOULDER JOINT

(*a*) *Flap incision.*

1. The patient lies at the edge of the table half on his healthy side, with his thorax *somewhat raised*. The more he is placed in a sitting position, the more convenient it is for the operator, but the more dangerous for anæsthesia.

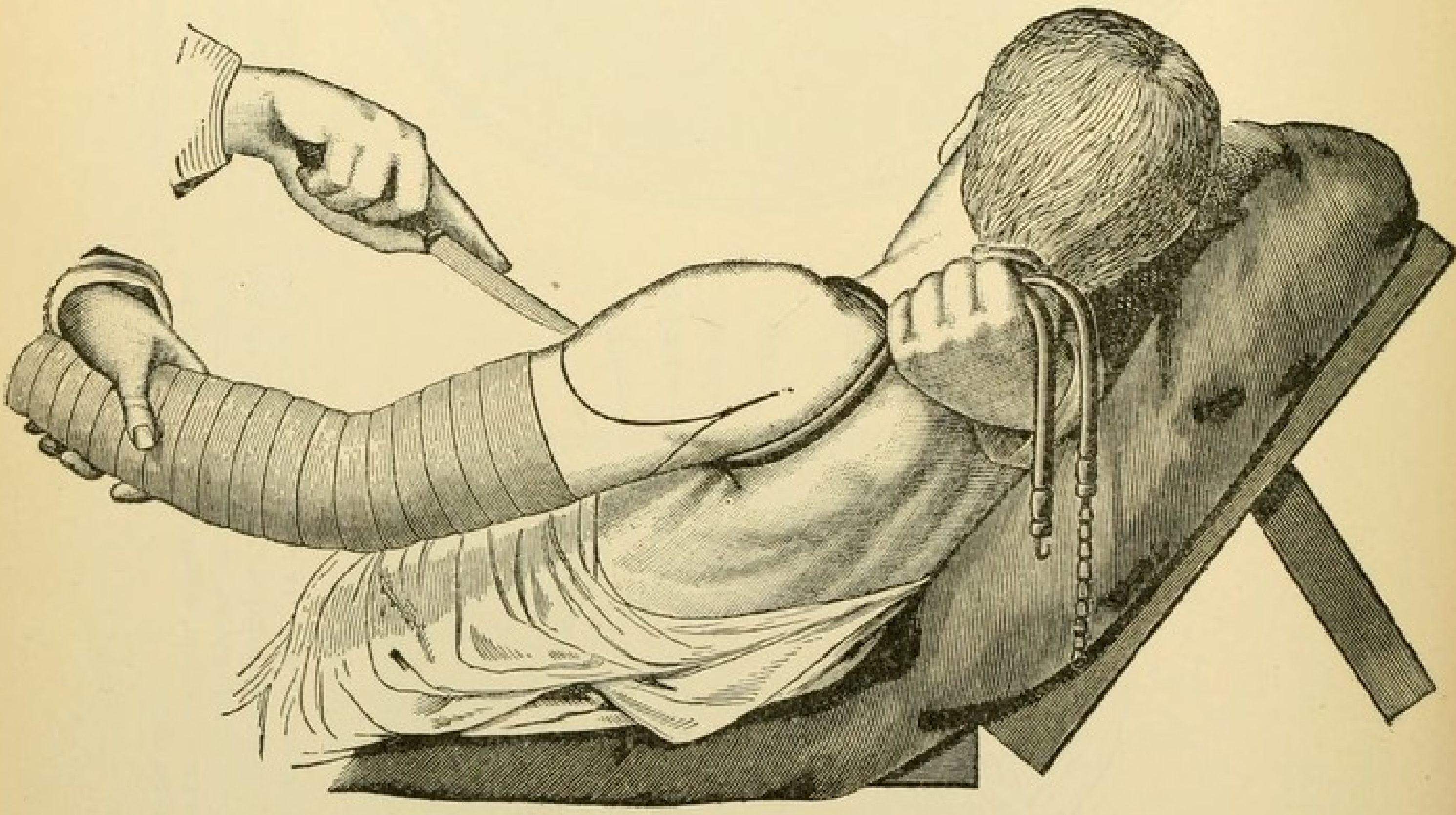


FIG. 672. DISARTICULATION AT THE SHOULDER JOINT (flap incision)

2. On the external surface of the shoulder, a rounded square flap is outlined with the knife, the base of which extends from the coracoid process to the root of the acromion, and the inferior border of which corresponds with *the inferior limits of the deltoid muscle* (Fig. 672).

3. With long sweeps of the knife, penetrating more and more deeply into the deltoid muscle, the flap is detached as far as the acromion, and turned upward so that the outer surface of the shoulder joint is freely exposed.

4. A bold incision across the head of the humerus, forced upward, above the two tuberosities, divides the capsule together with the tendons lying over it.

5. The head of the humerus is forced forward, the knife inserted behind it, and the posterior capsule is divided.

6. The operator with his left hand draws the head of the humerus toward himself, directs the knife with long sawing movements down along the inner side of the bone as far as 6 centimeters below the axillary fold;

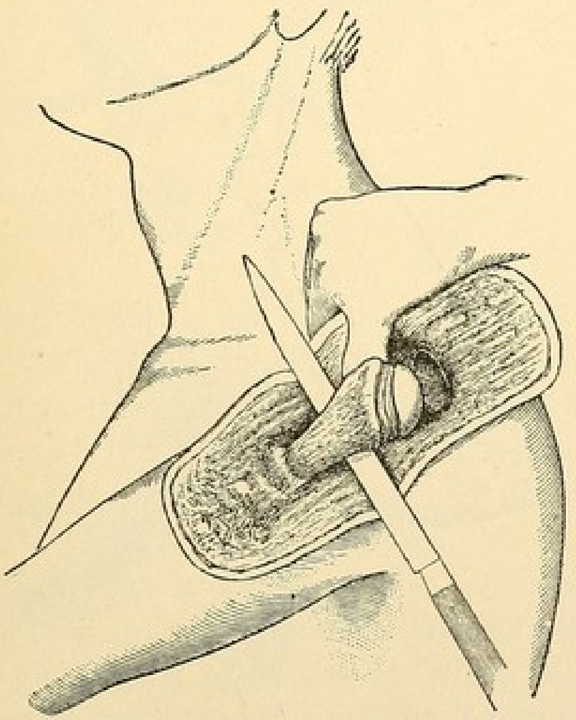


Fig. 673. Disarticulation at the Shoulder Joint Forming Second Flap on the Inner Surface

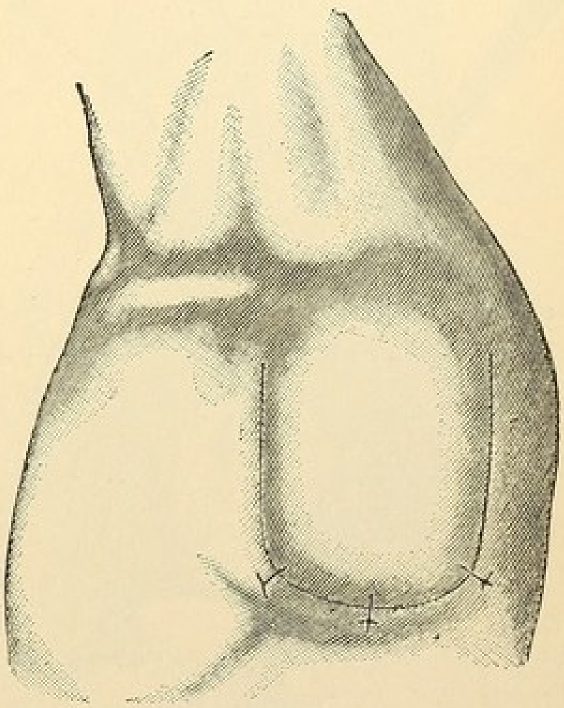


Fig. 674. Stump after Disarticulation at the Shoulder Joint by Flap Incision

then he turns the edge inward (against the thorax), and divides with one sweep all soft parts in which the large blood vessels and nerves are coursing.

7. In such cases, where he does not succeed in arresting completely the afferent flow of the circulation by *compressing the subclavian*, an assistant, before the last incision is completed, must reach into the wound from above, and compress with his thumb the axillary artery against the skin (Fig. 673).

8. Figure 674 shows the appearance of the wound after suturing.

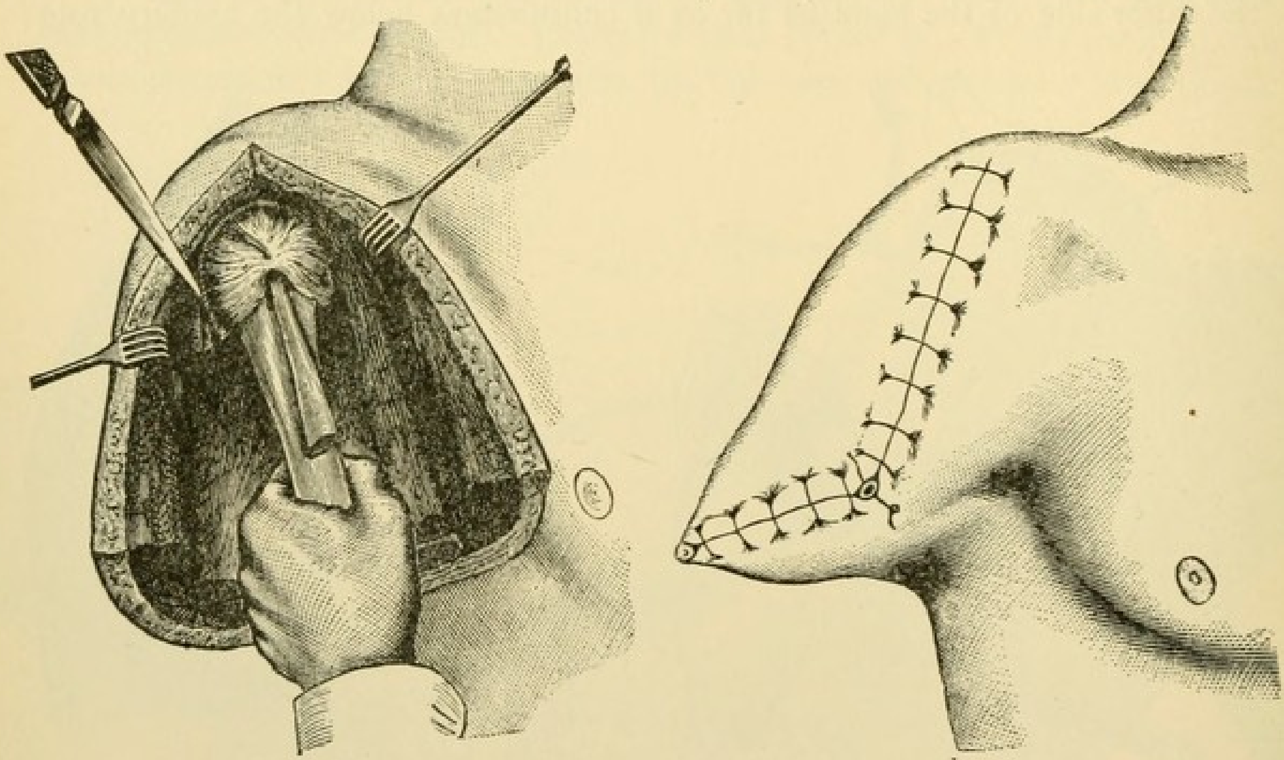
(*b*) *Circular incision.*

1. The arm is held in abduction. A *circular incision* at the level of the ower limit of the deltoid muscle divides all soft parts down to the bone.

2. The bone is sawed off at the same level; all visible blood vessels are ligated.

3. A *longitudinal incision* from the *anterior margin of the acromion* to the circular incision divides all soft parts down to the bone.

4. The lower end of the bone is grasped with strong bone-holding forceps or with the left hand, and while an assistant draws apart with strong retractors the margins of the wound of the longitudinal incision, the operator removes the bone from the articulation by continuous rotations (Fig. 675).



a *b*

Fig. 675 Fig. 676

Disarticulation at the Shoulder Joint (circular incision and longitudinal division)
a, disarticulation of the stump of the humerus; *b*, sutured stump

This disarticulation is made by short incisions *always directed against the bone*, or in suitable cases by *detaching the periosteum with elevators and the raspatory*.

5. In order to remove the acromion and the coracoid process, which project into the wound, they should be resected as much as may be deemed necessary (*Helferich*).

6. Figure 676 shows the appearance of the stump. The skin flaps can also be rounded off by cutting off the lower edge.

(*c*) *Oval incision.*

The point of the oval can be placed either *on the outside* below the acromion — in which case the deltoid muscle must be removed in part — (Fig. 677), or the operator begins with an *anterior* longitudinal incision in an out-

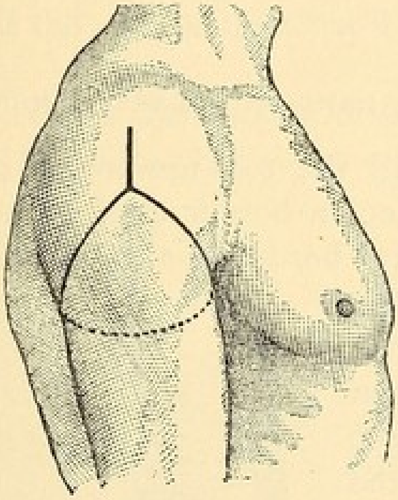


FIG. 677. DISARTICULATION OF THE SHOULDER JOINT (Larrey's oval incision)

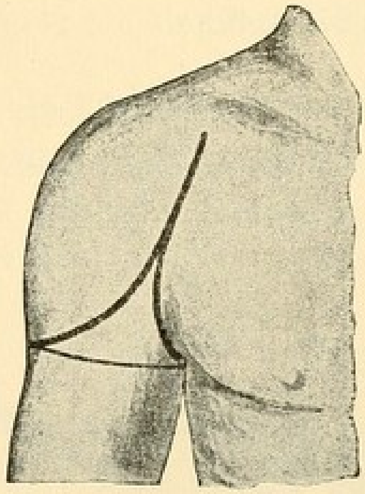


FIG. 678. DISARTICULATION OF THE SHOULDER JOINT (oval incision)

ward direction from the coracoid process below the clavicle, circumscribes with the knife the border of the deltoid muscle, and then returns transversely across the posterior side of the arm to the axillary fold, and from there upward to its beginning (*Kocher*, Fig. 678). If the edges of the incision in Fig. 675 are largely rounded off, almost the same incision is produced.

The latter methods are especially adapted to cases in which the operation is performed for tumors, when it is desirable first to establish the diagnosis. *The longitudinal incision* is made *first*, and the circular or oval incision is added to it.

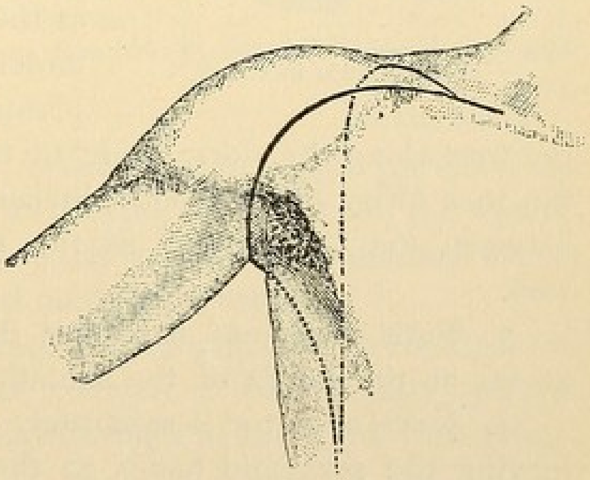


FIG. 679. DISARTICULATION OF THE SHOULDER GIRDLE

For **disarticulating the shoulder girdle** (shoulder together with clavicle and scapula) for the removal of tumors, it is best to make an *oval incision* (Fig. 679) with its point above the clavicle, which passes down in a curve in front to the anterior axillary fold, posteriorly passes across the acromion, and unites with the anterior incision in the axilla (*Berger*).

AMPUTATIONS AND DISARTICULATIONS ON THE LOWER EXTREMITY

DISARTICULATION OF THE SEVERAL TOES

This is made in the same manner as the disarticulation of the fingers (see pages 336–340).

DISARTICULATION OF ALL TOES IN THE PHALANGOMETATARSAL JOINTS

1. While the left hand forcibly flexes all the toes upward, a *curved incision* beginning (on the left foot) at the median border of the first phalangometatarsal joint and ending at the lateral border of the joint of the same name of the fifth toe is made in the groove between the plantar surface and the base of the toes (Fig. 680).

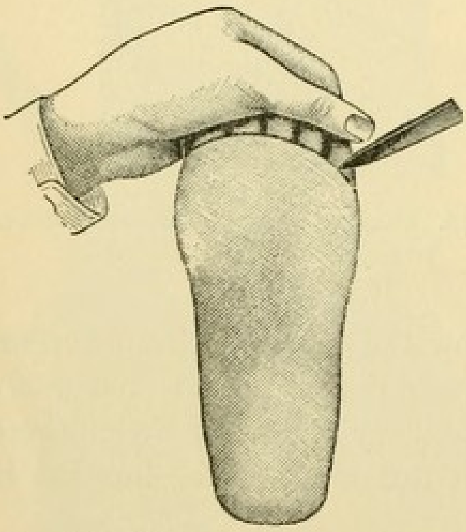


FIG. 680. DISARTICULATION OF ALL TOES (plantar incision)

(On the right foot the incision is reversed.)

2. A similar incision, the ends of which meet those of the first, is made under a forcible plantar flexion of the toes along the dorsal side of the base of all the toes (Fig. 681). Both incisions penetrate between the toes as far as the middle of the web.

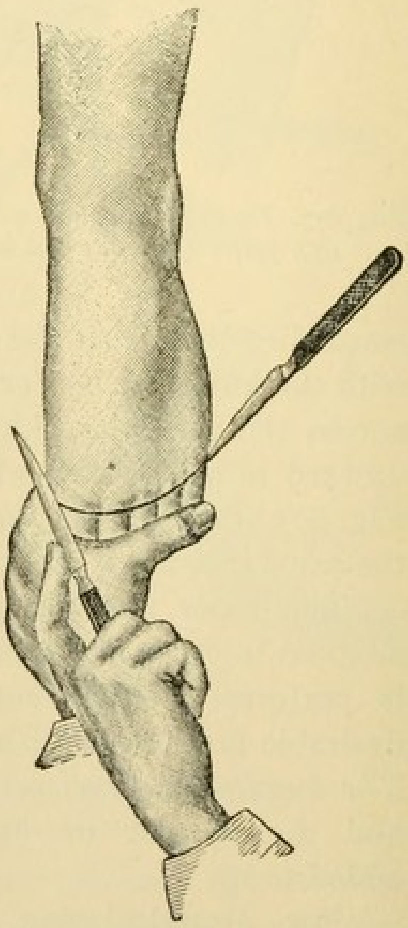


FIG. 681. DISARTICULATION OF ALL TOES (dorsal incision)

3. Both semilunar flaps are dissected back as far as the heads of the metatarsal bones.

4. Next, each toe is separately disarticulated, leaving the sesamoid bones at the head of the first metatarsal bone in position.

5. Should the skin not be sufficient to cover conveniently the prominent heads of the metatarsal bones, they can be singly removed with the phalangeal saw or the bone-cutting forceps.

6. Figure 682 shows the appearance of the stump.

AMPUTATION OF ALL METATARSAL BONES — JÄGER'S METATARSAL AMPUTATION

1. A *curved incision* is made from one border of the foot to the other across the anterior limiting furrow of the plantar surface, and the semilunar flap of the skin is dissected back to the place where the amputation is to be made.

2. Upon the dorsum of the foot, a smaller semilunar flap is made, the ends of which meet those of the plantar flap at the borders of the foot.

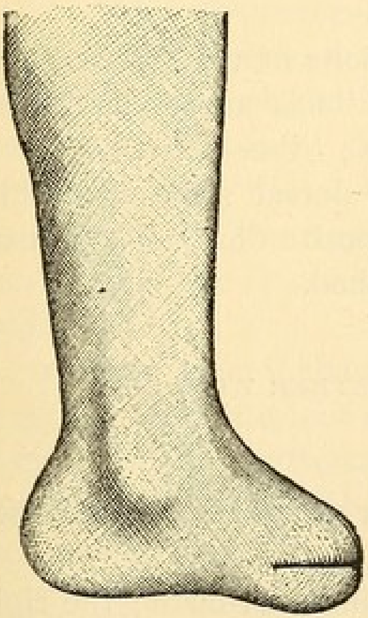


FIG. 682. STUMP AFTER DISARTICULATION OF ALL TOES

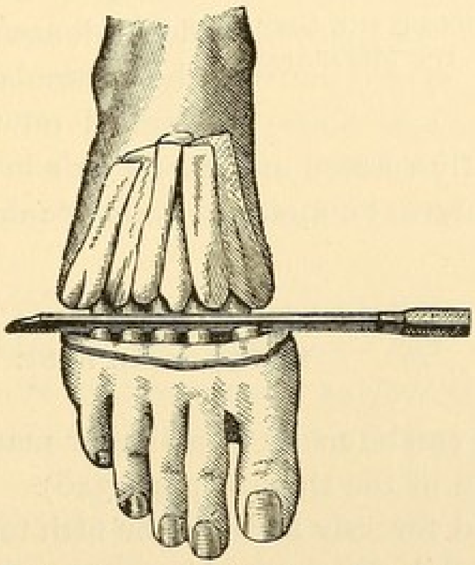


FIG. 683. AMPUTATION OF FOOT AT THE METATARSAL BONES BY SAWING

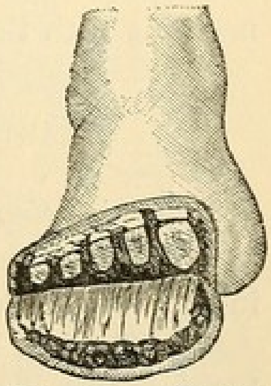


FIG. 684. WOUND RESULTING FROM SAWING OFF METATARSAL BONES

Instead of the dorsal flap, a *semicircular incision* can be made, provided the skin of the plantar surface is sufficient for covering the surface of the wound.

3. At the base of both flaps, the soft parts are carefully divided with a small knife upon and between the several metatarsal bones.

4. By means of small strips of sterilized gauze, which, with forceps, are drawn between the several bones, the soft parts are drawn forcibly upward, and all the bones close to them are sawed through at the same time (Figs. 683, 684).

DISARTICULATION OF THE GREAT TOE — TOGETHER WITH ITS METATARSAL BONE

The *oval incision* is made in the same manner that has been described on page 340, in *disarticulation of the thumb*.

On account of the great breadth of the base of the first metatarsal bone, it is advisable to make upon the upper end of the incision a transverse incision at a right angle across the articulation (Fig. 685). This is about 4 centimeters in front of the eminence of the **tubercle of the scaphoid bone,** and the upper and lower flaps formed thereby are dissected back until the whole bone and the articulation are exposed.

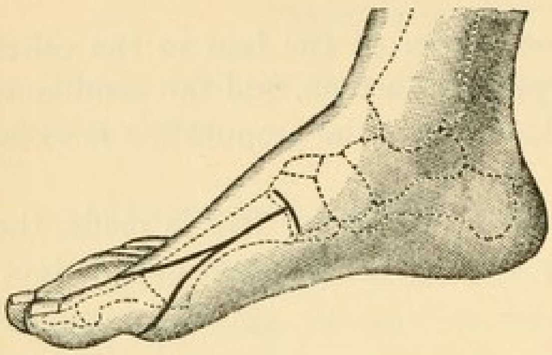


Fig. 685. Disarticulation of the Great Toe together with its Metatarsal Bone

2. The tendons of the extensor and flexor longus hallucis are divided over the articulation ; the articulation is opened on the dorsal side, and while the bone is constantly rotated around its axis in opposite directions, its connections with the internal cuneiform bone are detached.

DISARTICULATION OF THE FIFTH TOE — TOGETHER WITH ITS METATARSAL BONE

Flap incision.

1. This incision can be made in a similar manner as previously described in the disarticulation of the thumb (page 340).

2. The left hand forcibly abducts the fifth toe from the fourth ; the right hand carries a small knife from the web with sawing movements between the two metatarsal bones upward until it meets with resistance (Fig. 686).

3. The end of the skin incision, as well on the dorsal side as on the plantar side, is extended about 1 centimeter upward.

4. Under a forcible abduction of the fifth metatarsal bone, its base is first separated from the fourth metatarsal bone, and next from the cuboid bone.

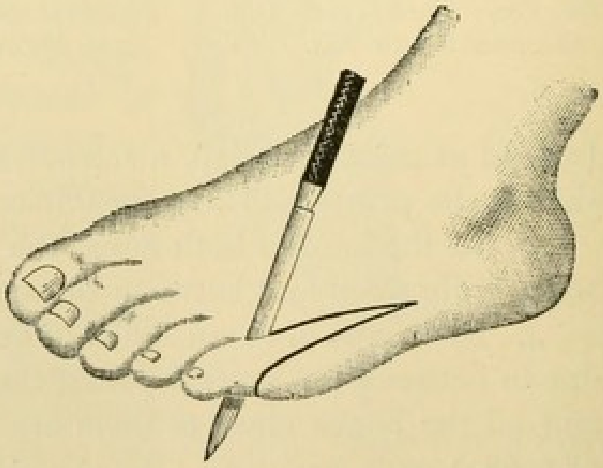


Fig. 686. Disarticulation of the Fifth Toe together with its Metatarsal Bone

5. The knife is then carried around the tuberosity of the fifth metatarsal bone projecting upward ; thence closely along the outside of the bone in sawing movements downward; a tongue-shaped external flap is thus formed,

the point of which must be rounded off exactly at the level of the first incision in the web (Fig. 686).

6. In the same manner, the second, third, and fourth toes, together with their metatarsal bones, can be extirpated.

LISFRANC'S DISARTICULATION IN THE TARSO-METATARSAL ARTICULATIONS (EXARTICULATIO TARSOMETATARSEA)

1. Along the external border of the foot, between the cuboid bone and the metatarsal bone, the joint lying *directly in front of the tuberosity* of this bone is sought; at the internal border of the foot, the articulation is sought for between the internal cuneiform bone and the first metatarsal bone, which is 4 centimeters *in front of the tuberosity of the scaphoid bone.* The line is marked by small incisions with the knife.

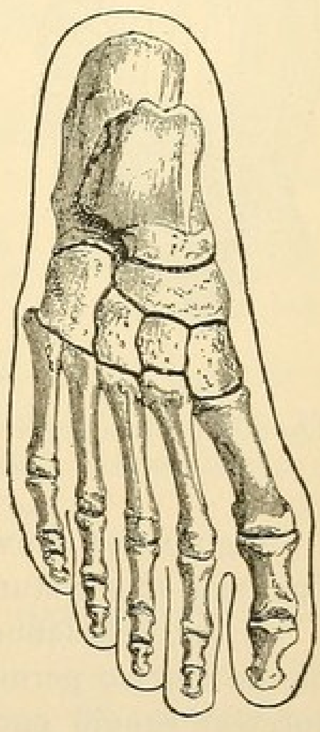


Fig. 687. Skeleton of the Foot

2. From one of these points to the other (from left to right), while the foot is raised, a large *semilunar flap* is circumscribed with the knife on the *plantar surface,* the convexity of which passes over the heads of the metatarsal bones.

3. The foot is lowered and strongly flexed, the knife is carried from one point of the plantar flap to the other in a *shallow curve,* across the *dorsum of the foot,* dividing all soft parts down to the bone (Fig. 689).

4. The small dorsal flap is drawn upward, the point of the knife searches gropingly, to open the articulation farthest to the left (on the right foot, the fifth metatarsal joint), while the left hand *flexes* the front of the foot strongly *toward* the plantar surface.

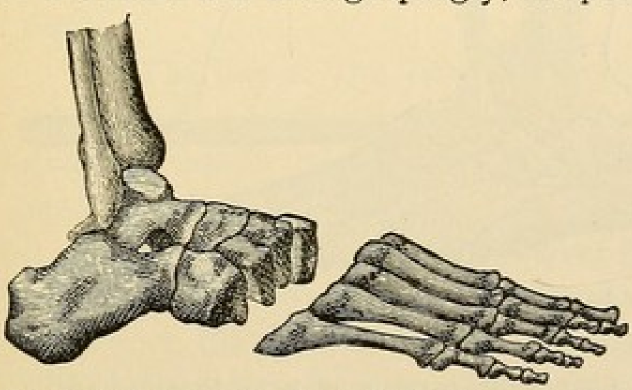


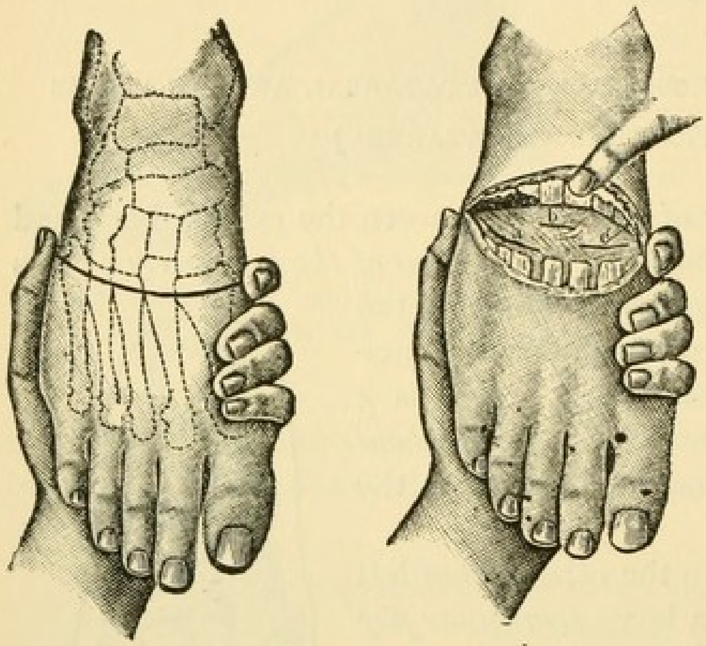
Fig. 688. Lisfranc's Disarticulation of the Tarsometatarsal Articulation

5. As soon as the joint gapes, the knife is carried farther in a curve slightly convex anteriorly; the knife opens the fourth and third joints (*a*), slides across the

base of the second metatarsal bone and opens the first articulation (*c*) (Fig. 690).

6. The articulation of the *second* metatarsal bone, located about *one centimeter higher* than that of the first, is opened by a small transverse incision (*b*); the lateral connections of the bone with the internal and external cuneiform bones, between which the base of the bone articulates, are divided by inserting the knife with its edge directed upward (Fig. 691).

7. All articulations are now gaping more extensively; the knife divides the remaining connections of the joint along the lateral borders and on the plantar side, and divides the muscles on the plantar surface for the greater part; next, its edge is directed forward in completing the plantar flap (Fig. 692).



a *b*

Fig. 689 Fig. 690

Lisfranc's Disarticulation of the Foot. *a*, dorsal incision; *b*, dividing articulation

Figure 693 shows the appearance of the wound before its union; Fig. 694, that of the stump.

If the well-defined extent of the disease permits it, the surgeon should endeavor to preserve the healthy metacarpal bone or bones (**atypical amputation.** *Küster* obtained a good success by disarticulating the second to the fifth metatarsal bones. He preserved the first metatarsal bone as well as the great toe, whereby the important support of the foot, the condyle of the first metatarsus, was preserved (Fig. 695). Else the surgeon can disarticulate the first metatarsus and saw off

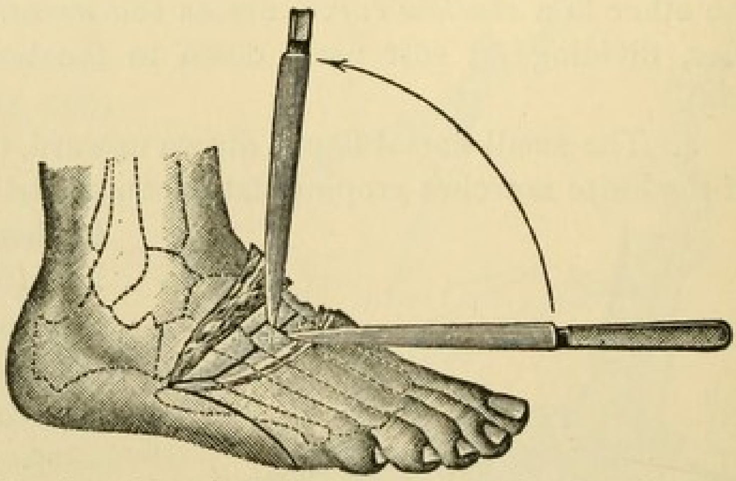
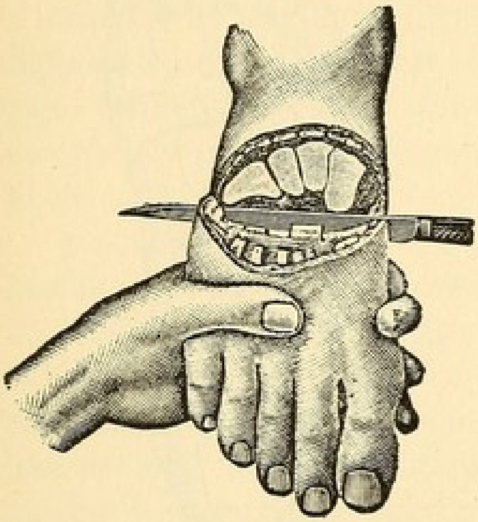


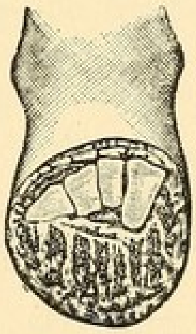
Fig. 691. Lisfranc's Disarticulation Opening Second Metatarsal Articulation

only a portion from the other metatarsal bones, whereby likewise the important support of the tuberosity of the fifth metatarsus is left in position. If the *three cuneiform bones* must be removed, the cuboid bone, together with



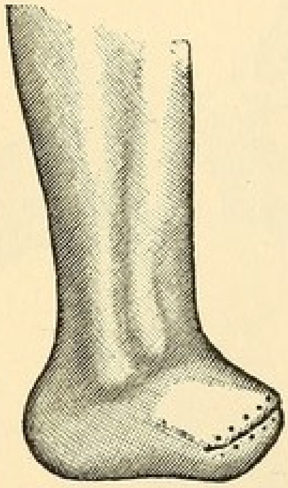
a

FIG. 692



b

FIG. 693



c

FIG. 694

LISFRANC'S DISARTICULATION. *a*, forming plantar flap; *b*, wound surface; *c*, stump

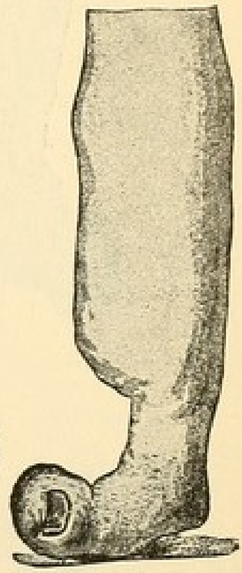


FIG. 695. LISFRANC'S DISARTICULATION. Preserving hallux

the tuberosity of the fifth metatarsus, can be preserved. But it is better to make in that case a transverse amputation by dividing transversely the cuboid bone at an equal height with the anterior line of articulation of the scaphoid bone (**intertarsal disarticulation**, *Jäger, Bona*).

CHOPART'S DISARTICULATION AT THE TARSUS — MEDIOTARSAL DISARTICULATION

1. The disarticulation is made in the joint connecting the *scaphoid bone* with the head of the *astragalus*, and the *cuboid bone* with the *os calcis* (Fig. 696).

2. The line of the joint is found and marked along the *internal* border of the foot, 1 centimeter *above the tuberosity of the scaphoid bone*, and at the *external* border of the foot, 2 centimeters *above the tuberosity of the fifth metatarsal bone*.

3. Across the *plantar surface* of the raised foot, a *curved skin incision* is made, extending from the point marked on the left anteriorly along the border of the foot, a thumb's breadth behind the heads of the metatarsal bones, transversely across the plantar surface, and along the other border of the foot back to the point on the right side (Figs. 697–699).

4. The foot is lowered and *forcibly pressed* downward, the knife is inserted in the left angle of the wound and carried in a small curve across the

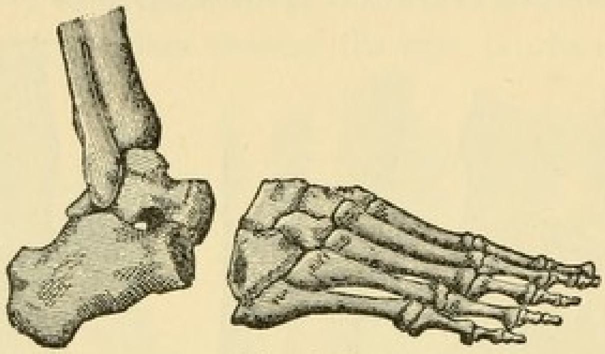


Fig. 696

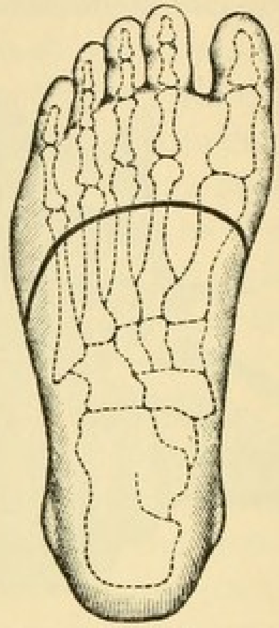


Fig. 698

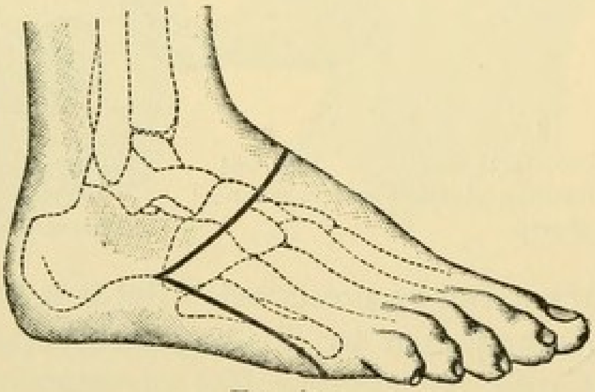


Fig. 697

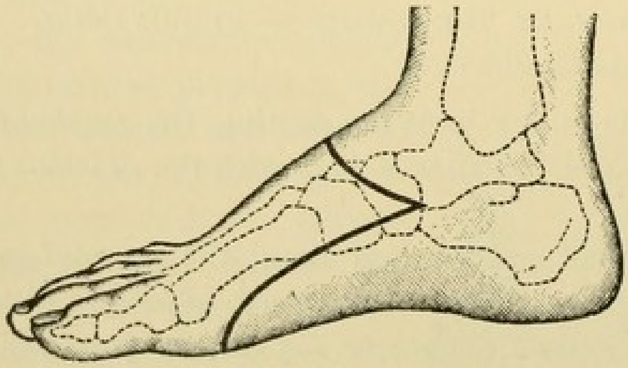


Fig. 699

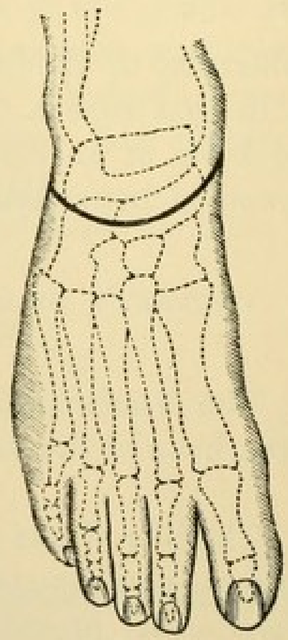


Fig. 700

Chopart's Disarticulation at the Tarsus

dorsum of the foot, only through the skin, as far as the right angle of the wound of the plantar incision (Fig. 700).

5. The little dorsal flap is retracted forcibly, a deep incision transversely across the articulation divides all tendons, and penetrates at once into the

articular connection (most safely, first above the *tuberosity* of the scaphoid bone, *which can be distinctly felt*).

6. Under the edge of the knife, carried across the union of the joint (slightly ∼-shaped curve), the joints are opened with a cracking noise. The point of the knife divides the tense ligaments everywhere, last on the plantar side, until the front of the foot can be completely pressed downward against the heel.

7. After a somewhat deeper incision has been made of the plantar flap on both borders of the foot, the edge of the knife, directed forward, is applied to the lower side of the freed scaphoid and cuboid bones, and drawn forward by sawing movements until the plantar flap is completed (Fig. 701).

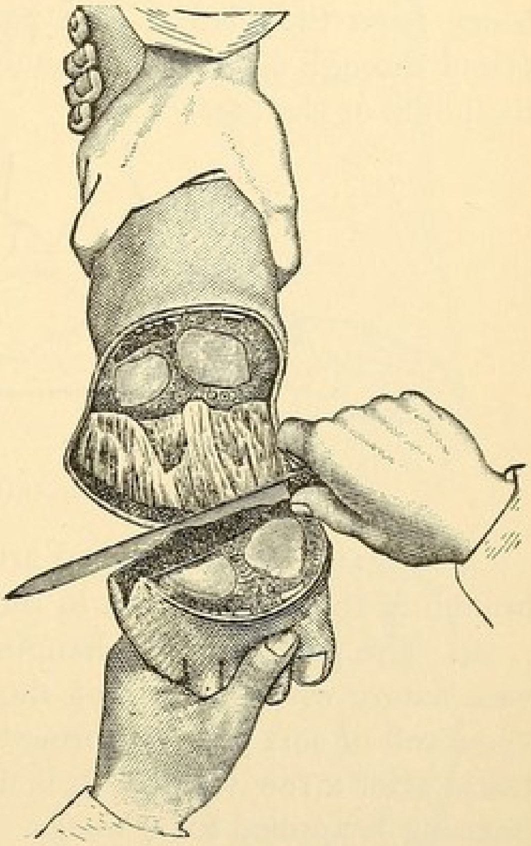


FIG. 701. CHOPART'S DISARTICULATION AT THE TARSUS. Finishing plantar flap

8. Figure 702 shows the appearance of the stump.

The anterior inferior edge of the os calcis, which projects conspicuously and is apt to produce decubitus of the stump, can be chiselled off to some extent (*Helferich*). During the healing process the foot must be placed in strong dorsal flexion (if necessary, by making tenotomy of the tendon of Achilles). After the healing, a sole extending obliquely upward is useful for walking, since the stump is apt to assume the talipes-equinus position. To prevent the same, *Helferich* advises, after a previous tenotomy of Achilles, to open the astragalo-crural articulation from *Chopart's* wound, and, after removal of its cartilaginous surfaces, to effect a coalescence (arthrodesis), the limb being placed in a right-angular position.

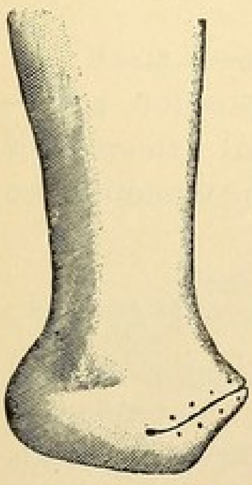


FIG. 702. STUMP AFTER CHOPART'S DISARTICULATION AT THE TARSUS

If the disease involves only the metatarsus, the disarticulation can be made in *Chopart's* joint, thus **preserving the toes** (*Linck*, 1887, *Witzel*).

1. From the extremities of the dorsal transverse incision longitudinal

incisions are made along the exterior and interior border of the foot toward the toes and beyond the diseased portion. The extremities of these incisions are connected by a dorsal transverse incision, so that a square soft-part flap is produced thereby (Fig. 703).

2. Disarticulation in *Chopart's* joint and amputation of the diseased bones from the plantar soft parts, after the metatarsal bones have been sawed through either transversely, or after they have been disarticulated in the joints of the toes.

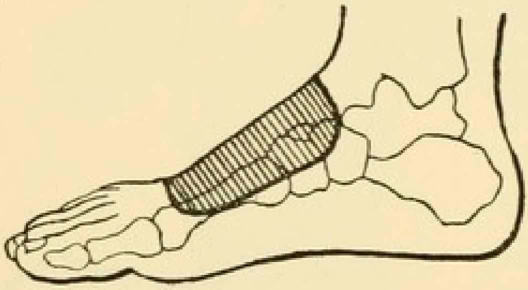


Fig. 703

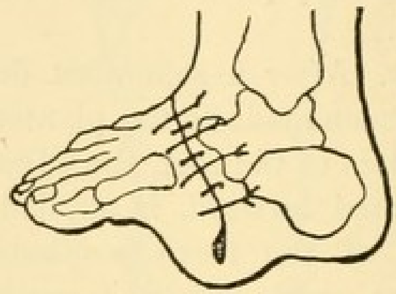


Fig. 704

Chopart's Disarticulation preserving Toes (Witzel)

3. Ligation of the dorsal artery of the foot and of the communicating branch of the plantar arch in the metatarsal interstice.

4. The portion of toe hanging loosely at the plantar bridge is united by wire suture with the skin of the upper dorsal flap, whereby a strong transverse roll of soft parts is formed on the plantar side (Fig. 704), which contracts after a few weeks. It is drained on both sides, and an immobilization dressing is applied for 4 weeks.

5. The result is a well-formed, but considerably shortened, small foot without any arch; it does not assume any talipes-equinus position, and is well movable in the astragalo-crural articulation. The dorsal extension of the toes, of course, does not take place, since the sutures of the tendons have been omitted.

MALGAIGNE'S DISARTICULATION OF THE FOOT — BELOW THE ASTRAGALUS

1. *Two lateral flaps* are formed by an incision, beginning behind directly above the tuberosity of the os calcis and detaching the tendon of Achilles from it; encircling the external malleolus in a large curve, it extends across the lower half of the os calcis (Fig. 705) and thence ascends across the middle of the cuboid bone to the dorsum of the foot, over the anterior margin of the scaphoid bone (Fig. 706); it then descends perpendicularly downward along the internal side of the metatarsus (Fig. 707), until it reaches the middle of the plantar surface (Fig. 708); from here it turns at

a right angle backward, meeting the beginning of the incision at the inner border of the tendon of Achilles.

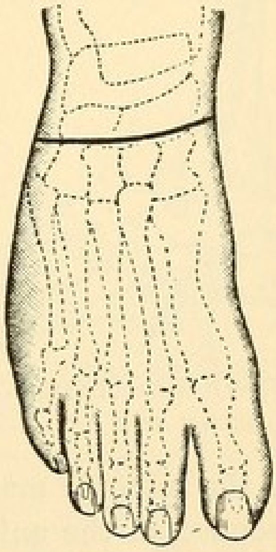


Fig. 706

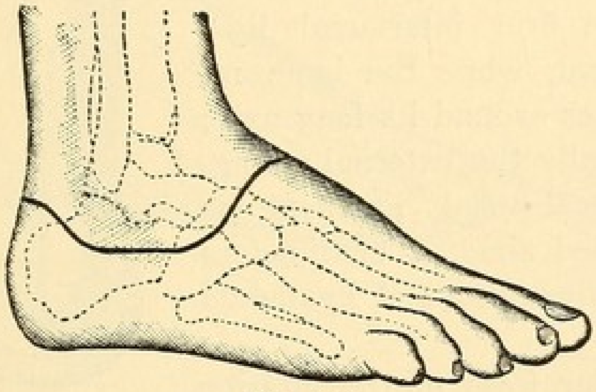
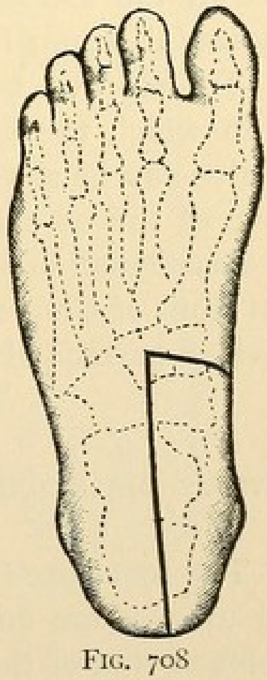


Fig. 705



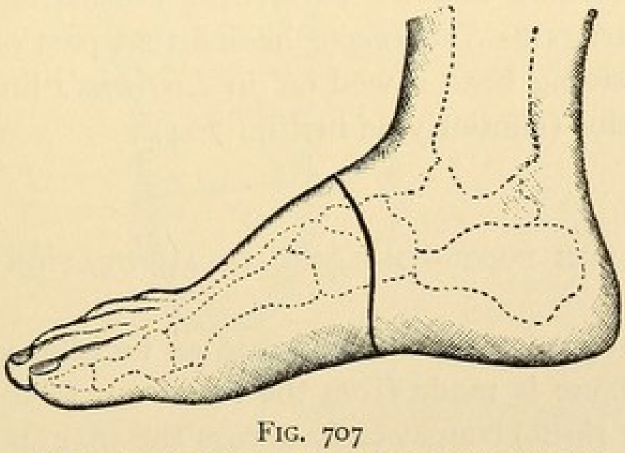


Fig. 707

Fig. 708

Malgaigne's Disarticulation between the Astragalus and the Os Calcis (below the astragalus)

2. The two flaps are detached from the bone until both lateral surfaces of the calcaneum and of *Chopart's* articulation are exposed. Care must be taken not to come too near the tips of the malleoli, for fear of injuring the tibiotarsal articulation.

3. By the disarticulation of *Chopart's* joint, the amputation is completed.

4. With bone forceps, the anterior border of the os calcis is grasped, and while the bone is pressed downward and held in supination, the calcaneofibular ligament is divided with a small knife 1 centimeter below the tip of the external malleolus; it next enters the joint, divides the firm intertarsal ligament, while the bone rotates around its long axis; finally the external astragalocalcaneal ligament is freed about 3 centimeters below the internal malleolus (see illustrations of ligaments in resection of the ankle joint).

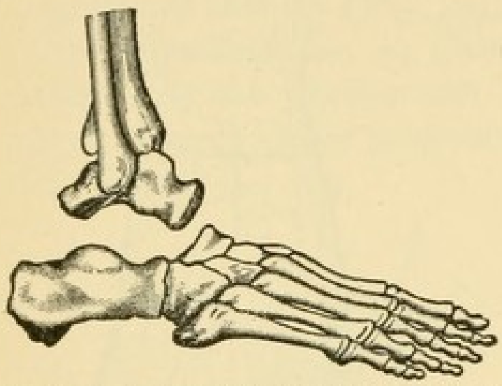


Fig. 709. Disarticulation of the Foot below the Astragalus

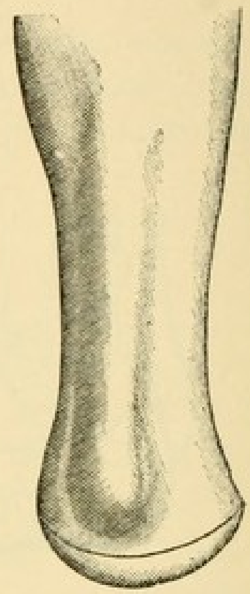


Fig. 710. Stump after Disarticulation of the Foot below the Astragalus

5. In spite of the very irregular form of the inferior surface of the astragalus (Fig. 709), this operation yields a very useful stump for walking (Fig. 710).

6. To improve this form of the stump, especially in cases in which the soft parts are scanty, the head of the astragalus can be sawed off. *Hancock* applied *osteoplastically* the sawed-off tubercle of the os calcis to the vivified inferior surface of the astragalus. After disarticulation below the astragalus *Ssabanejeff* healed that part of the foot in front of Chopart's joint (having been sawed off in *Lisfranc's* line) to the vivified surface of the astragalus (similarly as in Fig. 704).

SYME'S DISARTICULATION OF THE FOOT — MALLEOLAR AMPUTATION

1. The foot flexed at a right angle is well elevated, and an incision penetrating everywhere down to the bone is made from the tip of one (the left) malleolus to that of the other (the right) transversely across the plantar surface (Figs. 711–713).

2. The foot is lowered and forcibly pressed downward with the left hand, and a second incision is made from one tip of the malleolus to the other, transversely across the anterior side of the tibiotarsal articulation (Fig. 714).

3. A transverse incision across the articular surface of the astragalus opens the articulation in front; two incisions below the two malleoli divide

the lateral ligaments, and the superior articular surface of the astragalus is freely exposed.

4. The left hand forces the foot more and more toward the posterior side of the leg; next, while it is rotated around its axis in turns, first to one

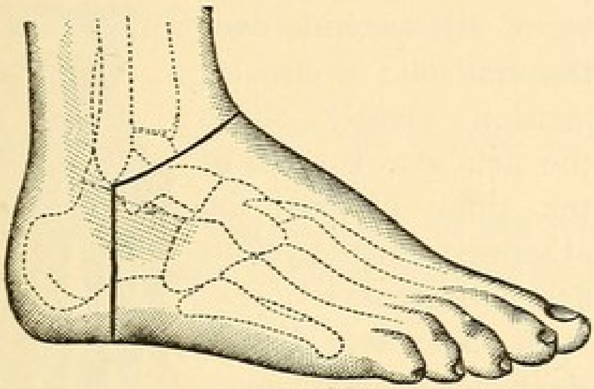


FIG. 711

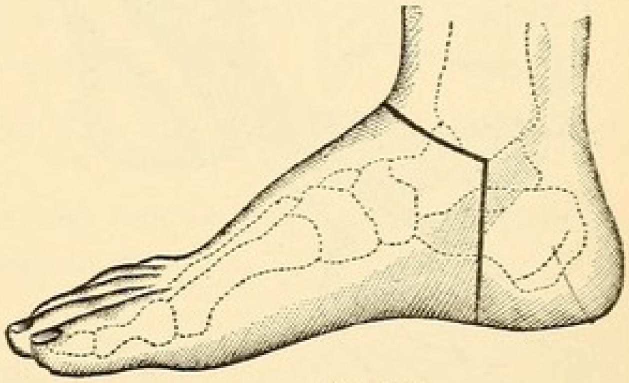


FIG. 713

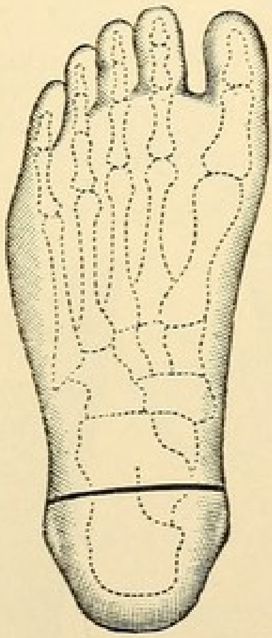


FIG. 712

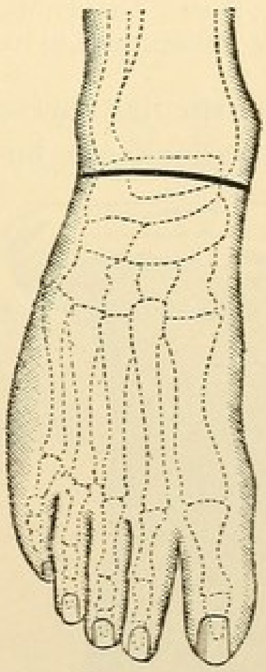


FIG. 714

SYME'S DISARTICULATION OF THE FOOT

side and then to the other, the *os calcis* is enucleated from the skin covering the heel, " Fersenkappe " (sustentaculum tali), and detached from the tendon of Achilles by incisions closely following each other, and alternating, now from above, now from the sides, and finally from behind and below, but always directed **toward the bone**. (Care should be taken not to injure the posterior tibial artery behind the internal malleolus.) (Fig. 715.)

In inflammatory diseases, it is well to enucleate the os calcis from the periosteum, not with the knife, but subperiosteally with the elevator and the raspatory (*Ollier*).

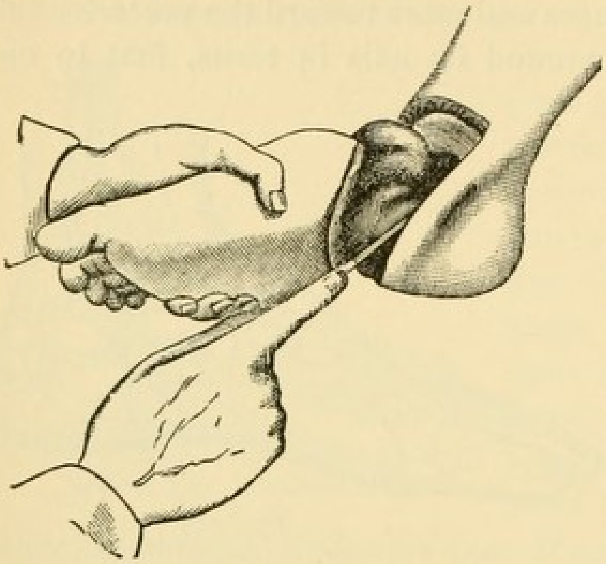


FIG. 715. SYME'S DISARTICULATION OF THE FOOT (Disarticulating the os calcis)

5. The heel flap and the skin are drawn upward all around over the malleoli; a circular incision closely above the articular surface of the tibia divides the other soft parts (tendons and periosteum).

6. The *saw* divides the bones in such a manner that only the two *malleoli* and *a thin layer of cartilage* are removed from the articular surface of the tibia (Figs. 716, 717).

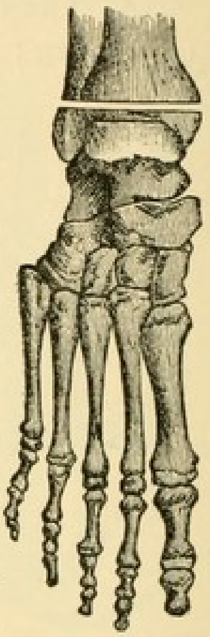
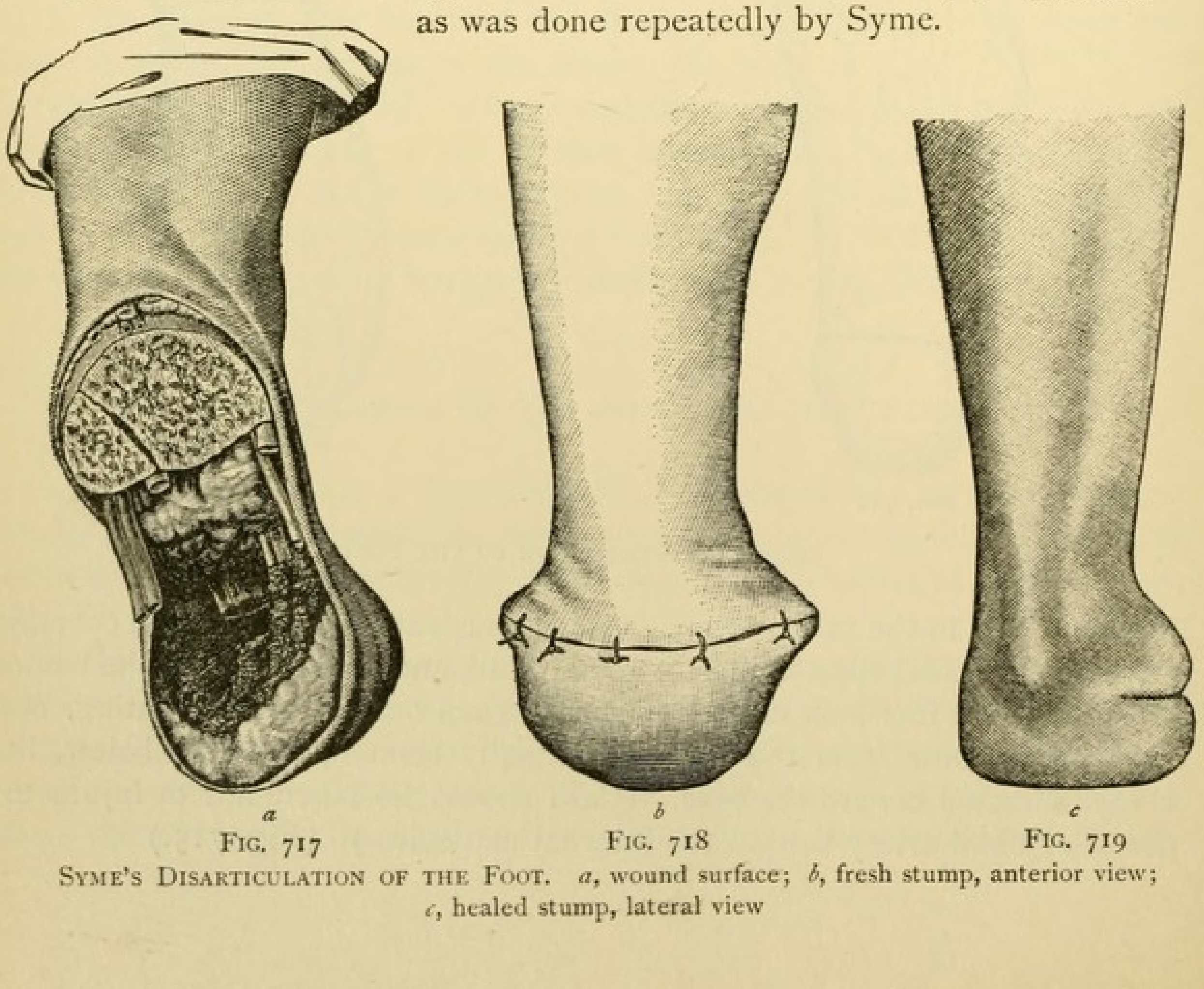


FIG. 716. SAWING THROUGH THE BONE

The malleoli can be nipped off with bone-cutting forceps, as was done repeatedly by Syme.



a FIG. 717 *b* FIG. 718 *c* FIG. 719

SYME'S DISARTICULATION OF THE FOOT. *a*, wound surface; *b*, fresh stump, anterior view; *c*, healed stump, lateral view

7. After ligation of all bleeding vessels, the skin over the outer side of the tendon of Achilles is divided with a small knife, a *drainage tube* is inserted through the opening, and the wound (Fig. 717) is united by suture (Figs. 718, 719).

PIROGOFF'S DISARTICULATION OF THE FOOT (AMPUTATIO TIBIOCALCANEA OSTEOPLASTICA)

1. The soft parts are divided in the same manner as in *Syme's* method (page 209).

2. After disarticulation of the joint, the foot is forcibly flexed until the posterior border of the astragalus appears to view.

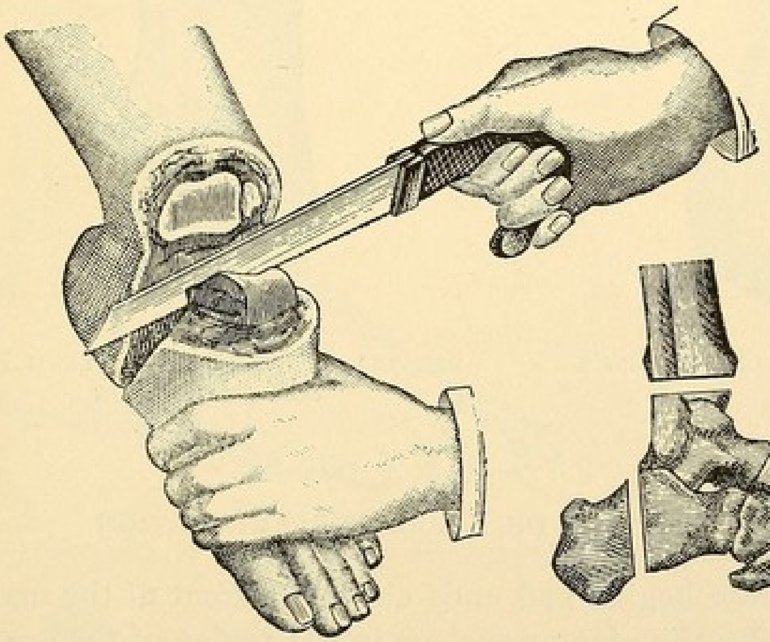


FIG. 720. PIROGOFF'S DISARTICULATION OF THE FOOT (Sawing off the os calcis)

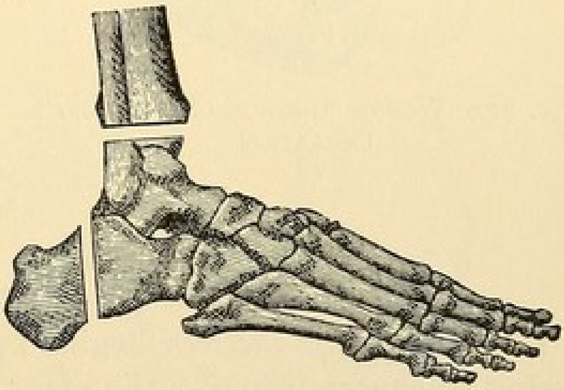


FIG. 721. SAWING OFF BONES BY PIROGOFF'S OPERATION

3. Immediately behind it, the saw is applied upon the upper surface of the os calcis, and the same is sawed through vertically and exactly in the plane of the plantar incision (Figs. 720, 721).

4. The two malleoli and a thin layer of the articular surface of the tibia are sawed off, as in *Syme's* method.

5. The *tendon of Achilles* is *divided* transversely, closely above its insertion, and the skin is fenestrated at the same place to make space for a drainage tube.

6. Figures 722 and 723 show the appearance of the surface of the wound and of the stump.

Rydygier's procedure is worthy of notice for suitable cases, namely, to make *Pirogoff's* operation with a very large plantar flap, which serves for covering a large loss of substance (incurable ulcer) on the anterior surface of the leg.

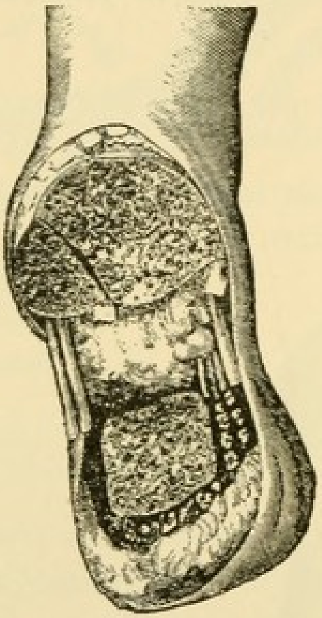


Fig. 722. Wound Surface of Pirogoff's Operation

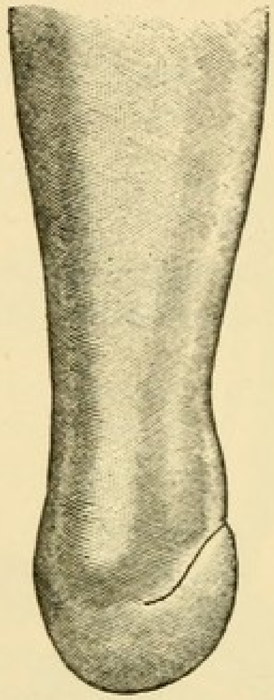


Fig. 723. Stump resulting from Pirogoff's Operation

GÜNTHER'S MODIFICATION OF PIROGOFF'S AMPUTATION

1. The *plantar incision* begins and ends closely **in front** of the malleoli, passing transversely across the plantar surface in the region of the posterior margin of scaphoid bone (Figs. 724–726).

2. The *dorsal incision* forms a small semilunar flap, extending as far as the scaphoid bone (Fig. 727).

3. After the articulation has been opened, the soft parts are dissected off on both sides of the os calcis obliquely upward in a posterior direction as far as the insertion of the tendon of Achilles; injury to the *posterior tibial artery* must be carefully avoided.

4. Immediately in front of the insertion of the tendon of Achilles, a metacarpal saw is applied upon the os calcis; and the same is sawed through **obliquely** from behind, above, forward, and downward.

5. In the same manner, the tibia and the fibula are divided *obliquely* from behind, above, forward, and downward (Fig. 728).

6. The sawed surfaces of the bone can easily be brought in apposition by this procedure *without* dividing the tendon of Achilles.

(Division of the tendon of Achilles is superfluous if the necessary mechanical precautions are practised to prevent retraction of the heel.

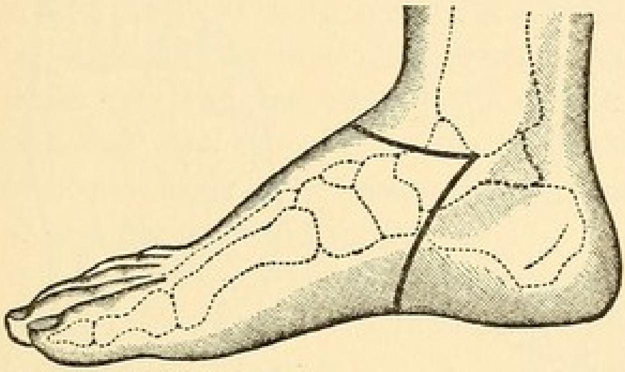


FIG. 724

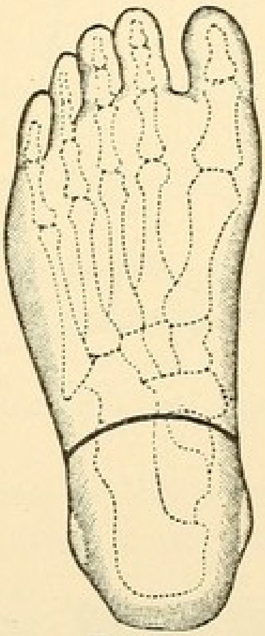


FIG. 725

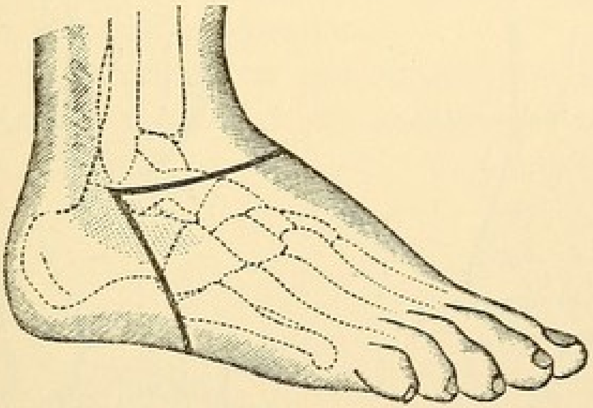


FIG. 726

GÜNTHER'S MODIFICATION OF PIROGOFF'S OPERATION

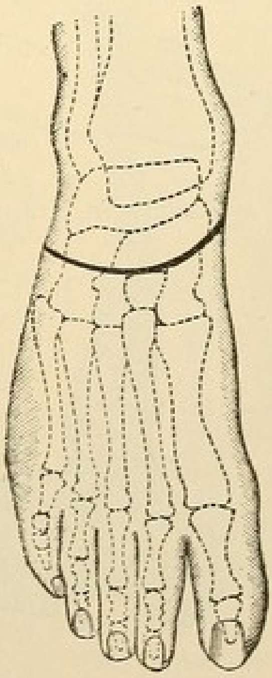


FIG. 727

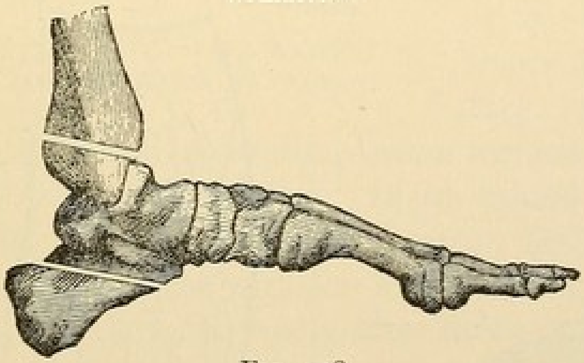


FIG. 728

GÜNTHER'S METHOD OF DIVIDING BONES BY SAWING

The two bone surfaces can be kept in accurate uninterrupted contact by: (1) Suturing of extensor to flexor tendons; (2) direct fixation of os calcis to tibia with an ivory nail; (3) silver wire suture.)

LE FORT AND VON ESMARCH'S MODIFICATION OF PIROGOFF'S AMPUTATION

1. The *plantar incision* begins 2 centimeters below the tip of the external malleolus (on the right foot), extends in a shallow convex manner across the

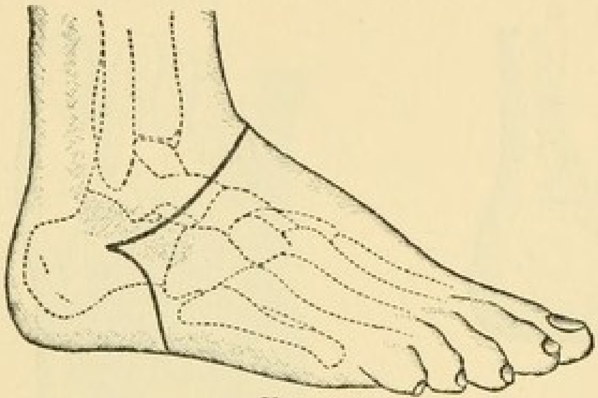


FIG. 729

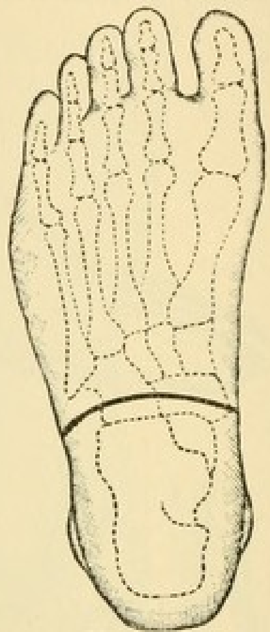


FIG. 730

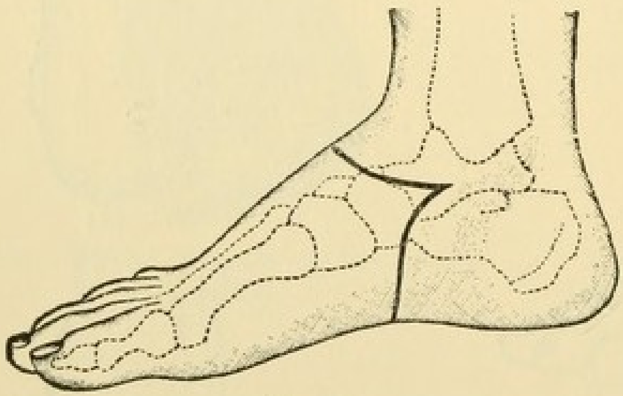


FIG. 731
LE FORT'S MODIFICATION OF PIROGOFF'S OPERATION

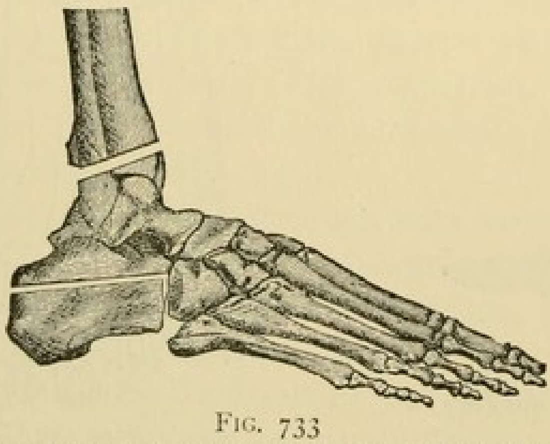


FIG. 733
LE FORT'S METHOD OF DIVIDING BONES BY SAWING

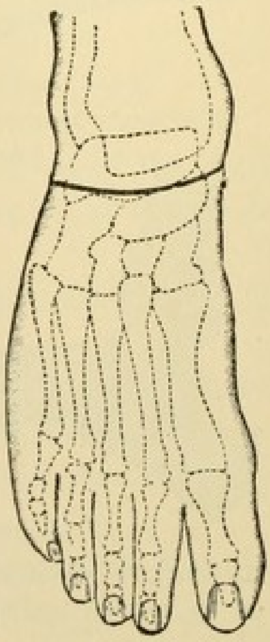


FIG. 732

plantar surface of the cuboid and scaphoid bones, and ends at the inner side, 3 centimeters in front and below the internal malleolus (Figs. 729–731).

2. The *dorsal incision* from the same points forms a slightly curved flap, the anterior border of which passes across *Chopart's* line of articulation (Fig. 732).

3. The dorsal flap is dissected upward as far as the tibiotarsal articulation, and the joint is opened as in *Pirogoff's* method.

4. The foot is turned backward, and the upper surface of the os calcis is dissected free far enough to enable a metacarpal saw to be inserted behind the upper border of the tuberosity of the os calcis and the upper third of the bone to be removed by *a horizontal incision* from behind, forward and backward (Fig. 733).

5. As soon as the saw has penetrated into *Chopart's* articulation, the bones of this articulation are separated in the same manner as by *Chopart's* method.

6. The two malleoli and the articular surface of the tibia are sawed off as in *Pirogoff's* operation.

7. According to *von Bruns*, the os calcis can also be sawed off in a **concave** manner with the metacarpal saw, and the bones of the tibia and fibula convexly (Fig. 734). By this method the stump receives a very broad surface for walking (Fig. 735).

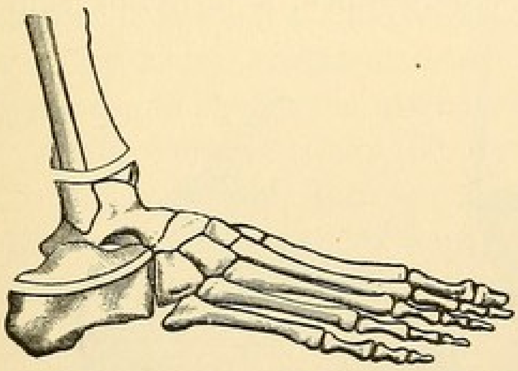


Fig. 734. Von Bruns's Method of dividing Bones by Sawing

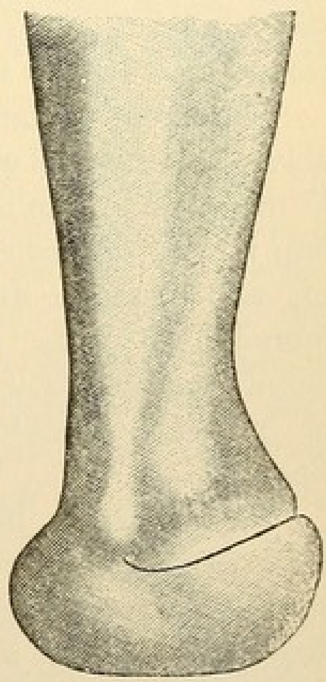


Fig. 735. Stump resulting from Le Fort's Method

8. In all these operations it is advisable, after union of the soft parts, to fasten the bones together with a long *steel nail* (Fig. 571), driven in from the plantar surface through the os calcis deep into the tibia. If the wound is and remains aseptic it heals rapidly by primary intention; the nail does not interfere with an ideal healing of the wound. It can be extracted easily after three weeks.

If only the external or the internal side of the foot is diseased, *Pirogoff's* operation may finally be modified in this manner: the os calcis is sawed through in a *sagittal* line, its healthy surface is laterally turned upon the sawed surface of the leg (*Tauber*). Or else, with *Malgaigne's* mode of incision, the interior half, well rounded off at its borders with the bone-cutting forceps, can be inserted into the bifurcation of the malleoli which has been left uninjured (*Quimby*). *Küster* recommends as a good substitute for *Le Fort's* operation to open the ankle joint from the incisions indicated in Figure 736, to remove the astragalus, to disarticulate the foot between os calcis, cuboid, and scaphoid, and to heal firmly the os calcis left uninjured into the malleolar bifurcation **without** removing any portion of bone.

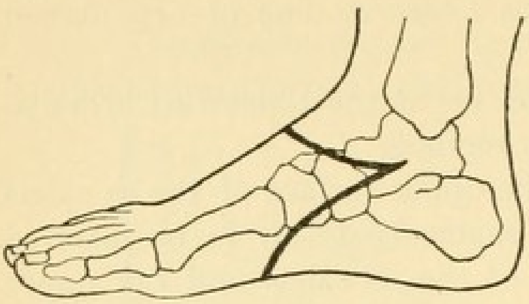


Fig. 736. Küster's Modification of Le Fort's Operation

AMPUTATION OF THE LEG

Circular amputation by two incisions and *the skin flap incision* are best adapted to the amputation of the leg.

In **the lower third** (above the malleoli), two lateral skin flaps of equal length are especially suitable (Fig. 604); an anterior skin flap can easily be perforated by the sharp spine of the sawed-off tibia; a posterior skin flap draws the margins of the wound apart by its weight.

(The spine of the tibia should always be removed with the saw. If this is done, and the posterior flap is well supported by dressing and bandage, and the limb immobilized upon a posterior splint, there is little or no risk of pressure decubitus occurring.)

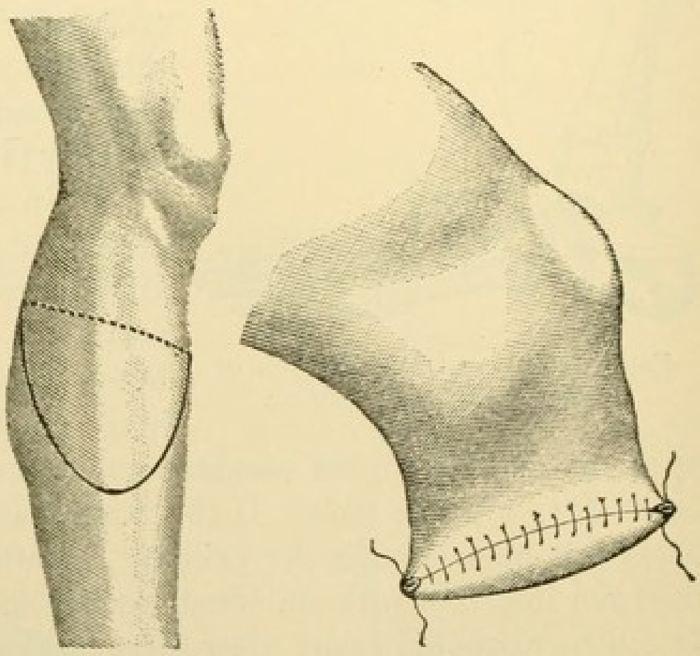


Fig. 737 Fig. 738
Von Langenbeck's Amputation of the Leg by forming a Lateral Skin Flap

In the **middle**, likewise, two skin flaps are formed, or, according to *von Langenbeck*, one *long oval lateral flap* (on the inner side) with half a circular incision on the opposite side, whereby the cicatrix is placed laterally (Fig. 738). This method is also well adapted to the **upper third**, where the amputation is usually made *below the tuberosity of the tibia* (**place of selection**).

(The best stump for the wearing of an artificial limb is obtained by performing the amputation at the junction of the lower with the middle third. The skin flaps should include the strong muscular fascia, and must be taken from the side of the limb where the tissues are best adapted to a suitable covering for the wound, in preference to a long oval anterior and a short oval posterior flap.)

Von Bardeleben formed at this place a large anterior skin flap, in which he included at the same time the *periosteum* (*cut around in the shape of a flap*) of the anterior smooth surface of the tibia; the sawed surface of the tibia is covered with this periosteal flap, and by the new formation of bone the sharp edge of the tibia is somewhat rounded off. The same object is obtained by *sawing off* the sharp border of the tibia *obliquely*.

Helferich forms *on the inner side* of the leg an oval flap in which the fascia and the whole periosteum of the circumsected tibial surface is preserved; the periosteum is carefully elevated from the bone. Next, a circular incision is made through the skin at the base of the flap, the soft parts and the interosseum are divided vertically; the bones are sawed off. When the suture is applied a cuneate lobule is formed over the eminence of the tibial surface by the abundant skin. This lobule protects the bone. The band of periosteum covers the sawed surfaces.

Hüter proceeded as follows: —

Longitudinal incision upon the crest of the tibia, corresponding in length to the manchette (cuff) to be formed; the incision penetrates through the periosteum down to the bone. At its lower end, across the free surface of the tibia, a short transverse incision is made as far as the inner margin, and from this *angular incision* the skin, together with the periosteum, is reflected from the tibia; the broad strip of periosteum thus formed is subsequently applied upon the sawed surface of the tibia. The transverse incision is next completed into a *circular incision* through the skin down to the fascia, and the rest of the operation is made in the same manner as in circular amputation.

The amputation at the place of selection (*von Esmarch*) produces stumps which can support most, and with which the patient, kneeling on a simple wooden leg (broom-handle fixed in a plaster of paris dressing) can walk about very well (Fig. 631). Hence, if the patient has not the means to buy an expensive artificial limb, which must be often repaired, it is advisable to make the amputation at the place of selection, even if a healthy part of the leg must be sacrificed.

To make *longer* stumps of the leg useful in *directly* supporting the weight of the body upon a peg leg, the primary *closure* of the opened medullary cavity is advisable by means of a **bone cover** taken from the tibia.

BIER'S OSTEOPLASTIC AMPUTATION

1. *Skin flap incision.* Beginning a thumb's breadth in an outward direction from the anterior border of the tibia and ending at the opposite side, a large skin flap is circumsected, the base of which corresponds to half the circumference of the limb. Without injuring the periosteum it is dissected back in an upward direction as far as its base (Fig. 739).

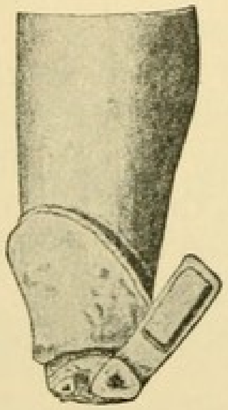


Fig. 739

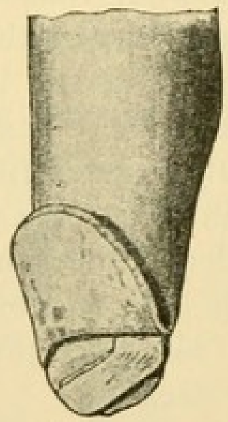


Fig. 740

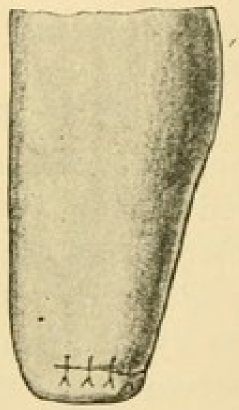


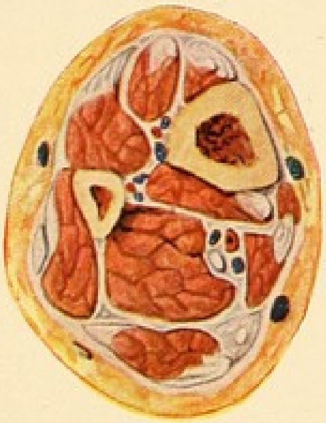
Fig. 741

Bier's Osteoplastic Amputation of the Leg

2. *Formation of bone cover.* From the periosteum of the tibia a square flap is excised, large enough to cover the sawed surfaces of the tibia and fibula. The longitudinal incisions lie a little beyond the tibial borders. From the transverse incision the flap is reflected in an upward direction for about $\frac{1}{2}$ centimeter. Next, a fine amputation saw with its blade placed obliquely is inserted in the transverse incision and a fine furrow is sawed. From this furrow a lamella is sawed out from the tibial surface in an upward direction, while an elevator keeps the saw incision gaping. Arrived at the base of the skin flap, the saw is carried more toward the periosteum for the purpose of completing the bone flap; the periosteal bone portion is then deflected, and the periosteum only is somewhat reflected at its upper end. The pedunculated bone flap is inverted in an upward direction (Fig. 739).

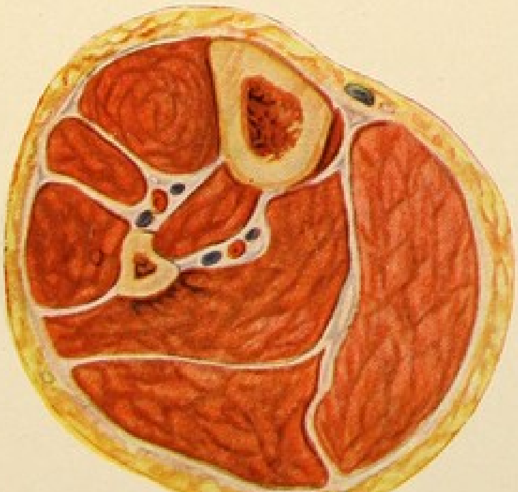
3. The *amputation* is then made from the extremities of the skin flap with a deep circular incision through the calf; division of the interosseus space, sawing off the tibia close at the border of the inverted bone flap, next of the fibula at an equal height (*without* reflecting the periosteum).

PLATE XIV

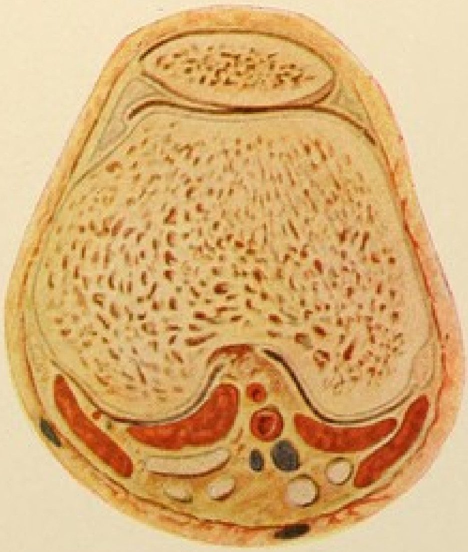


At its lower third

At its middle third



At its upper third



Through the knee-joint
(Line of Condyles)

Sections of the Right Leg

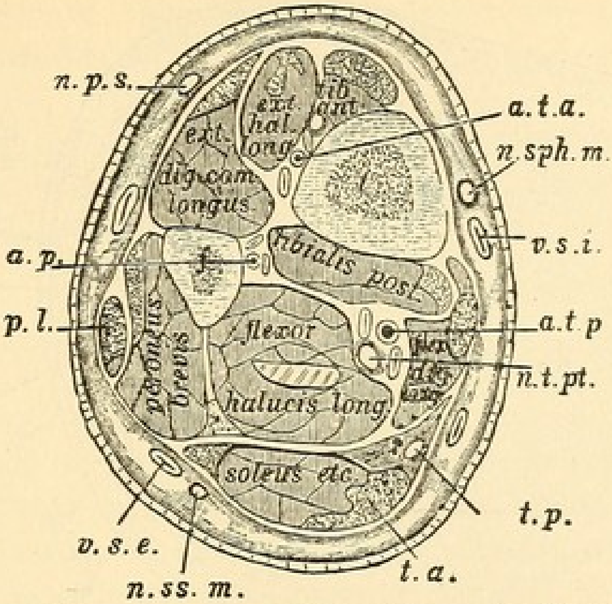


FIG. 742. SECTION OF THE RIGHT LEG AT ITS LOWER THIRD (see Plate XV). *n.p.s.* nerv. peron. superf.; *a.p.* art. peronæa; *p.l.* peron. long.; *v.s.e.* vena saphena ext.; *n.ss.m.* nerv. suralis major; *t.a.* tendo achillis; *t.p.* tendo plantaris; *n.t.pt.* nerv. tib. post.; *a.t.p.* art. tib. post.; *v.s.i.* ven. saph. int.; *n.sph.m.* nerv. saph. major; *a.t.a.* art. tib. antica.

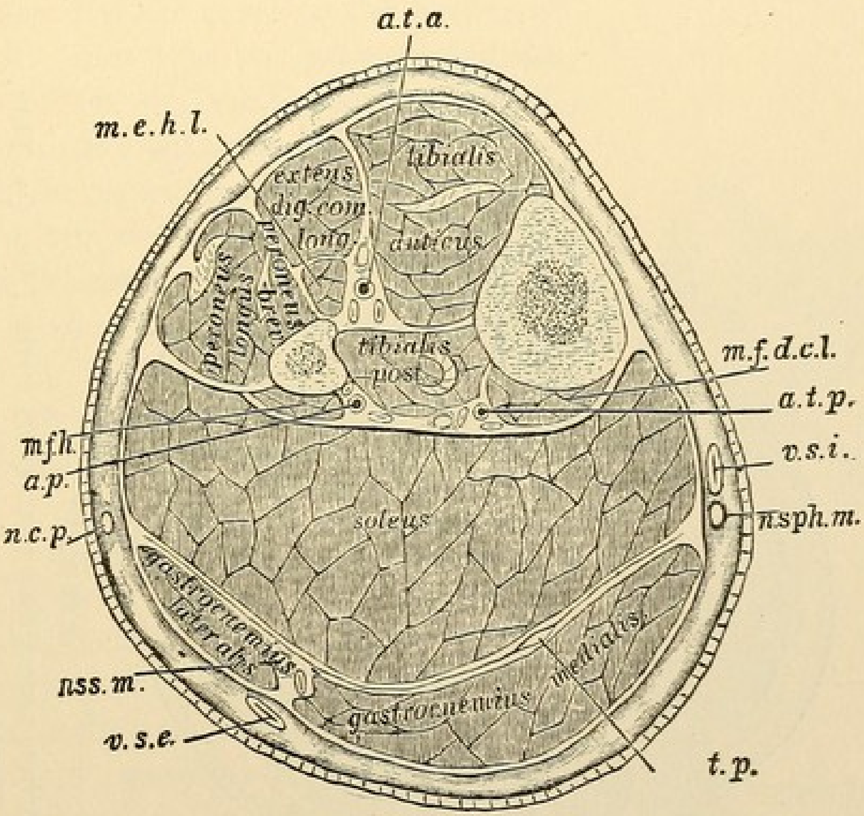


FIG. 743. SECTION OF THE RIGHT LEG AT ITS MIDDLE THIRD (see Plate XV). *a.t.a.* art. tibial. antica; *m.e.h.l.* musc. ext. hall. long.; *m.f.h.* musc. flex. hall.; *a.p.* art. peronæa; *n.c.p.* nerv. cutan. post. ext.; *n.ss.m.* nerv. suralis major; *v.s.e.* vena saph. ext.; *t.p.* tendo plantaris; *n.sph.m.* nerv. saph. major; *v.s.i.* vena saph. int.; *a.t.p.* art. tibialis post.; *m.f.d.c.l.* musc. flex. dig. comm. long.

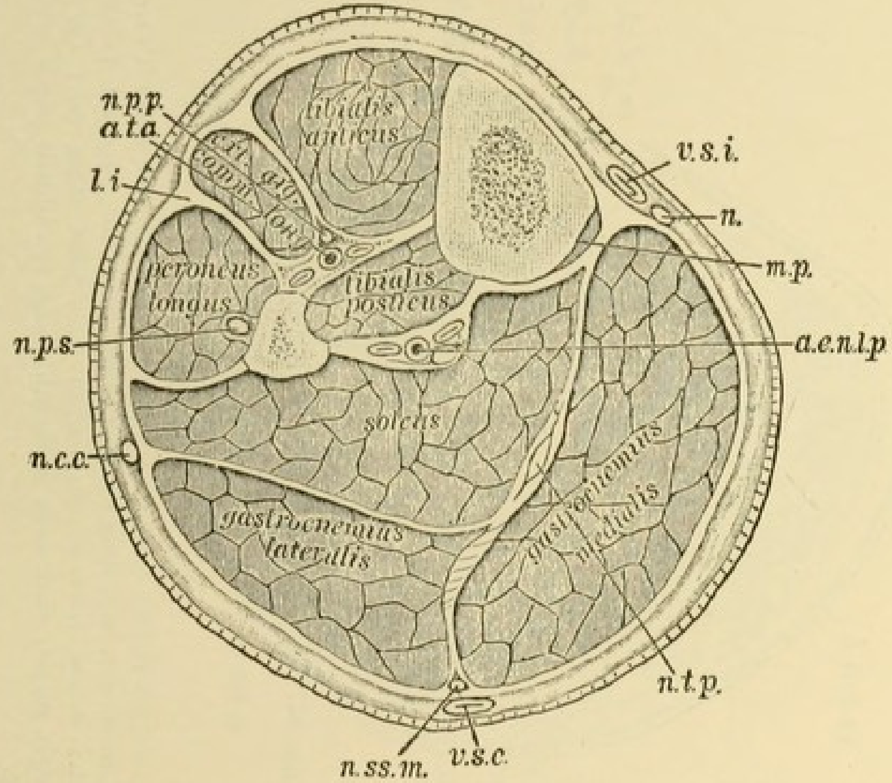


FIG. 744. SECTION OF THE RIGHT LEG AT ITS UPPER THIRD (see Plate XVI). *n.p.p.* nerv. peroneus prof. seu tib. ant.; *a.t.a.* art. tibialis ant.; *l.i.* ligam. intermusc. fibulare; *n.p.s.* nerv. peron. superf.; *n.c.c.* nerv. cutan. crur. post.; *n.ss.m.* nerv. suralis major; *v.s.e.* vena saphena ext.; *n.t.p.* tendo plantaris; *a.e.n.t.p.* art. et nerv. tib. post.; *m.p.* musc. popliteus; *n.* nerv. saphenus major; *v.s.i.* vena saphena int.

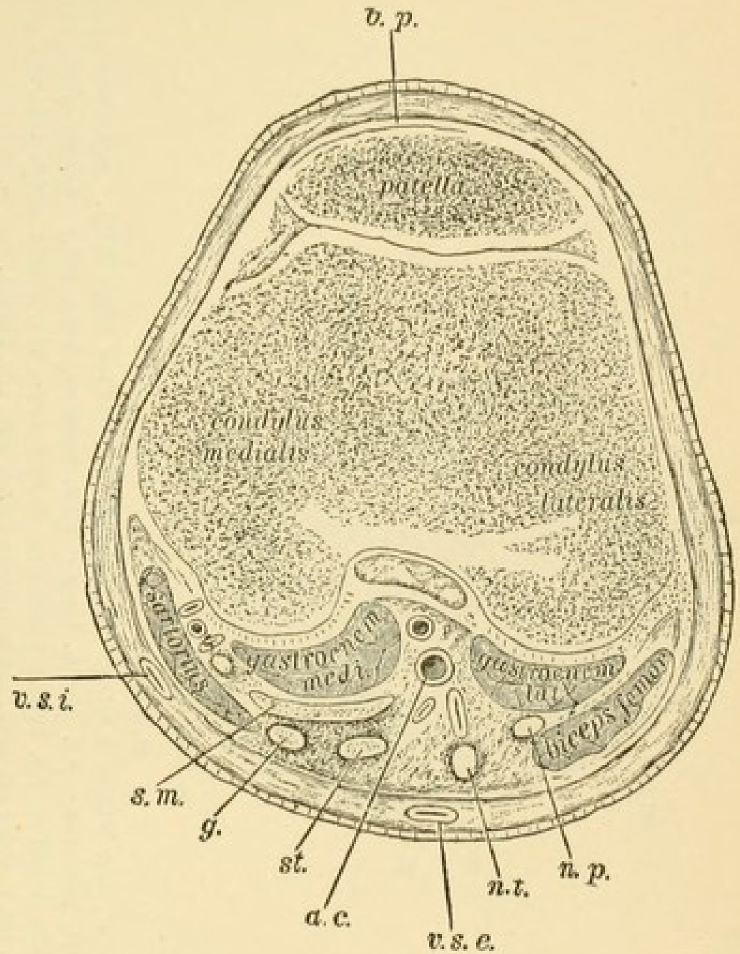


FIG. 745. SECTION OF THE LEFT THIGH IN THE LINE OF CONDYLES (see Plate XVI). *v.s.i.* ven asaph. int.; *s.m.* m. semimembranosus; *g.* m. gracilis; *st.* m. semitendinosus; *a.c.* art. cruralis; *v.s.e.* vena saph. ext.; *n.t.* nerv. tibialis; *n.p.* nerv. peroneus; *b.p.* bursa patellaris.

4. After ligation of the vessels the periosteum bone band is *turned over* the sawed surfaces and fastened in this position by a few sutures (Fig. 740).

5. The skin flap is turned down and sutured with the circular incision. Figure 741 shows the complete stump, which, after healing, is painless and capable of bearing.

DISARTICULATION OF THE LEG AT THE KNEE JOINT

(*a*) *Circular incision.*

1. While the leg is extended, a circular incision divides the skin of the leg 8 centimeters below the patella. The skin is dissected off all around as far as the inferior border of the patella and turned up like a cuff; to facilitate the latter, the manchette can be divided by a small *longitudinal incision* on one or both sides.

2. While the knee is flexed, first the ligamentum patellæ is divided just below the patella; next, the anterior capsular ligament and the two lateral ligaments are divided close to the border of the femur, in order that the menisci and the larger part of the articular capsule may remain in connection with the tibia.

3. After increased flexion of the knee, the crucial ligaments are detached from the inner surfaces of the two condyles of the femur. The knee is then again extended, and with one sweep of the knife from before backward, the remaining soft parts are divided on the posterior side of the articulation (Fig. 746).

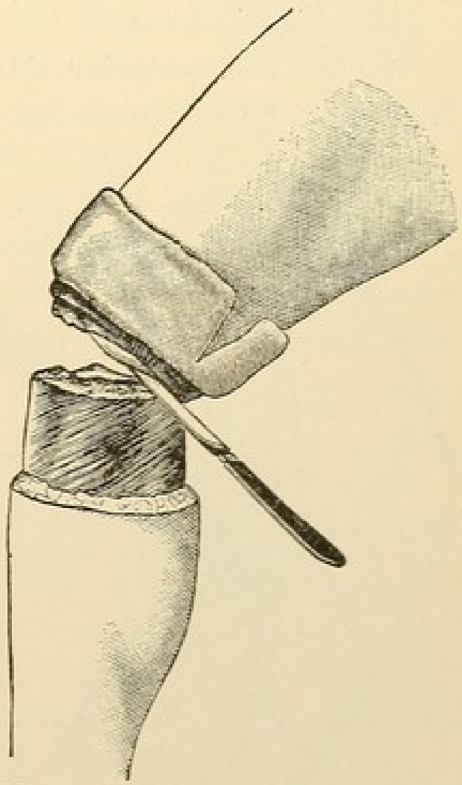


Fig. 746. Disarticulation of the Leg at the Knee Joint, by Circular Incision

4. The wound can be united transversely (Fig. 747); also in an antero-posterior direction, so that the cicatrix comes to lie between the two condyles (Fig. 748).

5. If, according to *Billroth's* method, the patella and the superior protrusion of the articular capsule are to be removed, then, after the circular incision has been finished, a longitudinal incision is made across the middle of the patella beginning 4 centimeters above its upper border. The patella is then removed from

the extensor tendon; the latter is turned upward, and the portion of the capsule lying under it is dissected out.

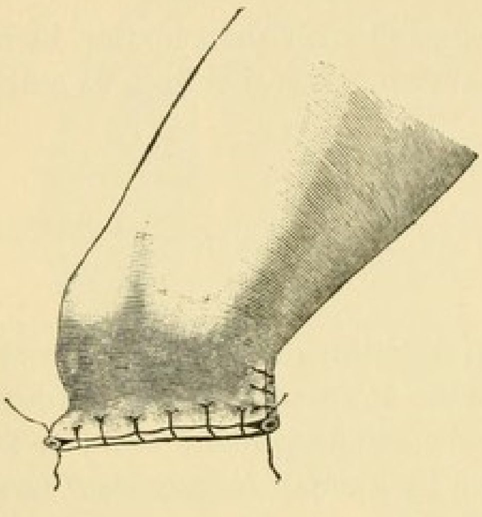


Fig. 747

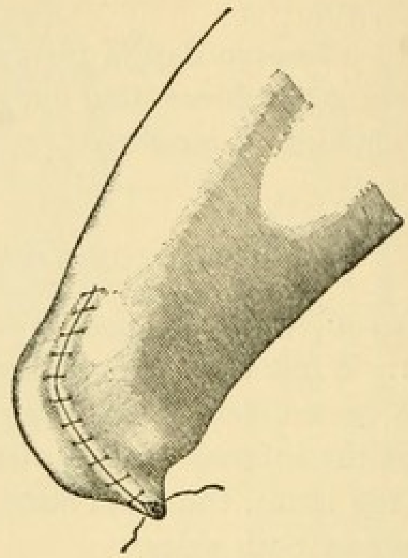


Fig. 748

Stump resulting from Disarticulation of the Leg at the Knee Joint by Circular Incision

(*b*) *Flap incision.*

1. On the posterior side of the leg well elevated, by a curved incision beginning 1 centimeter below the middle of the lateral margin of one condyle of the femur and ending 1 centimeter below the middle of the other condyle, a semilunar flap 8 centimeters long is formed from the skin of the upper part of the calf, and detached from the fascia as far as the base.

2. Next, the leg is lowered, flexed at the knee, and from the same points on the anterior side a

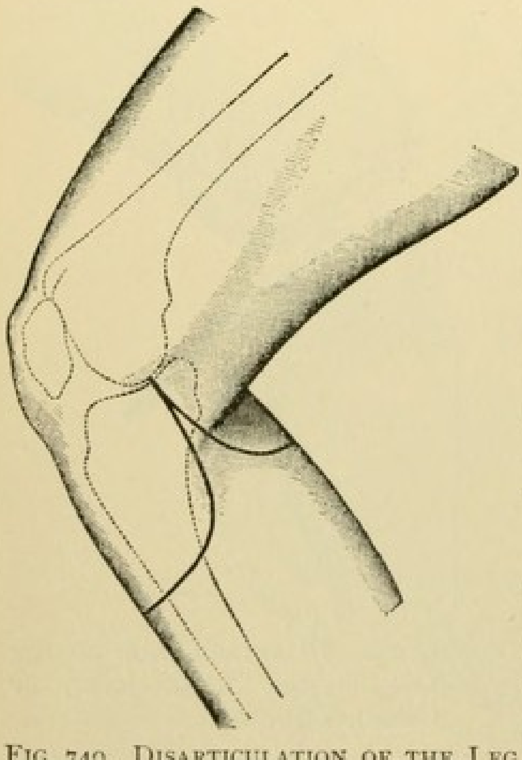


Fig. 749. Disarticulation of the Leg at the Knee Joint by forming Two Flaps

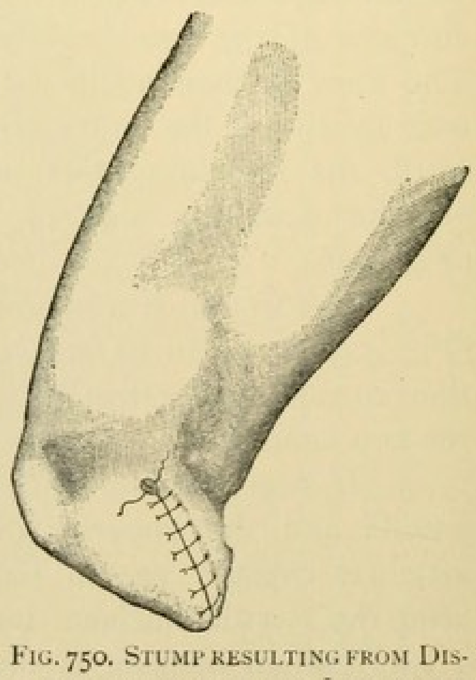


Fig. 750. Stump resulting from Disarticulation of the Leg at the Knee Joint with Flap Incision

larger skin flap 10 to 12 centimeters long is circumscribed with the knife, detached as far as the lower margin of the patella, and reflected (Fig. 749).

3. The separation of the articular ends is made in the same manner as in the circular incision.

Figure 750 shows the appearance of the stump.

(*c*) *Oblique incision* (anterior flap).

With the leg half flexed an incision is made in an anterior direction from the posterior line of articulation in the popliteal space about three inches below the tuberosity of the tibia (Fig. 751). For the remainder, see the preceding page.

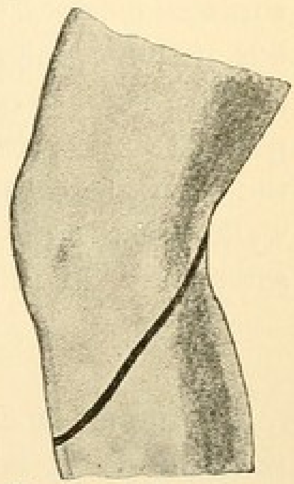


FIG. 751. DISARTICULATION OF THE LEG AT THE KNEE JOINT (Oblique incision)

If there is a lack of skin for making the flap sufficiently large, or if the lower surface of the condyles is diseased or injured, then by forming smaller flaps, of which the anterior extends about as far as the tuberosity of the tibia, a portion of the condyles of the femur can be sawed off in its greatest width (*Syme* and *Carden's* **intracondylic amputation**, Fig. 752). The sharp edges of the sawed surface must be rounded off subsequently with the saw or the bone-cutting forceps. With a small saw the bone can be sawed off in a curve parallel to the surface of the condyles (*Butcher*). In children, it is simpler to divide the condyles in the line of the **epiphysis** (*Buchanan*), which can be generally done with an elevator.

When the patella is healthy, it can be made to unite with the sawed surface of the condyles; the stump is thereby made longer and stronger for

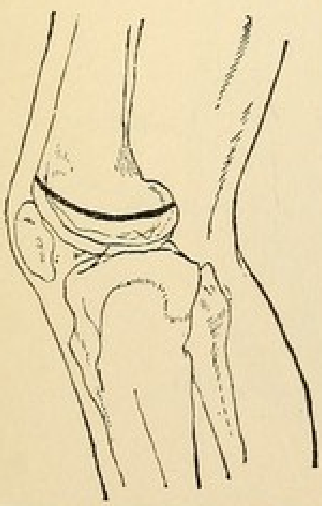


FIG. 752. CARDEN'S INTRACONDYLIC AMPUTATION

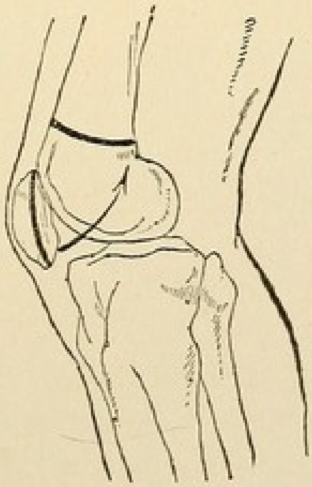


FIG. 753. GRITTI'S OSTEOPLASTIC SUPRACONDYLIC AMPUTATION

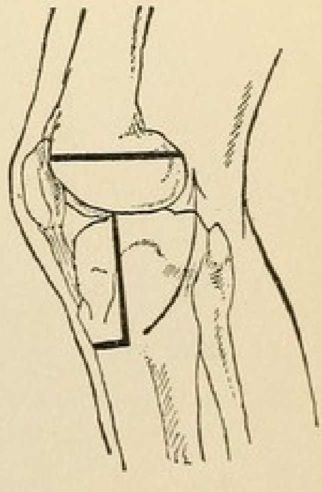


FIG. 754. SABANEJEFF'S OSTEOPLASTIC INTRACONDYLIC AMPUTATION

support (*Gritti's* **osteoplastic supracondyloid amputation,** Fig. 753). For this purpose, the cartilaginous surface of the patella must be removed with the saw in the form of a thin disk, and after the union of the skin wound, it must be nailed upon the sawed surface of the condyles. After dissecting off the anterior flap this can be done most easily if immediately the posterior surface of the patella, on which the lower ligament of the patella has been preserved for the purpose of support, is removed vertically with a broad amputation saw from before backward. To make the two sawed surfaces correspond in size, it is necessary to saw off the condyles entirely, but without opening the medullary cavity. *Sabancjeff* excised from the anterior surface of the tibia a portion which he left in connection with the patella, and which he nailed upon the sawed surface of the condyles of the femur (**osteoplastic intracondyloid amputation,** Fig. 754). The patient walks on the anterior tibial surface as in the amputation on the place of selection. The tibia and femur can be sawed off *obliquely* (*Djelitzyn*).

AMPUTATION OF THE THIGH

In the **lower** and the **middle third** the *circular amputation* is the simplest procedure. It is made *by one incision*, especially in the lower part, and in

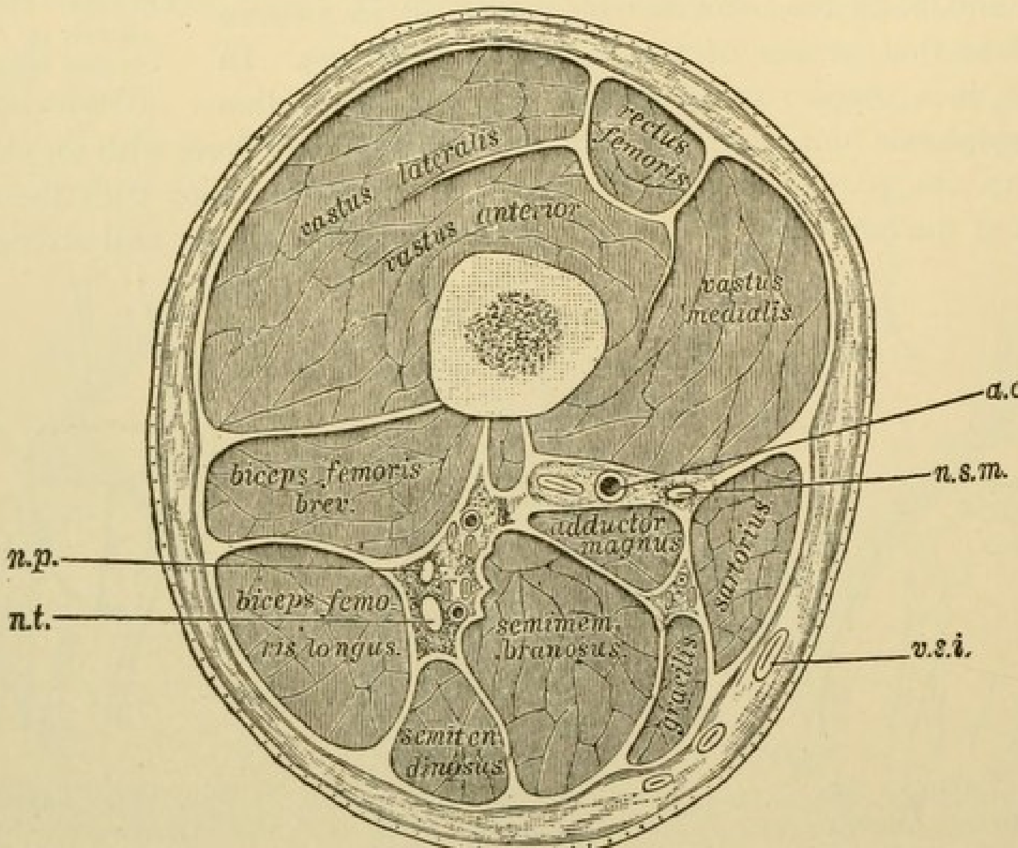
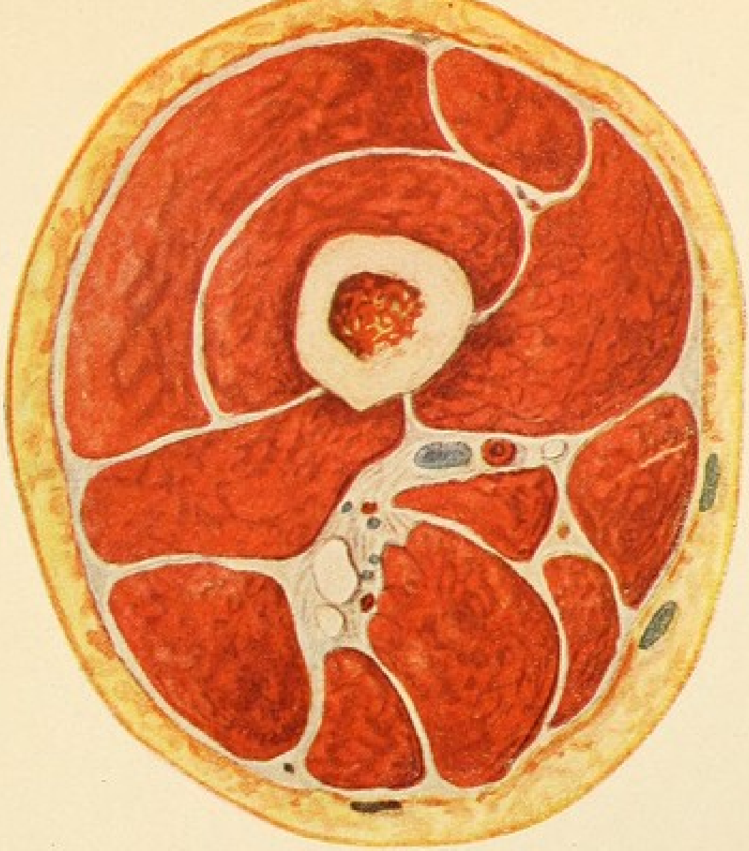
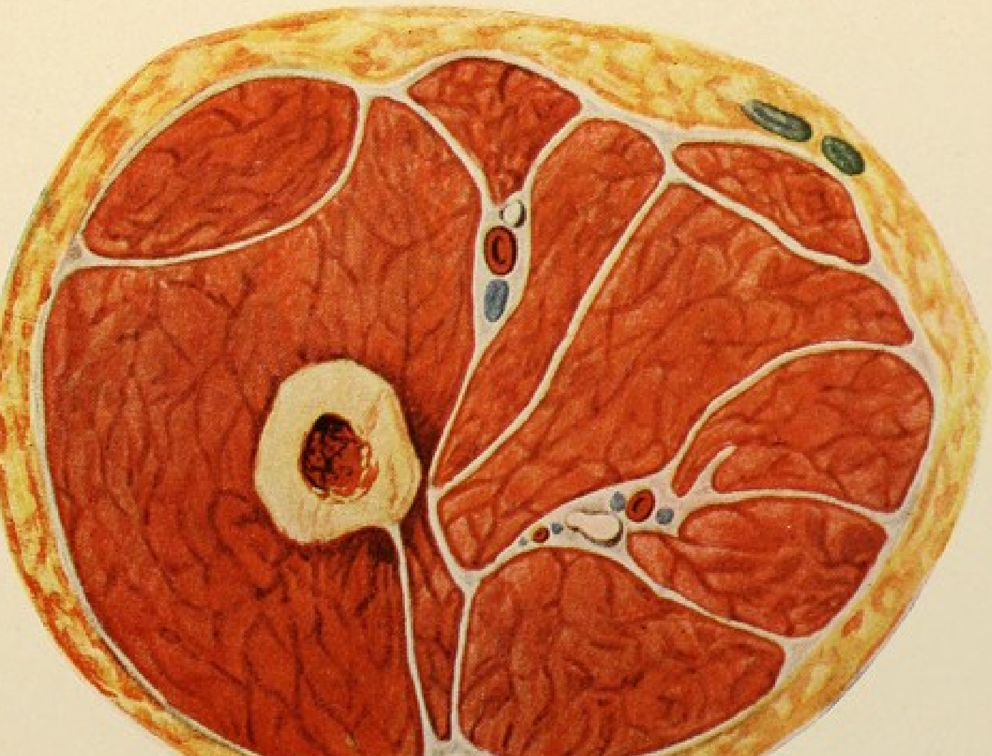


FIG. 755. SECTION OF THE RIGHT THIGH AT ITS LOWER THIRD (see Plate XVII). *n.p.* nerv. peroneus; *n.t.* nerv. tibialis; *v.s.i.* vena saph. int.; *n.s.m.* nerv. saph. major; *a.c.* art. cruralis.

PLATE XV



At its lower third



At its middle third

Sections of the Right Thigh

subjects with defective muscular development and freely movable skin; just as good, however, is the *circular operation by two incisions* with or without reflection of the skin cuff. In the middle of the thigh, where the surface of the wound is larger, the *skin flap incisions* with a large anterior and a small posterior flap are to be recommended.

In the **upper third** it is best to form a *large anterior* rounded square *skin flap*, the base of which is wider than half the circumference of the limb and

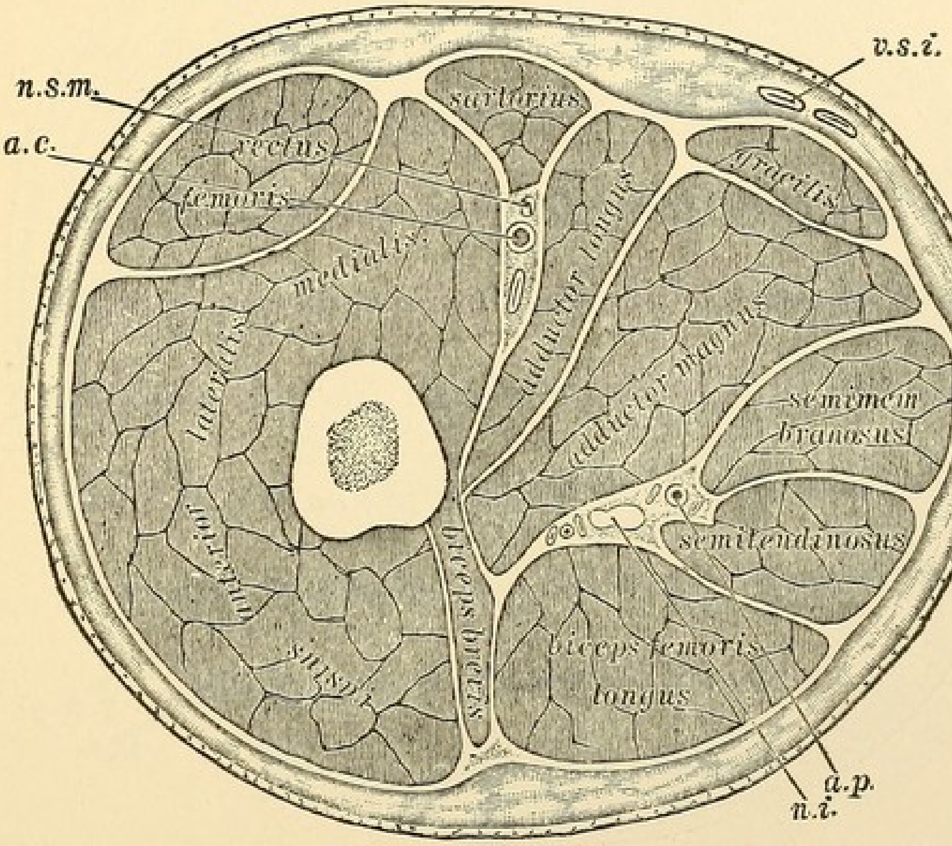


FIG. 756. SECTION OF THE RIGHT THIGH AT ITS MIDDLE THIRD (see Plate XVII). *n.s.m.* nerv. saph. major; *a.c.* art. cruralis; *n.i.* nerv. ischiadicus; *a.p.* art. profunda; *v.s.i.* vena saph. int.

the length of which must be equal to the diameter of the limb (third part of the circumference). This is dissected back in an upward direction, and the skin is divided at the posterior side, either by a circular incision, or still better, by a slightly curved incision, and forcibly retracted; next, the soft parts are divided down to the bone by a circular incision, as smooth as possible. After the bone has been sawed off, the large flap falls like a curtain over the large surface of the wound, and can be united with the posterior skin incision without tension. The drainage of the secretions takes place according to gravitation; the cicatrix comes to lie laterally.

For applying and changing the dressings after the amputation of the thigh, *von Volkmann's* procedure is to be recommended.

The patient is raised, and a square piece of wood or a hard cube-shaped pillow covered with rubber (pelvic support) is placed under the buttock of

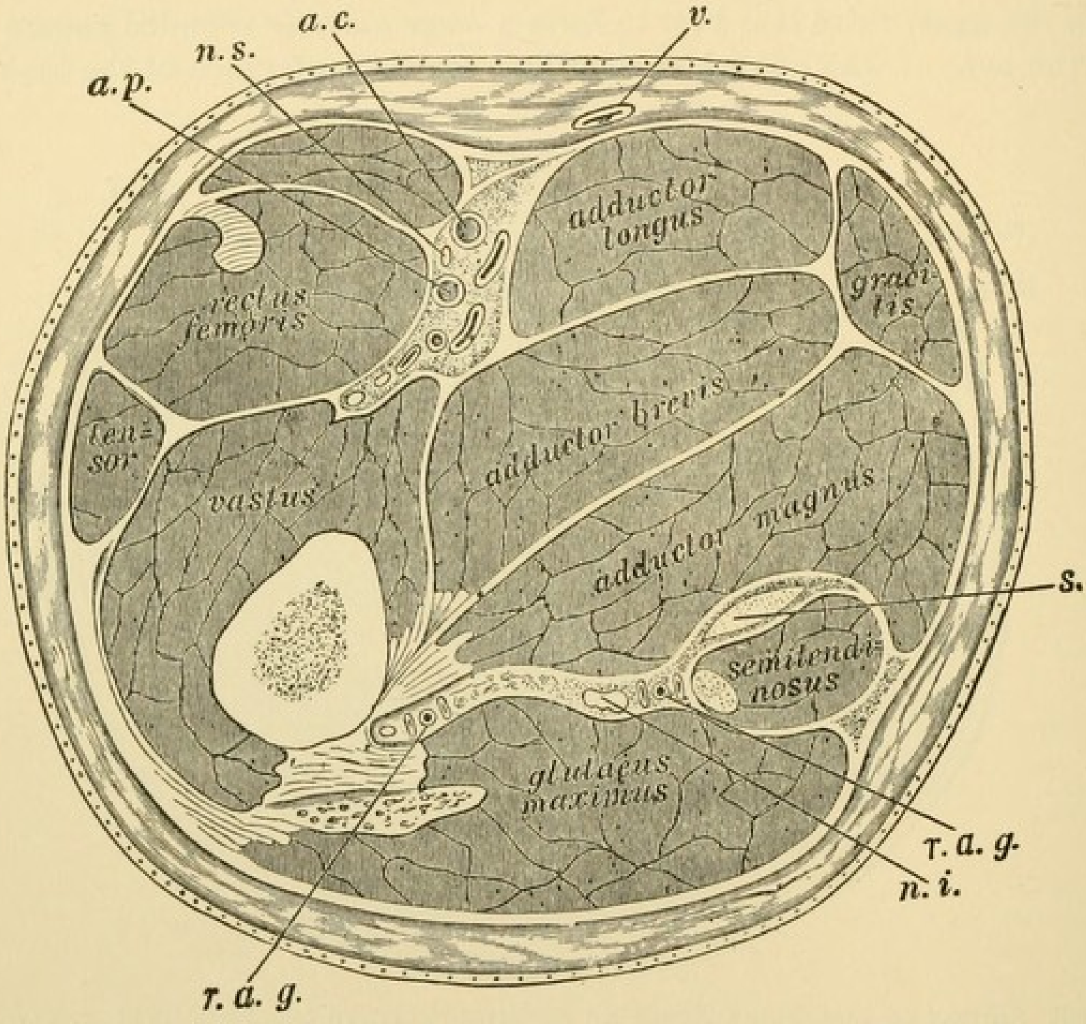


FIG. 757. SECTION OF THE RIGHT THIGH AT ITS UPPER THIRD (see Plate XVIII). *a.c.* art. cruralis; *n.s.* nerv. saph. major; *a.p.* art. profunda fem.; *r.a.g.* rami art. glutææ inf.; *n.i.* nerv. ischiadicus; *s.* semimembranosus; *v.* vena saphena int.

the healthy side so that the amputation stump can be balanced freely during the dressing and need not be held by an assistant. The lumbar region above the sacrum becomes thereby so accessible that the tours of the spiral bandage of the hip which fasten the dressings can be carried around the body (Fig. 758).

PLATE XVI

At its upper third

Section of the Right Thigh

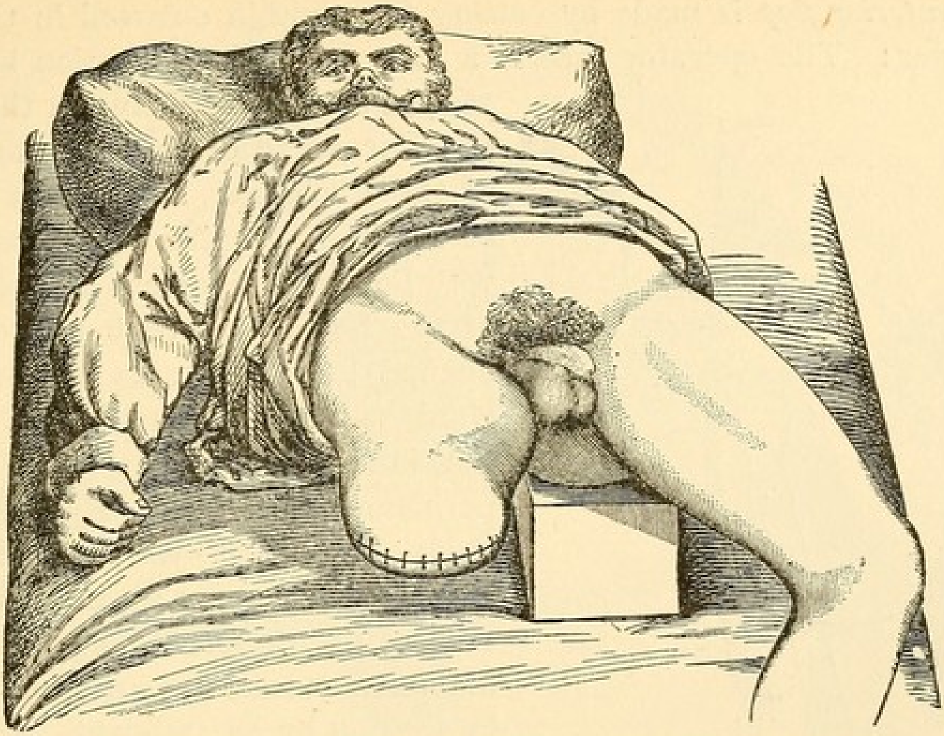


FIG. 758. POSITION OF AMPUTATED PATIENT FOR CHANGING THE DRESSINGS

DISARTICULATION OF THE THIGH

I. BY AN ANTERIOR LARGE AND A POSTERIOR SMALL FLAP

(Transfixion, *Manec's* Puncture Method)

1. The patient is placed in such a position that the pelvis of the diseased side projects half over the lower edge of the table. The thorax must be well fixed, the scrotum must be drawn upward toward the healthy side (Fig. 759).

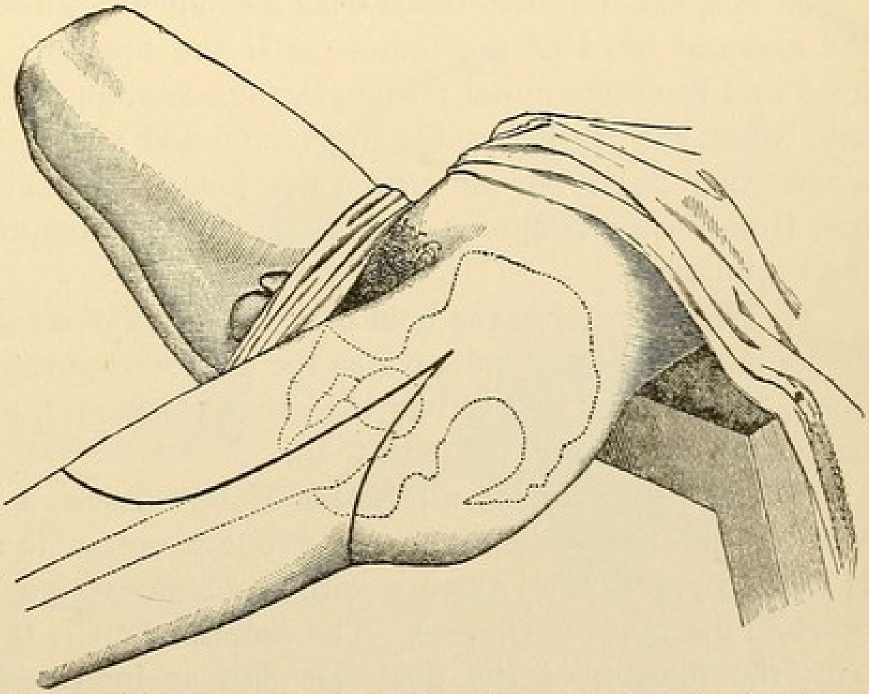


FIG. 759. DISARTICULATION OF THE THIGH BY AN ANTERIOR LARGE AND A POSTERIOR SMALL FLAP

2. After the leg has been rendered bloodless according to the method described on page 229,

a *large anterior flap* is made by cutting from within outward in the following manner: The operator inserts a long pointed amputation knife (Fig. 760) in the middle between the anterior superior spine of the ilium and the tip of the trochanter, and allows the point of the knife to glide along first parallel with Poupart's ligament across the head of the femur (whereby the capsule is opened); next, he turns the point downward and inward, and brings it out on the inner side of the thigh near the perineum (Fig. 760). By carrying the knife downward with rapid sawing movements, he cuts a well-rounded flap 18 to 20 centimeters long, which is immediately turned upward and held there in position by an assistant.

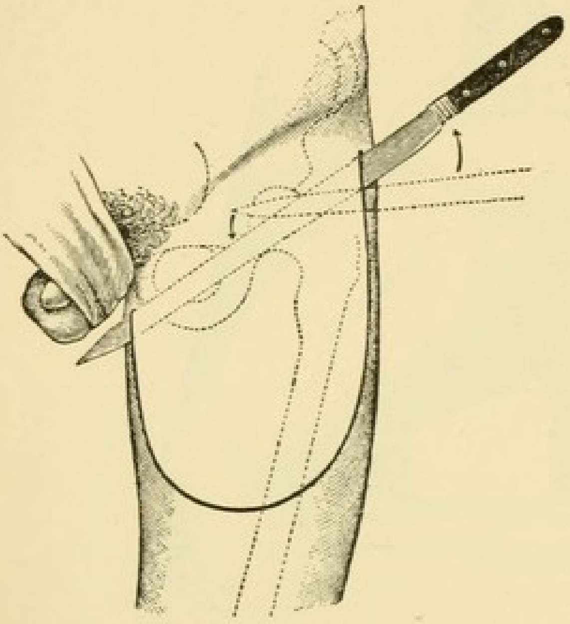


Fig. 760. Forming Anterior Flap by Transfixion

3. The knife is then applied beneath the thigh along its inner side, and a *smaller posterior flap* is cut from without inward, the convexity of which extends as far and below the gluteal fold, the base of which meets on both sides the base of the anterior flap (Fig. 761).

4. A quick incision, made with a small flap knife perpendicularly upon the exposed head of the femur (as if the operator intended to divide the head and leave the upper portion in the acetabulum), opens the articular capsule, while the leg is forcibly hyperextended and rotated outwardly. With a smacking noise the air enters the joint, the head of the femur projects half from the acetabulum; on dividing the ligamentum teres it escapes from the acetabulum.

5. The operator takes hold of the head of the femur with his left hand, draws it toward him, and divides the posterior portion of the capsular ligament, the muscles inserted in the great trochanter, and all soft parts which have remained undivided until then.

6. After ligation of all visible blood vessels, a large drainage tube is inserted into the acetabulum and brought out at the middle of the wound. It is also practical to remove with the bone-cutting forceps the projecting cotyloid margins (*Helferich*). The anterior flap is turned down and united with the margin of the posterior flap as indicated in Fig. 762. (It is much better to make a buttonhole in the posterior flap at the most depend-

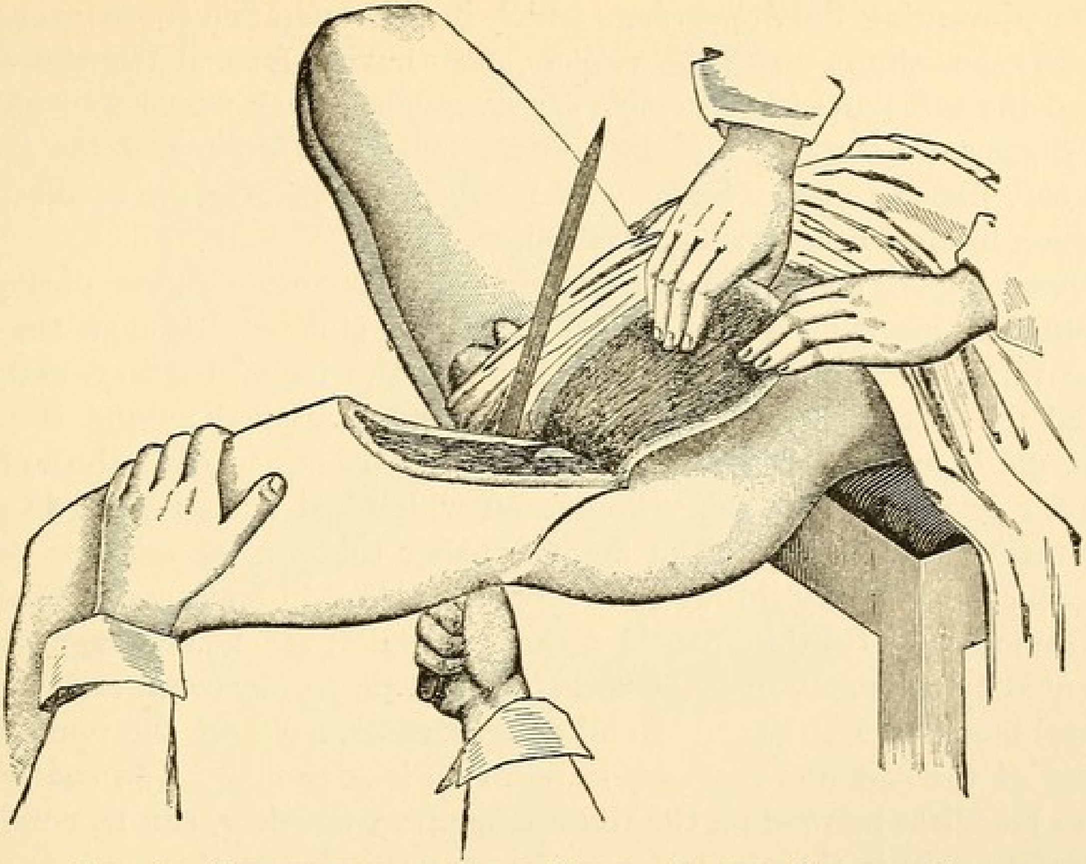


FIG. 761. DISARTICULATION OF THE THIGH. FORMING POSTERIOR FLAP

ent point of the wound for the drain, as by doing so the whole amputation can be sutured with the expectation of obtaining primary healing through-

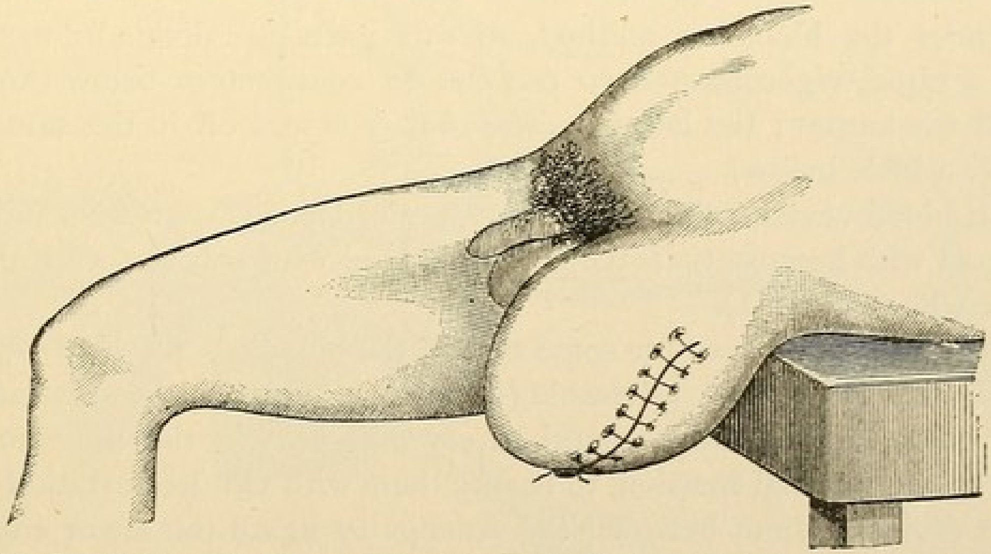


FIG. 762. STUMP RESULTING FROM DISARTICULATION OF THE THIGH AT THE HIP JOINT BY FLAP INCISION

out, which is no small advantage in the treatment of such a large wound.)

For preventing the *hemorrhage* which in this operation (now rarely performed) especially is *very profuse*, *Rose*, after having formed two skin flaps, divided the soft parts in successive *layers*, grasped each vessel immediately with hemostatic forceps, and ligated it; hence, he *extirpated* the femur, so to say, like a tumor. Since very many ligatures must be applied, this operation in most cases lasts several hours.

Trendelenburg controlled the hemorrhage to a certain degree during the operation by inserting a long straight *steel pin* obliquely through the base of the thigh from the anterior side beneath the femoral artery, and constricted the soft parts over it with a rubber tube applied around the ends of the pin (acupressure). *Wyeth* transfixed two long needles through the thigh for preventing the tube slipping off which had been applied in a circular manner. *Senn* applied a double rubber tube on the anterior side of the femur transversely through the limb and tied it in front and behind.

In some cases (in thin, flaccid abdominal walls) the hemorrhage can be prevented by compression of the aorta (see Fig. 420), or by compression of the external iliac (see Fig. 431). In all difficult cases, however, the preliminary *ligation* of the common iliac artery and vein is advisable. The *rubber tube* for the bloodless method on the thigh (Fig. 412), however, can be employed with safety only in the

II. DISARTICULATION BY THE CIRCULAR METHOD (*Vetsch*)

1. Under the bloodless method, all soft parts are divided down to the bone by a rapid, vigorous *circular incision* 12 centimeters below the tip of the great trochanter; the latter is *immediately* sawed off in the same plane (or better, a little below).

2. All blood vessels which can be recognized as such, arteries and veins, are grasped with hemostatic forceps and ligated with catgut (see transverse section, on Plate XVIII).

3. Only in cases where for some reason the bloodless method cannot be employed with safety is it advisable (according to *Larrey*) to expose, prior to the circular incision, the femoral artery and vein in the iliofemoral triangle by a longitudinal incision, to secure them with two hemostatic forceps, and after dividing them between the forceps to ligate the lower ends; the upper ends are held upward until the amputation is finished (Fig. 763).

4. If all hemorrhage has been arrested after the removal of the constrictor, a flap knife is inserted 5 centimeters above the tip of the great trochanter down to the head of the femur, and from here a *longitudinal incision* is

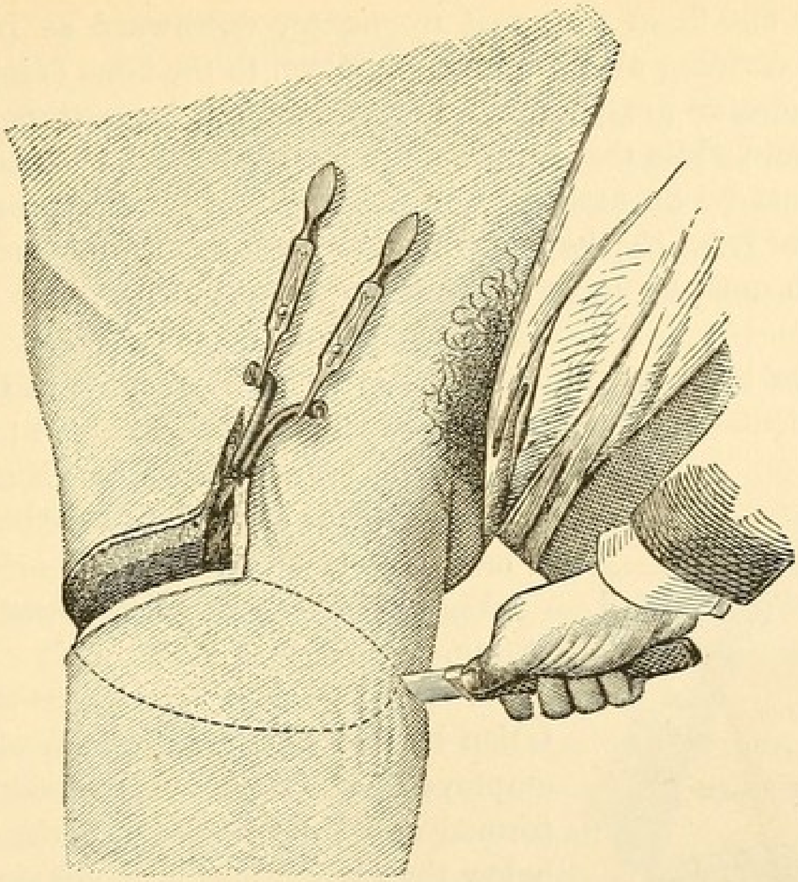


FIG. 763. DISARTICULATION OF THE THIGH AT THE HIP JOINT (Circular incision)

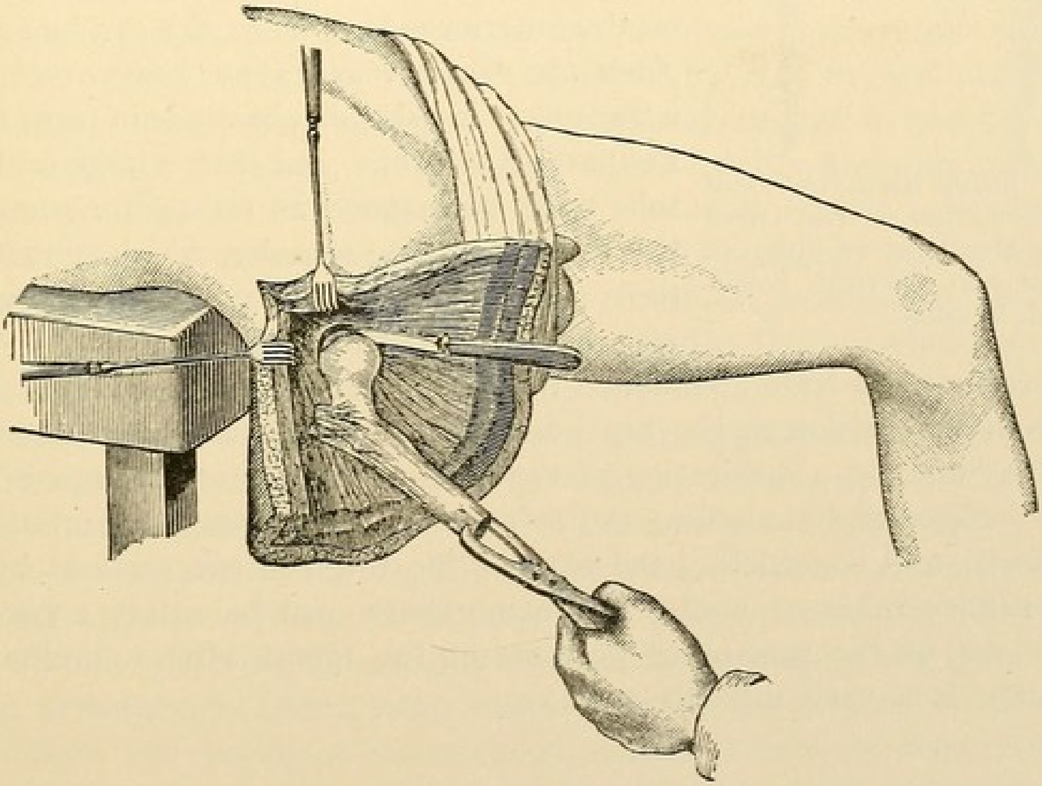


FIG. 764. DISARTICULATION OF THE THIGH AT THE HIP JOINT

made over the middle of the great trochanter downward as far as the circular incision, dividing all the structures down to the bone (*Dieffenbach*).

5. The operator grasps the lower end of the bone stump with strong bone forceps, and while the margins of the wound of the longitudinal incision are drawn apart by an assistant, he reflects with the raspatory the periosteum all around from the bone until he reaches the firmer insertions of the muscles, which must be detached from the bone by short cuts with a strong knife.

6. After the bone has been dissected free in this manner as far as the capsule of the articulation, the latter is opened as described above; and the head of the femur is disarticulated (Fig. 764). During this part of the operation the hemorrhage is usually very slight.

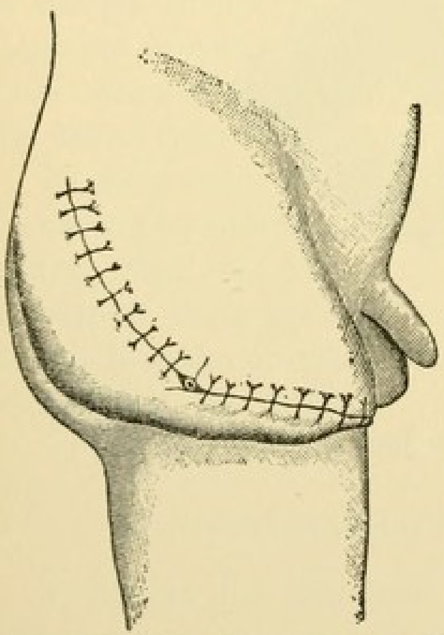


FIG. 765. STUMP RESULTING FROM DISARTICULATION OF THE THIGH AT THE HIP JOINT BY CIRCULAR INCISION AND VERTICAL LONGITUDINAL INCISION

Figure 765 shows the appearance of the stump.

7. In very muscular subjects circular amputation by two incisions instead of one can be employed, or a large anterior skin flap can be formed and the soft parts divided posteriorly below the gluteal fold by a circular incision.

8. If sufficient soft parts are not present on the anterior side, a large *flap* can be formed *from the posterior side* (*von Langenbeck*), and a transverse incision can be made in front below Poupart's ligament. But then a large drainage tube must be inserted as far as the stumps of the psoas and iliac muscles, which retract into the pelvic cavity, in order that no secretions may be retained there.

(Most surgeons have abandoned the preliminary high amputation of the thigh to disarticulation at the hip joint. By constriction above transfixion pins, or by making a dislocation of the head of the femur through a short vertical incision and tunnelling the soft tissues with strong hemostatic forceps (*Senn*), and constricting the base of the thigh in two sections by two strong rubber tubes or cords, the hemorrhage can be safely controlled. The removal of the remaining portions of the femur after a preliminary amputation is a very difficult task.)

RESECTION OF JOINTS

Resection of joints is made to remove detached or diseased portions of the articular ends, by wounding the healthy soft parts *as little as possible*, and thus preserve not only life but also the utility of the limb.

Not only the blood vessels, but also muscles, tendons, ligaments, and *especially the nerves*, must be preserved to prevent muscular atrophy; furthermore, the capsule and the *periosteum* must be preserved to secure as far as possible reproduction of the bones destroyed by the disease and removed by the operation.

Resections are made: —

1. In serious injuries (extensive complicated splinter fractures) where the conservative treatment remained without success.

2. In serious suppurative or sanious *inflammations* or chronic *diseases* of the articular ends of the bones or of the capsule, after antiseptic drainage has been given a fair trial and has failed.

3. In serious complicated and old irreducible dislocations.

4. In angular *anchylosis*, which renders the limb useless.

5. In some neoplasms of the articular extremities.

6. In *loose, freely movable joints* caused by paralysis, for effecting anchylosis (**arthrodesis**).

A special indication is presented by *tubercular disease* of the joints (*fungus*). First the attempt should be made by *rest*, *ice*, and *extension*, or by injecting emulsion of iodoform, or by artificial congestion and hyperæmia (*Bier*), to effect a healing, or at least an improvement; and only when these therapeutic agencies have failed *the joint should be opened*. While in former times **typical resections** were made for this purpose, that is, from *both* bodies of the joints such portions were sawed off smoothly in such a way that the line of section was made through healthy tissue (whereby often a considerable portion of the healthy bone was sacrificed), now the operator is content, wherever it is possible, to remove in an **atypical** manner only diseased tissue so as not to interfere with the growth and development of the diseased bones (**arthrectomy**, *Willemer, von Volkmann*). Accordingly, as the disease has implicated the capsule of the joint or the bone, we distinguish: **synovial arthrectomy**, that is, the complete extirpation of the diseased capsule without removing the epiphyses and the articular cartilage; and the **osseal arthrectomy** (arthrectomia ossalis), that is, the removal of all *diseased* portions of bone with the sharp spoon, chisel, or saw; in most cases, however, the capsule must be extirpated (**synovial and osseal arthrectomy**). If the operation is made very thoroughly and all diseased portions, especially of the capsule, are removed as carefully as in operations for malignant disease (*König*), arthrectomy yields good results, for the joints remain normal in their contour, the limb is not shortened, and joint motion is often restored. Moreover, the growth of the bones is not arrested when the epiphyses have been preserved.

If the healing of a diseased joint has been effected by *conservative* means, it is often necessary to improve a subsequent *malposition* by a later resection.

GENERAL RULES FOR RESECTIONS

1. The **incisions** in skin and muscle must preferably be made in the *axis* of the limb, and every injury of large blood vessels, nerves, and tendons must be carefully avoided.

2. The **preservation of the periosteum** in connection with all the tendons and muscles inserted into the region of the joint (**subperiosteal resection,** *von Langenbeck, Ollier*) is of great importance, as well for the healing of the wound as also for the subsequent restoration of the function of the limb; hence it should always be attempted. The operation is thereby made more difficult in recent cases, but is rendered easier in chronic cases. For this reason, in resections of the several joints, the older (non-subperiosteal) methods will be described.

3. To *preserve the periosteum*, it must be divided in the direction of the external incision, and reflected in connection with the overlying soft parts by means of blunt instruments (raspatory, Fig. 586) and the periosteal elevator (Figs. 766–770 — "Skelettierung" of the bone).

4. The fibrous capsular ligaments, the accessory ligaments, and the insertions of the muscles cannot be detached with blunt instruments, but must be detached from the bone with strong short-bladed knives (Fig. 766), by incisions made *vertically upon the bone;* they must, however, always remain in connection with the neighboring periosteum. Hence, during this operation the surgeon must constantly *change* from the knife to the blunt elevator, and must operate as carefully as possible in order not to contuse or lacerate the periosteum.

5. In many cases, this work can be facilitated by detaching with the *hammer and chisel* (according to *Vogt*) the cortical lamellæ of the processes of the bones (tubercles, malleoli, condyles, trochanters) in which the muscles and ligaments are inserted.

6. After the articular ends have been bared of all soft tissues, they are forced out of the wound, grasped with strong forceps (Figs. 771–773),

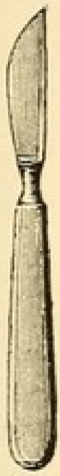
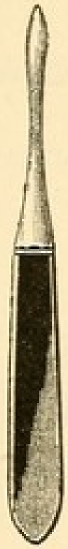
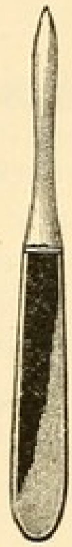


Fig. 766
Resection Knife



a
Fig. 767



b
Fig. 768

Von Langenbeck's Elevators
a, small; *b*, broad

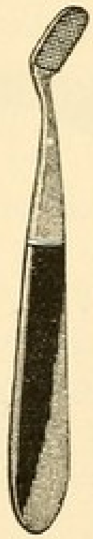


Fig. 769
Lever-like Elevator

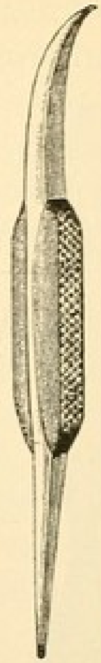


Fig. 770
Sayre's Elevator

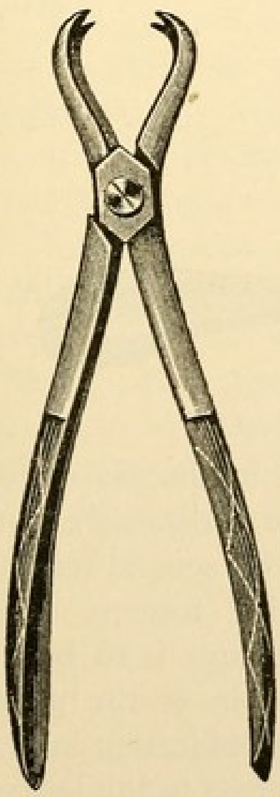


Fig. 771
Von Langenbeck's Forceps

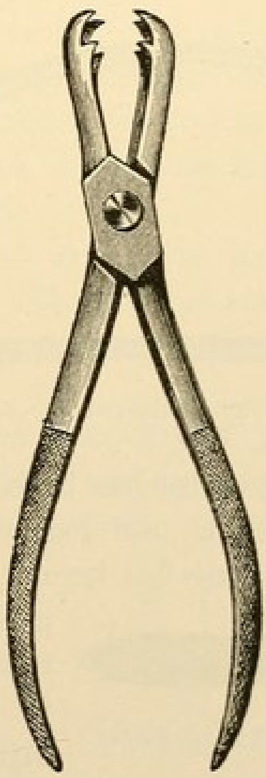


Fig. 772
Fergusson's Lion Forceps

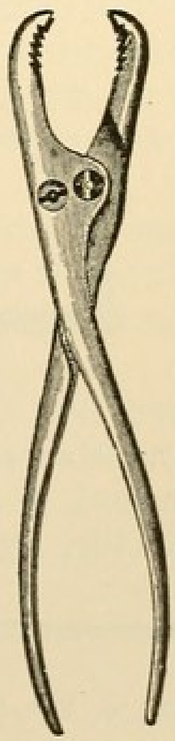


Fig. 773
Farabœuf's Forceps

and removed with a saw (Figs. 774–778); the soft parts must be retracted and protected by blunt retractors or a strip of zinc (Fig. 787).

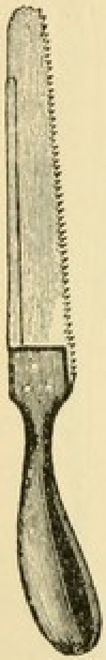


Fig. 774 Metacarpal Saw

Fig. 775. Von Langenbeck's Metacarpal Saw

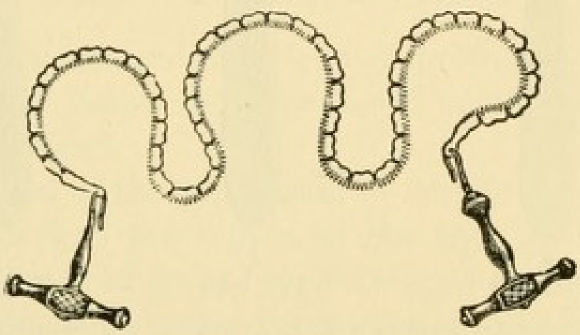


Fig. 777. Chain Saw

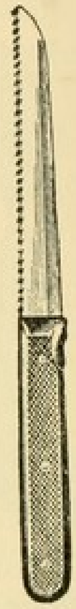


Fig. 776 Metacarpal Saw

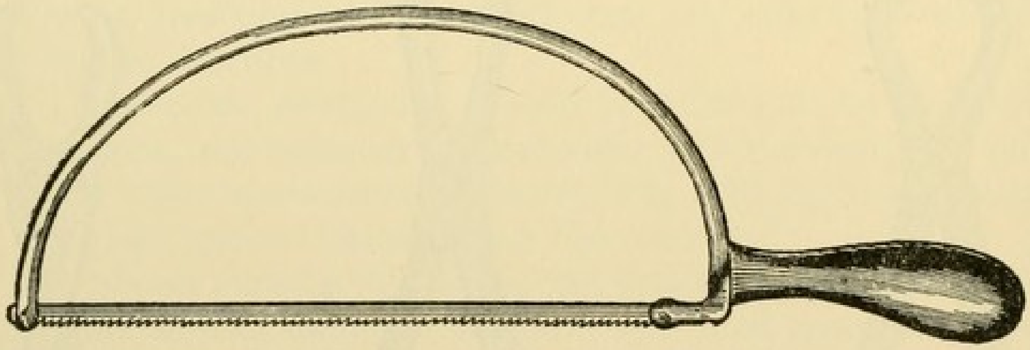


Fig. 778. Helferich's Amputation Saw

7. If an articular extremity has become separated by disease or injury (gunshot), it can be grasped and extracted with *von Langenbeck's* sharp hook (Fig. 779). If the bone has been comminuted, the several fragments are grasped with forceps and removed, if no attempt is to be made to let them heal in at the place of injury under immobilization in a plaster of paris dressing. This has met with very good success in the last wars.

Fig. 779. Von Langenbeck's Sharp Hook

8. Since regeneration of the joint is usually most complete when only *one* articular end has been removed, it is advisable, when the injury of *one*

articular end is very extensive, to resect this alone, and to leave the other intact (*partial resection*), at least in the joints of the upper extremity.

9. Most resections can be made with great advantage under the bloodless method. But at the end of the operation, all divided blood vessels must be carefully ligated before the wound is closed, else secondary hemorrhage is liable to occur, which may necessitate an early removal of the dressings and unnecessary disturbance of the wound.

10. When healing of the resection wounds does not take place rapidly, entirely, or for the greater part, by primary intention, but slowly after long suppuration, then, in consequence of the prolonged rest, the ligaments and tendons may contract and become adherent to the surrounding tissues, causing stiffness, deformity, atrophy (**paralysis from inactivity**). To the layman, in such a case, the whole limb appears to have become useless; indeed, it remains subsequently in this useless condition, unless something is done for it.

11. For preventing this condition or for correcting it, immediately after cicatrization of the wound, *methodical passive movements* must be made of all the joints of the extremity, first under anæsthesia if the manipulations cause too much pain (**apolysis**, according to *Neudörfer*).

12. The joints of the upper extremity, especially of the fingers, which it is desirable to render useful as soon as possible, can be kept movable from the beginning by careful passive motions and position; by giving, for instance, at each change of dressings other positions to the joints and by excluding the fingers from dressings.

13. The function of *muscles* and *nerves* can be soon restored by **warm baths** and by applying **electricity**. Methodical **massage** of the limbs after previous *cold douches* and subsequent *movement cures* are usually still more effective for this purpose.

14. If an excessive mobility and flaccidity of the resected joint (**loose, freely movable joint**) has remained after the resection, the limb can be made useful by the wearing of an artificial support.

RESECTIONS OF THE UPPER EXTREMITIES

RESECTION OF FINGERS

1. For resecting *the articulation of a finger* an incision is made 2 to 3 centimeters long *laterally* along the border of the *extensor* tendon (digital artery and nerve!) through all soft parts down to the articulation.

2. While the soft parts are elevated and reflected toward both sides, the articular capsule is split by a longitudinal incision. While the finger is flexed in a lateral direction, the *condyle* of the diseased articulation is turned out and nipped off with the bone-cutting forceps.

3. Now the *peripheral* free body of the joint can also be removed in the same manner, but if it is healthy it is left in position uninjured.

The **resection of an entire phalanx** can be made from a unilateral or bilateral *dorsal incision* which passes over the neighboring articulations laterally from the extensor tendon. The incision is made immediately down to the bone. After elevation of all soft parts around the bone, and a transverse division of the articulations, the phalanx is disarticulated from its condyle to the base, the cavity of the wound is sutured, and drainage provided.

The **resection of a metacarpal bone** is made from a *dorsal incision* extending over both articulations. On the thumb and little finger the longitudinal incisions are made, respectively, on the radial and ulnar exterior sides. After division of the skin, the extensor tendons are carefully drawn aside, the periosteum is divided and elevated with the elevator toward both sides for the whole length of the bone, and the metacarpophalangeal articulation is opened by a transverse incision. At this place the bone is grasped with forceps or a bone hook and disarticulated subperiosteally toward the carpus from the volar soft parts. Finally, it is also disarticulated at its base, or, if possible, divided in its basal line of epiphyses, whereby the opening of the articulation is avoided.

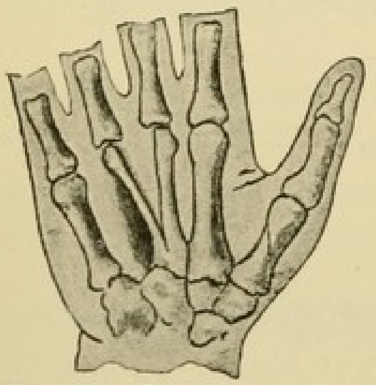


Fig. 780. Replacing a Resected Metacarpal Bone

The cavity of the wound, according to the manner of disease, can be sutured or tamponed in its entire extent. *For the purpose of replacing a missing metacarpal bone, Bardenheuer* divided a neighboring metacarpal bone longitudinally and inserted one-half of it into the defect (Fig. 780).

RESECTION OF THE LOWER ARTICULAR ENDS OF THE RADIUS AND THE ULNA BY BOURGERY'S BILATERAL INCISION

1. A longitudinal incision, beginning below the styloid process of the ulna, divides the skin 4 to 5 centimeters on the ulnar side of the ulna upward (Fig. 781).

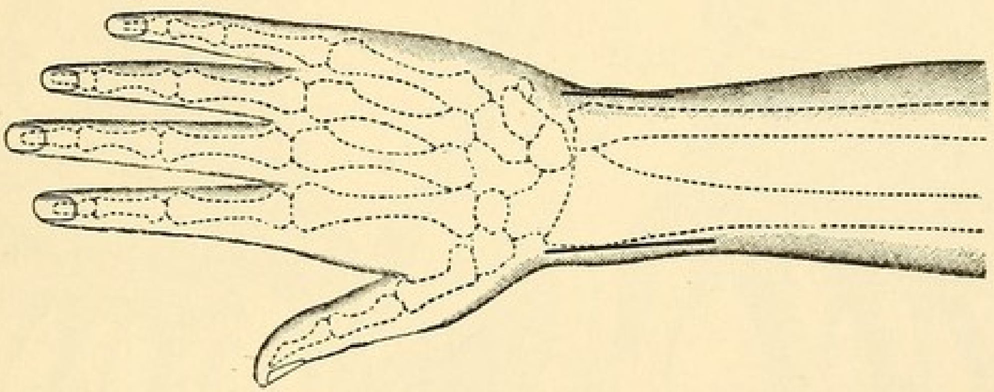


FIG. 781. RESECTION OF THE LOWER EXTREMITIES OF THE BONES OF THE FOREARM (Bourgery's bilateral incision)

2. In the same direction, the periosteum is then divided exactly between the extensor and flexor carpi ulnaris muscles, and reflected from the bone with the raspatory and elevator, first on the dorsal side, next on the volar side (pronator quadratus) as far as the interosseous ligaments (Fig. 782).

3. The denuded portion of the ulna is sawed through below the upper angle of the incision with a metacarpal saw, or nipped off with strong bone-cutting forceps.

4. Next the sawed-off portion is grasped with bone forceps, rotated outward, and disarticulated by cutting it off from the interosseous ligament, the lateral ulnar ligament, and the straight accessory ligament (Figs. 783, 784).

5. A second longitudinal incision, beginning below the styloid

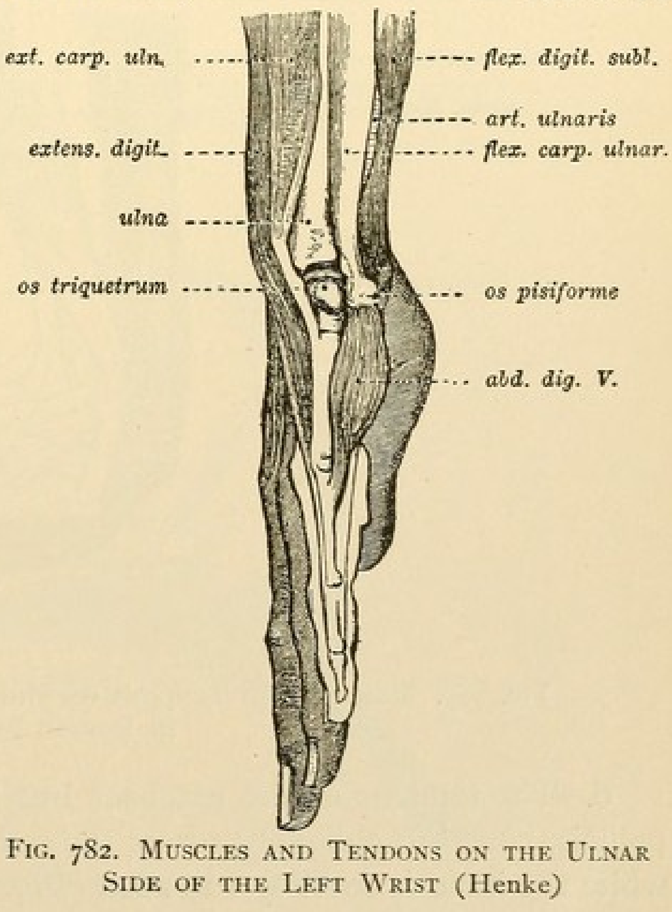
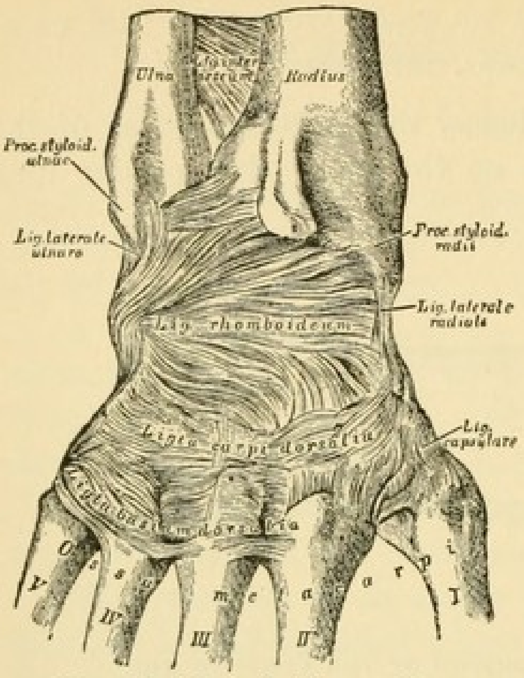


FIG. 782. MUSCLES AND TENDONS ON THE ULNAR SIDE OF THE LEFT WRIST (Henke)



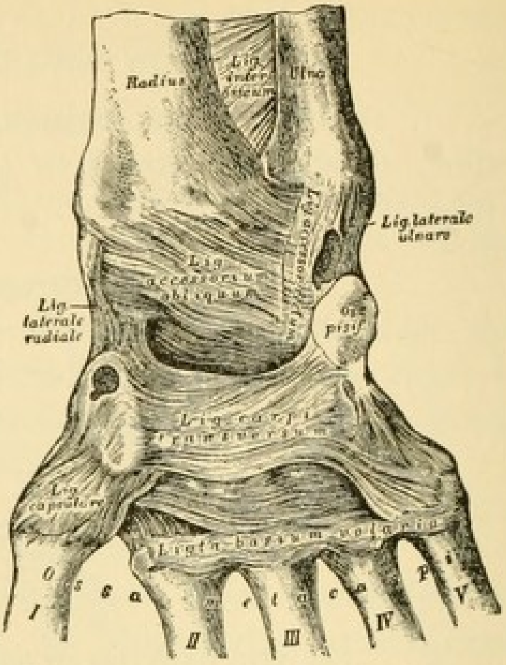


FIG. 783. Dorsal side LIGAMENTS OF THE RIGHT WRIST FIG. 784. Volar side

process of the radius, divides the skin for 5 to 6 centimeters on the radial side of the radius, upward.

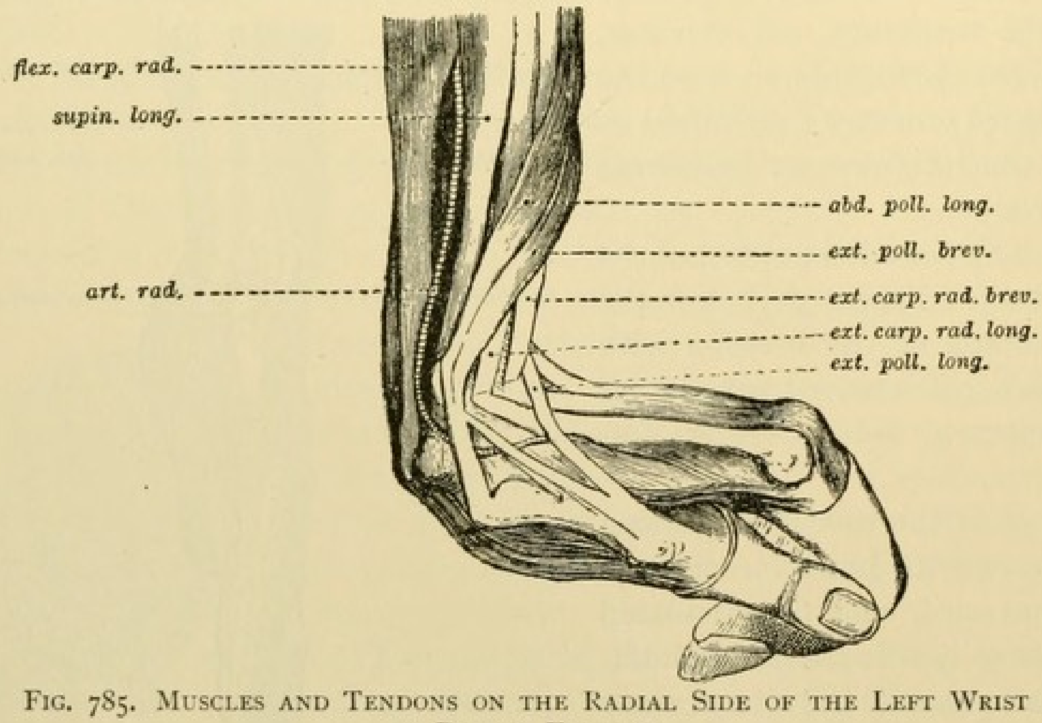


FIG. 785. MUSCLES AND TENDONS ON THE RADIAL SIDE OF THE LEFT WRIST IN DORSAL FLEXION

6. The tendons of the extensor brevis pollicis and the abductor longus pollicis, coursing obliquely across the radius, are drawn toward the dorsum while the hand is forcibly extended (Fig. 785).

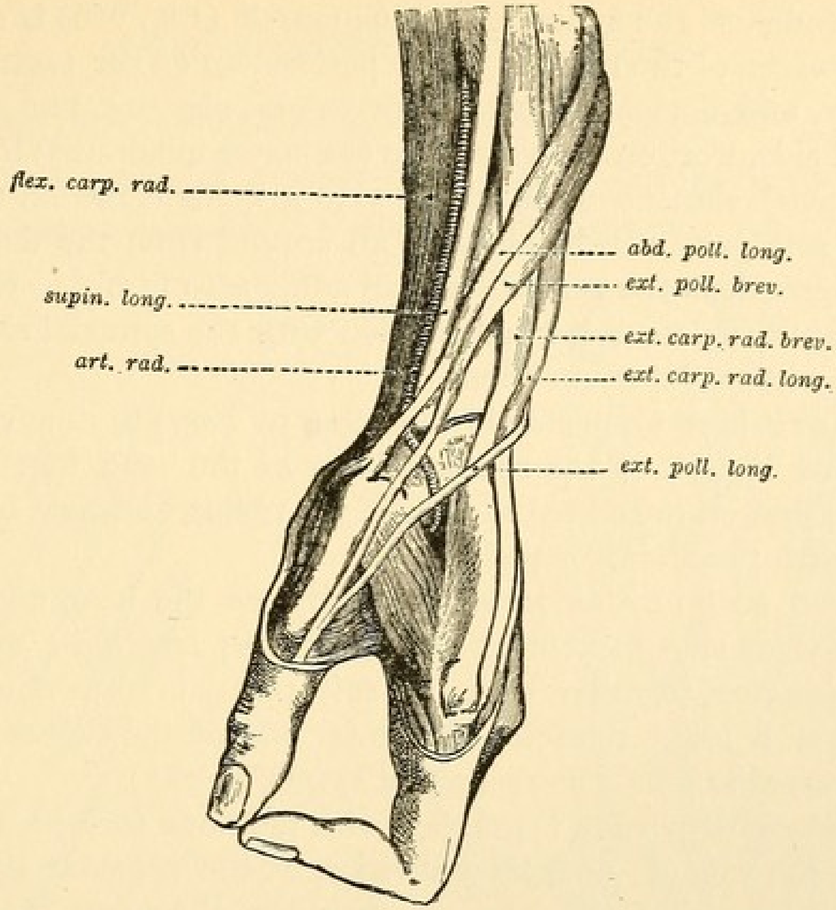


FIG. 786. MUSCLES AND TENDONS ON THE RADIAL SIDE OF THE LEFT (EXTENDED) WRIST (Henke)

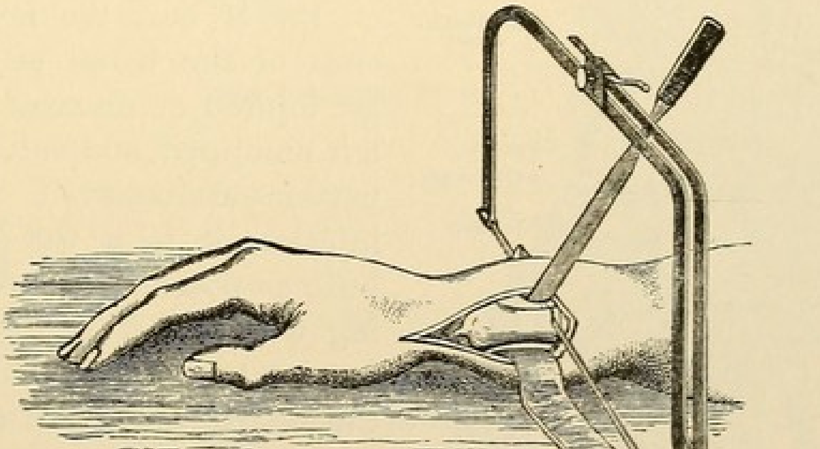


FIG. 787. SAWING OFF DENUDED RADIUS

7. The tendon of the supinator longus muscle (Fig. 786) is divided from the styloid process of the radius. The periosteum of the radius is divided longitudinally, and detached with the raspatory, elevator, and knife — first on the dorsal side, next on the volar side (pronator quadratus) in connection with all synovial sheaths, until, about 3 to 4 centimeters on the articular surface, the soft parts can be elevated all around from the denuded bone.

In early resections the periosteum still adheres so firmly to the bone that it is very difficult to detach it in connection with the synovial sheaths of the tendons, and without injury to them.

In this case it is recommended (according to *Vogt*) to remove with a fine chisel a shallow lamella of the compact layer of the bone, together with the periosteum — first on the dorsal surface of the radius, and next on the styloid process, beneath the abductor pollicis.

8. A broad strip of zinc is inserted between the bone and the periosteum on the volar side to protect the soft parts; and while on the dorsal side the periosteum, together with the soft parts, is drawn upward by a similar strip or a blunt retractor, the lower end of the radius is sawed off with a metacarpal saw or a fine resection saw (Fig. 787).

9. The sawed-off portion is grasped with the bone forceps, and is drawn forward into the wound; and, after division of the capsular ligaments, the articular ligaments (lateral radial ligament, rhomboid ligament, and accessory oblique ligament — Figs. 783, 784), it is extracted.

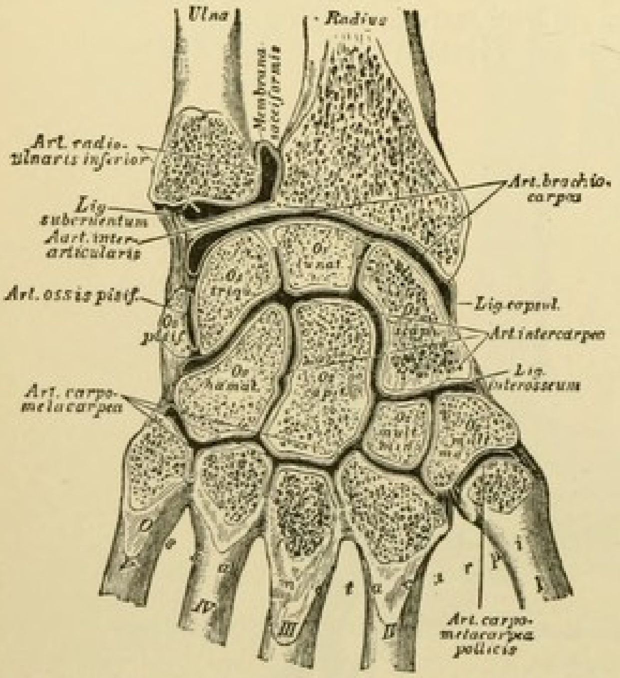


FIG. 788. FRONTAL SECTION OF THE RIGHT WRIST

10. If only the lower articular ends of the bones of the forearm are injured or diseased, the wrist is left uninjured, and only the diseased portions are removed. Especially in injuries, it is a rule to resect as little as possible, and to effect healing wherever it seems possible by a conservative treatment. But if the intercarpal joints are also diseased, all carpal bones (perhaps with the exception of the trapezium and the pisiform bone) must be removed, because all joints of the several carpal bones are connected with one another, and with the metacarpal bones (Fig. 788). In such cases it becomes necessary to make the

TOTAL RESECTION OF THE WRIST

BY VON LANGENBECK'S DORSAL RADIAL INCISION

1. The operator *sits* at a small table upon which the hand is placed in light ulnar flexion, and with the dorsal side upward. An assistant sits opposite to him.

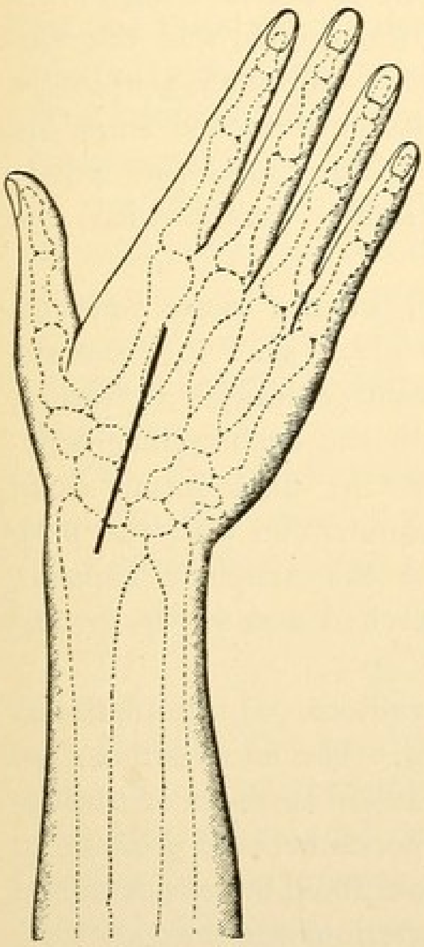


FIG. 789. VON LANGENBECK'S METHOD OF RESECTING THE WRIST

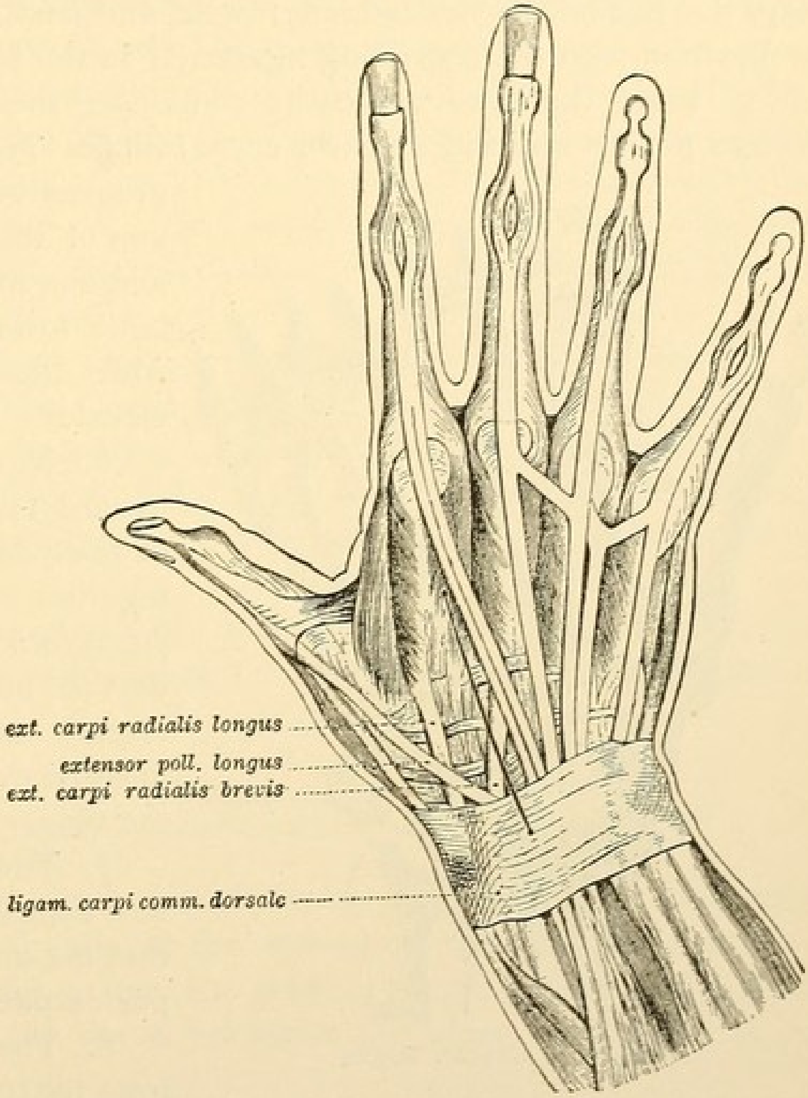


FIG. 790. TENDONS ON THE DORSAL SIDE OF THE HAND

2. An incision, beginning at the middle of the ulnar margin of the metacarpal bone of the index finger divides the skin 9 centimeters upward as far as and over the median line of the dorsal surface of the epiphysis of the radius (Fig. 789).

3. On the radial side of the extensor tendon of the forefinger, and without injuring its sheath, the incision penetrates more deeply, continues farther

above on the ulnar margin of the tendon of the extensor carpi radialis brevis (where it is inserted at the base of the third metacarpal bone), and divides the ligamentum carpi dorsale exactly between the tendon of the extensor longus pollicis and the extensor digiti indicis as far as the limit of the epiphysis of the radius (Fig. 790).

4. While an assistant draws apart the soft parts with fine retractors the capsular ligament is divided lengthwise, and next detached from the bone in connection with the remaining ligaments in the following manner: —

5. First, the fibrous sheaths containing the tendons of the extensor longus pollicis and the extensor carpi radialis longus et brevis lying in the grooves of the radius, and the tendon of the brachioradialis (supinator longus), must be detached from the bone toward the radial side partly with the knife, partly with the elevator.

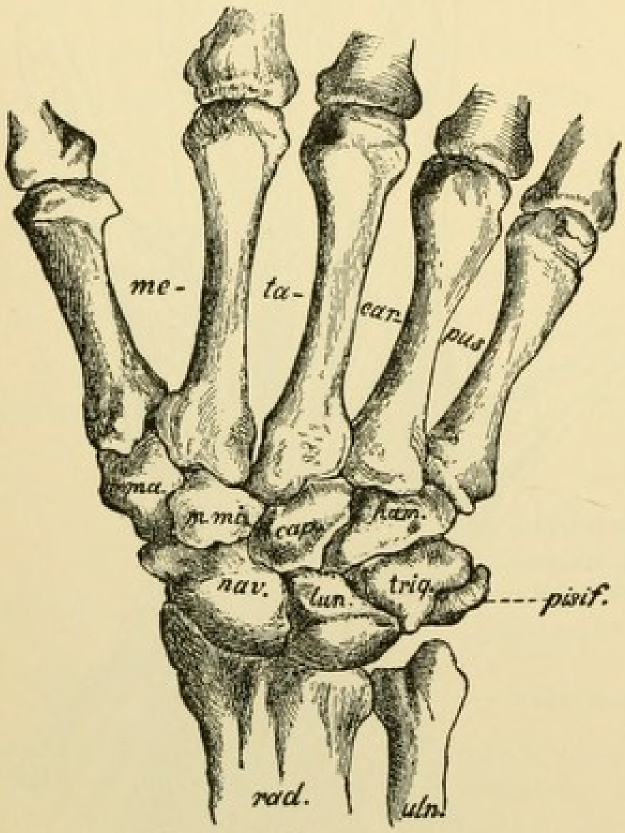


FIG. 791. CARPAL BONES

6. Next, in the same manner, toward the ulnar side, the tendons of the extensor communis digitorum, together with the ensheathing cellular layers of the ligamentum carpi dorsale, in connection with the periosteum and the articular capsule, must be detached and drawn toward the ulna.

7. The radiocarpal articulation is now exposed. The hand is flexed so that the articular surfaces of the upper carpal bones become prominent.

8. The scaphoid bone is detached from the trapezium and the trapezoid, the semilunar and cuneiform bones from the os magnum and the unciform bone by dividing the intercarpal ligaments, and raising them gently with a small elevator; the trapezium and the pisiform bone can be left in position (Fig. 791).

9. Next, the bones of the anterior carpal row are disarticulated. The globular articular surface of the os magnum is grasped with the fingers of the left hand or with the dressing forceps, and, while an assistant abducts the thumb, the articular connection of the trapezoid with the trapezium is

divided, and from here the operator tries to penetrate toward the ulnar side into the carpometacarpal articulation by dividing the ligaments on the extensor side of the upper heads of the metacarpal bones, while an assistant flexes the latter forcibly. Thus the three carpal bones of the anterior row (trapezoid, os magnum, and unciform bone) can be lifted out and removed together. In fungus disease of the carpus, the ligaments connecting the several bones are mostly destroyed, so that it is comparatively easy to remove the carpal bones singly with the *sharp spoon* alone.

10. If the bones of the forearm are also diseased, then, finally, the hand being in volar flexion, the epiphyses of the radius and ulna are made to project from the wound, and all soft parts detached from them (as described above), when they are sawed off. Care must be taken not to injure the large dorsal branch of the radial artery passing over the trapezium to the first metacarpal interspace (Fig. 786).

11. After completion of the operation, and after the application of the dressing, the limb must be placed upon one of the splints illustrated in Figs. 219, 232, and 256, and must be immobilized in proper position with the hand extended and fingers flexed. As soon as possible the extension treatment should commence (see Figs. 266, 277) with passive motion of the fingers.

For the purpose of protecting the insertion of the extensor carpi radialis, and also for *inverting* the articulation, thereby obtaining a better inspection, it is advisable to open

BY KOCHER'S DORSO-ULNAR INCISION

1. With the hand in slight *radial flexion*, an incision 7–8 centimeters long is made from the middle of the interspace between the fourth and the fifth metacarpal bones across the middle of the wrist on the dorsal surface of the forearm; the dorsal branch of the ulnar nerve must be preserved (Fig. 792).

2. After division of the fascia and the posterior annular ligament of the wrist, the operator penetrates between the tendons of the extensor digiti minimi and the extensor communis, opens the capsule at the base of the fourth metacarpal bone upon the unciform bone and the ulna, and detaches them toward both sides, after the tendons of the extensor digiti minimi and the extensor ulnaris have previously been drawn forward from the groove of the ulna (*u*) and the tendon of the extensor ulnaris has been detached from the fifth metacarpal bone.

3. Next, the operator penetrates into the cleft between the pisiform and the semilunar bones (*l*), and leaves the tendon of the flexor carpi ulnaris in connection with the latter bone.

4. The unciform process is freed; next the bundle of the flexor tendons is raised from its groove; the capsule along the third to the fifth metacarpal bones on the palm and the tight capsular insertion on the volar border of the radius are detached; the tendinous insertion of the flexor carpi radialis on the second metacarpal bone, however, is preserved.

5. Upon the dorsal border of the radius, the capsule is detached as far as and beneath the tendons of the extensor carpi and the extensor longus pollicis and lifted out of their grooves. The insertion of the supinator longus is detached from the styloid process of the radius.

6. The hand is then forcibly dislocated in the radiovolar direction until the thumb touches the radial side of the forearm (Fig. 793); the radiocarpal articulation can then be completely inspected. The removal of the diseased bones of the wrist, the removal of as thin a layer as possible from the bones of the forearm, cause no difficulty.

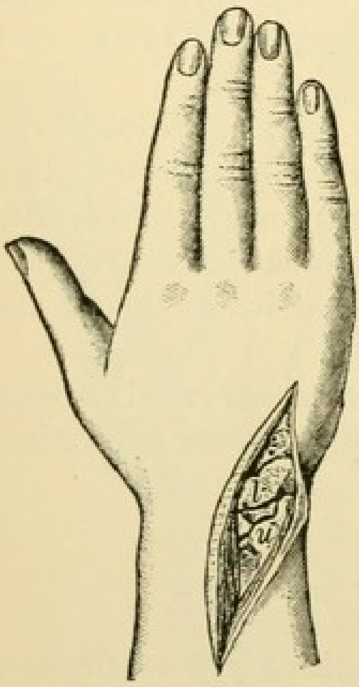


Fig. 792

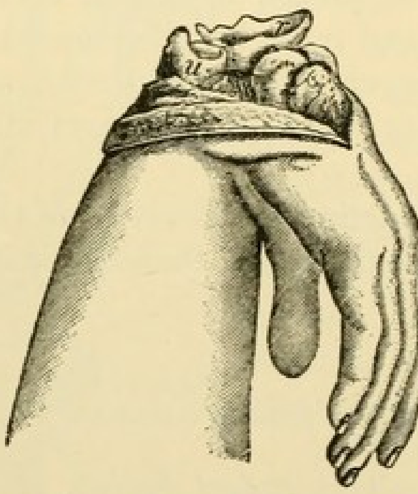


Fig. 793

Kocher's Resection of the Wrist

Gritti opened the wrist by a long **transverse incision** *across the dorsal side* of the carpus, dividing all tendons at the same time. By forcible volar flexion, the articular surfaces can be separated from each other; after removal of all diseased portions, the hand is placed in its normal position, and the divided tendons are carefully sutured.

Catterina reached the (anterior) parts of the carpus by *dividing* the *metacarpus* anteriorly. He divided the web between the third and fourth metacarpus and split their interstices. The volar incision is only 5 centimeters long (volar arch!); the dorsal incision, 15 centimeters long, extends over the carpus. The halves of the hand are then turned apart and the diseased portions removed.

During the *after treatment*, it is necessary in *all* resections of the wrist to place the hand upon a splint, fixing the wrist in *dorsal flexion* but permitting the movements of the fingers.

RESECTION OF THE ELBOW JOINT

LISTON'S T-INCISION

1. The posterior side of the elbow bent at an obtuse angle is presented to the operator by an assistant, holding the forearm with one hand and the arm with the other (Fig. 796).

2. A longitudinal incision 8 centimeters in length, the middle of which corresponds with the inner margin of the olecranon, opens the articular capsule between this and the internal condyle (Fig. 794).

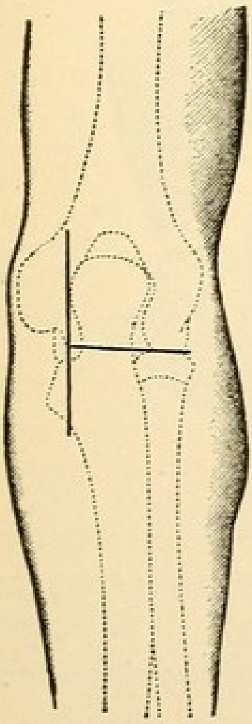


Fig. 794. Resection of the Right Elbow Joint (Liston's T-incision)

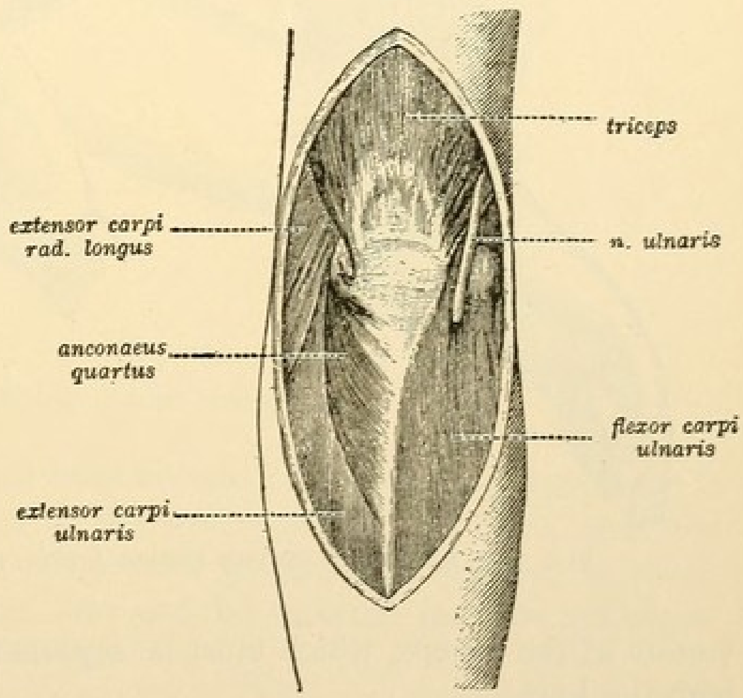


Fig. 795. Ulnar Nerve on the Dorsal Side of the Left Elbow Joint

3. While the nail of the left thumb forcibly draws the soft parts from the internal condyle inwardly, a short knife divides them completely by incisions *made vertically upon the bone*, until the epicondyle projects free from the wound (Fig. 796). During this procedure, the forearm must be flexed more and more by the assistant. The ulnar nerve lies in the middle of the parts dissected off and does not appear to view (Fig. 795).

4. By a semicircular incision made below the internal condyle, the internal lateral ligament (Fig. 797) and the origins of the flexor muscles are divided.

5. The arm is then extended, and the external incision is made transversely across the olecranon from the lower border of the external condyle to the middle of the first incision (see Fig. 794).

6. Upon the posterior side of the ulna, the periosteum is detached with the elevator from the internal margin, but remains in connection with the

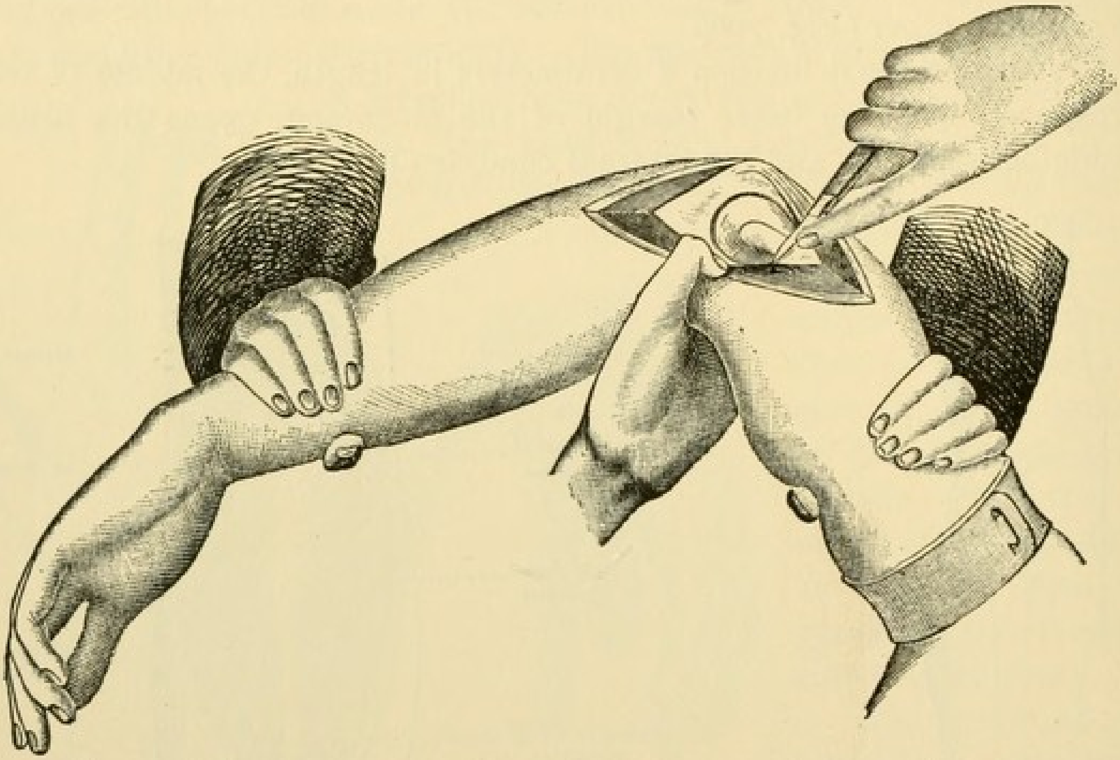


FIG. 796. RESECTION OF THE ELBOW JOINT DENUDING INTERNAL CONDYLE

tendon of the triceps, which must be separated from the tip of the olecranon with the knife.

7. Both are pushed outward over the external condyle; the articulation then gapes; a few incisions in the articular connection between the head of the radius and the articular surface of the external condyle above divide the annular ligament of the radius and the external lateral ligament (Fig. 798).

8. The articulation is now more freely exposed; the free articular end of the humerus is grasped with bone forceps, and sawed off at the limit of the cartilaginous covering.

9. By an incision toward the point of the coronoid process of the ulna, the superior fibres of the internal brachial muscle are detached; the ole-

cranon is grasped with the forceps, and the denuded part of the ulna, as far as it is covered with cartilage, is sawed off.

10. Next, the head of the radius is excised.

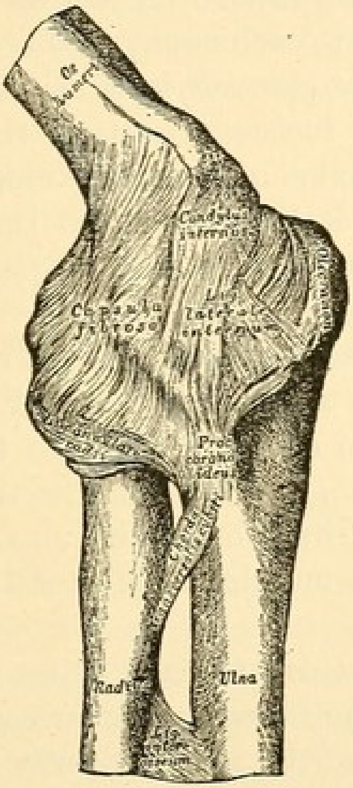


Fig. 797. Inner side

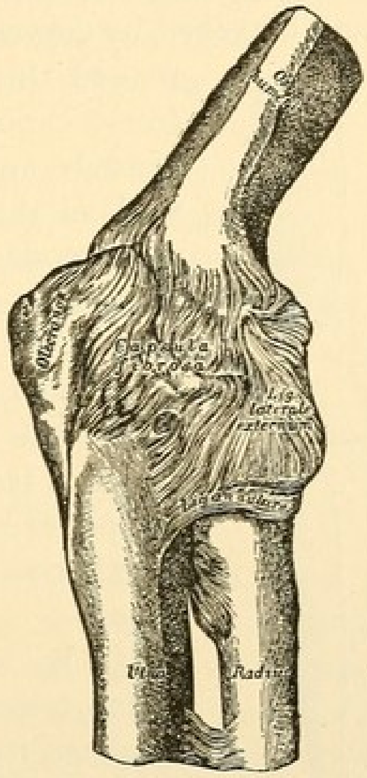


Fig. 798. Outer side

Ligaments of the Right Elbow Joint

11. After the hemorrhage has been arrested, the tendon of the triceps is first stitched with catgut sutures to the periosteum of the ulna; next, the transverse incision is united by sutures, the longitudinal incision, however, only at its two ends. A drainage tube can be inserted into the middle of the wound down to the resected ends.

VON LANGENBECK'S SIMPLE LONGITUDINAL INCISION — SUBPERIOSTEAL RESECTION

1. An incision 8 to 10 centimeters in length, extending over the extensor side of the articulation a little inwardly from the middle of the olecranon, begins 3 to 4 centimeters above the tip of the olecranon and ends 5 to 6 centimeters below the same upon the posterior border of the ulna; it penetrates the muscle, tendon, and periosteum everywhere down to the bone (Fig. 799).

2. With the raspatory and elevator, the periosteum of the ulna is first pushed toward the inner side; the internal half of the tendon of the triceps,

in connection with the periosteum, is divided (by short parallel longitudinal incisions always directed toward the bone).

3. With the nail of the left thumb, the soft parts covering the internal condyle and including the ulnar nerve are drawn toward the tip of the epicondyle and detached by curved incisions close to each other, always directed toward the bone, until the epicondyle projects and is freely exposed. The last incisions encircle the inner condyle, and divide the origins of the flexor muscles, as well as the internal lateral ligament from the same, without destroying the connection of these parts with the periosteum.

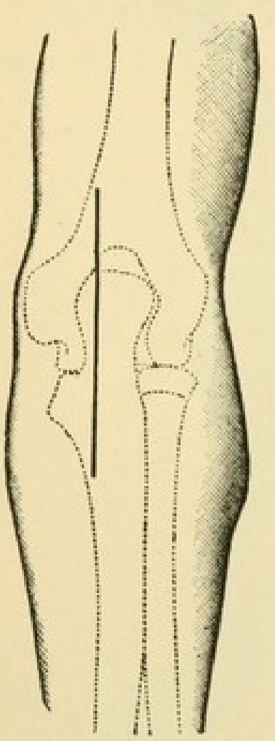


FIG. 799. RESECTION OF RIGHT ELBOW JOINT BY VON LANGENBECK'S EXTERNAL INCISION

4. After the detached soft parts have been replaced into their former positions, the external part of the tendon of the triceps is drawn outward, detached by short incisions from the olecranon, but left in connection with the periosteum of the external side of the ulna, which, together with the anconeus muscle, is elevated from the bone.

5. By incisions made close to each other and directed toward the bone, the fibrous articular capsule is detached from the margin of the articular surface of the humerus, first at the trochlea, next at the head of the bone, until the external condyle appears to view.

6. Next, the external lateral ligament, as well as the origins of the extensor muscles, are so detached from it that all these parts remain in connection with each other and the periosteum of the humerus.

7. After the external condyle has thus been divested from all attachments of soft parts, the joint can be strongly flexed; the articular ends are forced out of the wound and sawed off in the manner described above.

8. If it appears desirable to saw off the ulna below the coronoid process, the superior fibres of the tendon of the brachialis internus must be detached from it without destroying the connection of the tendon with the periosteum of the ulna.

BY HUETER'S BILATERAL LONGITUDINAL INCISION

1. A longitudinal incision 2 centimeters in length exposes the internal condyle; a curved incision, encircling its base, divides the internal lateral ligament.

2. A longitudinal incision over the outer surface of the joint 8 to 10 centimeters in length extends over the external condyle and the head of the radius.

3. The soft parts are drawn apart, and the external lateral ligament, together with the annular ligament of the radius, is divided.

4. The head of the radius is cleared of all attachments and removed with the metacarpal saw.

5. The insertion of the capsule of the joint is detached from before backward, first from the border of the rotula, then from the trochlea.

6. By abducting the forearm toward the ulnar side, the humerus is forced out of the wound when the ulnar nerve slips off from its posterior surface, and its articular end is excised with the saw.

7. The olecranon is then cleared and removed with the saw.

BY OLLIER'S BAYONET INCISION

1. With the forearm flexed (130°), the external incision on the posterior side of the elbow between the externus anconeus and the supinator longus, beginning 6 centimeters above the articulation, is made down to the lateral epicondyle; from here, it turns downward at an obtuse angle to the olecranon, and then descends 4 to 5 centimeters along the posterior border of the ulna (Fig. 800). The middle oblique portion of the incision corresponds about to the interspace between the triceps and the anconeus quartus muscles.

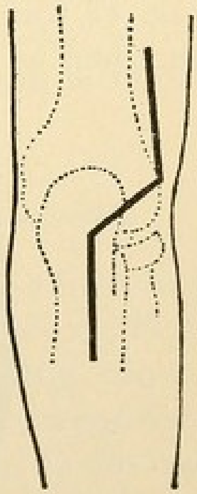


Fig. 800. Ollier's Resection of the Elbow Joint

2. In the upper portion of the incision, after division of the fascia, the operator advances between the triceps and the supinator longus and the extensor carpi radialis longus down to the bone, and divides the articular capsule in the direction of the skin incision.

3. With the arm slightly extended, the tendon of the triceps, together with the periosteum, which must be carefully preserved, is detached from the bone with the raspatory. The articulation is then opened behind after the olecranon has been exposed.

4. On the humerus, the periosteum, together with the lateral accessory ligament, is reflected with the raspatory, and the humerus is luxated laterally by dividing the median and anterior articular ligaments.

5. Finally, the articular surfaces of the humerus, radius, and ulna are excised with the saw.

Nélaton made an *angular incision* extending along the outer side of the humerus as far as the head of the radius, and turning from here at a right angle backward as far as the ulna (Fig. 801). It is true that the articulation and especially the head of the radius are well exposed thereby, but the *anconeus* muscle is transversely divided; this disadvantage can be avoided by making the resection

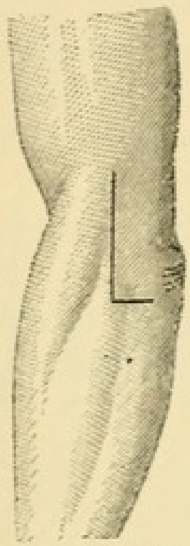


Fig. 801. Nélaton's Resection of the Elbow Joint

BY KOCHER'S HOOK-SHAPED INCISION

1. An incision beginning at the radial posterior side 4 centimeters above the line of articulation extends on the outer side of the inferior border of the humerus as far as the head of the radius, and 4 to 6 centimeters below the tip of the olecranon, and turns here about 1 to 2 centimeters upward as far as the median side of the ulna (Fig. 802).

2. The knife penetrates between the brachioradial muscle (supinator longus), extensor carpi radialis longus and brevis, and the extensor carpi ulnaris in front, and the anconeus muscle behind as far as the lateral border of the humerus and the capsule of the head of the radius, and deviates upon the lower third of the anconeus as far as the lateral side of the ulna.

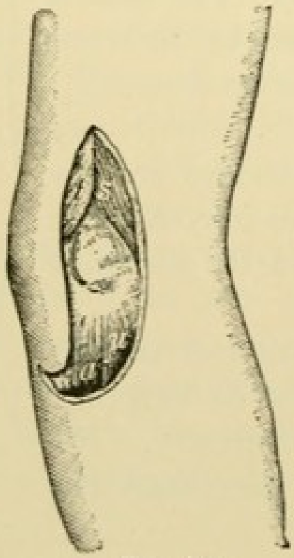


Fig. 802

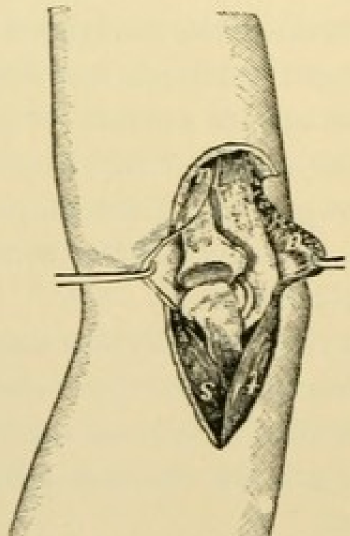


Fig. 803

Kocher's Resection of the Elbow Joint. *a*, m. anconeus quartus; *u*, extensor carpi ulnaris; *t*, m. triceps; *s*, supinator longus

3. After division of the capsule the olecranon is divided at its base with a chisel transversely in the line of incision (more deeply on its posterior

side), next turned up with the triceps and the anconeus toward the ulna, and subsequently enucleated if it is diseased.

4. If the olecranon is to be preserved, the external head of the triceps, with the periosteum and the capsular insertion, is detached from the humerus, also the anconeus from the external surface of the ulna, the insertion of the triceps from the tip of the olecranon, and a portion of the internal ulnar muscle from the internal surface of the ulna; this triceps anconeus flap is turned inward like a cap over the olecranon with the arm extended (Fig. 803).

5. After the detachment of the external lateral ligament and of the capsule on the external condyle of the humerus and on the neck of the radius, the articulation is opened freely.

6. Before the bones are sawed off, the internal lateral ligament must be carefully detached from the internal border of the ulna and the median surface of the trochlea, and the muscles, together with the periosteum, must be freed from the internal and the external condyle. The articular ends are sawed off in a light *curve* to guard against any subluxation which might occur during the healing process.

RESECTION OF THE OLECRANON

This can be made, according to *von Langenbeck*, by a posterior longitudinal incision (Fig. 799). The soft parts and the periosteum are then detached with the raspatory on both sides, and the olecranon is removed with the metacarpal saw or chisel and hammer.

TEMPORARY RESECTION OF THE OLECRANON (*Trendelenburg*)

can be made, aside from the incisions mentioned heretofore, also from *behind*, by chiselling off the olecranon, and by subsequently reuniting it with the bone suture. For this purpose a *curved incision* is made with the convexity directed upward across the extensor side of the articulation from one epicondyle to the other. The skin flap is detached from the tendon of the triceps and the olecranon, and the soft parts are elevated bluntly from the internal side of the olecranon, preserving carefully the periosteum and the ulnar nerve. The portion of the capsule of the joint lying under it is divided transversely; the olecranon is chiselled off transversely, and finally, in the same plane, the anconeus muscle and the portion of the articular capsule lying under it are divided transversely.

The olecranon can then be turned in an upward direction; with a flexed position of the arm a free inspection of the inside of the joint is obtained.

The olecranon is finally united with the ulna by a bone suture, the external incision is sutured, and the arm is bandaged in an extended position. It seems just as well to form the skin flap with *an upper base*, and to turn it up in connection with the olecranon to be sawed off.

In the **after treatment,** the advice of *Roser* to bandage the resected elbow joint first in the *extended position* to prevent the dislocation of the ends of the bone (subluxation), and to guard against the formation of a loose freely movable joint, must be strictly observed. The splints illustrated in Figs. 146, 152, 216, 236, and 238 can be used for this purpose. But also with a right-angular position a loose, freely movable joint can be avoided if the surgeon, in as extensive a manner as possible, places in apposition only the extremities of the bone. Thereby the resected bones of the forearm are prevented from coming to lie in front of the humerus. For this purpose ulna and humerus can be sawed off obliquely and placed in apposition, or the humerus end can be incised in the form of a Λ (or be divided longitudinally), the ulna cut out in the form of a wedge be inserted into the fissure. The radius can be sawed off to such an extent that it comes to lie upon the humerus (*Bardenheuer*).

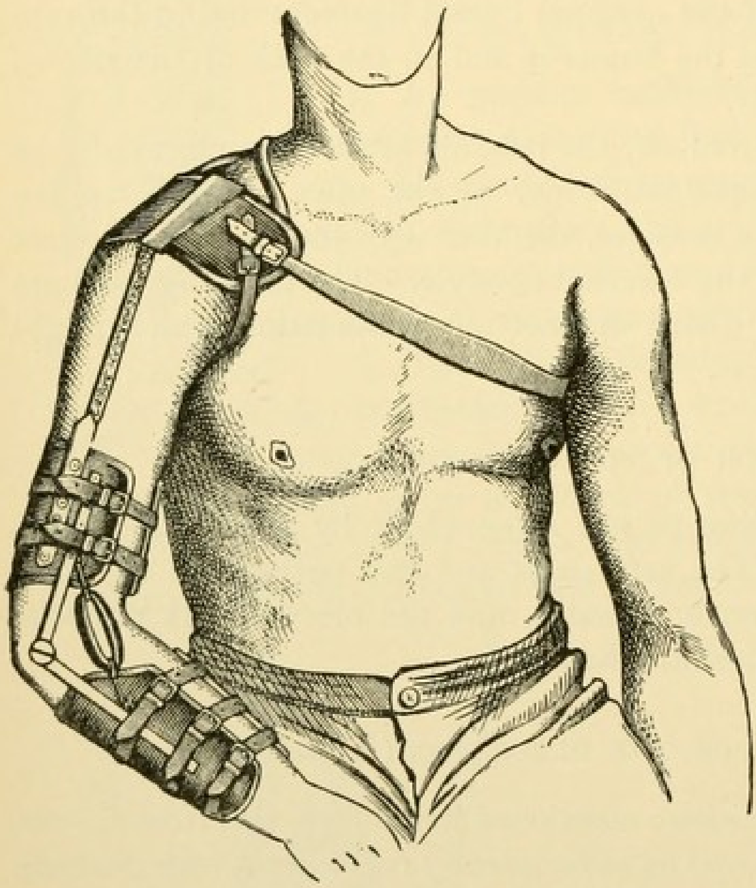


FIG. 804. SOCIN'S SUPPORTING APPARATUS FOR A LOOSE, FREELY MOVABLE JOINT AFTER RESECTION OF THE ELBOW JOINT

To prevent anchylosis with the limb in this position the forearm, as soon as the wound has healed or nearly healed, must be gradually flexed at the elbow with each change of dressings, and must be kept in the new position from one dressing to another until the desired degree of flexion is reached.

If a **loose, freely movable joint** has formed after resection of the elbow, firmness and usefulness can be restored by *Socin's* **supporting apparatus** (Fig. 804), to which are attached rubber rings which accomplish flexion.

(In all resections of the elbow joint temporary resection of the olecranon should be practised unless it is the seat of disease. After the resection has been completed the olecranon is united with the shaft of the ulna by a bone or ivory nail. In young subjects fixation by durable catgut sutures embracing the periosteum and the tissues outside of it will answer the purpose.)

RESECTION OF THE SHOULDER JOINT

BY VON LANGENBECK'S ANTERIOR LONGITUDINAL INCISION (OLDER METHOD)

1. The patient is placed on his back, the shoulder pressed forward by a pillow, and the arm held in such a manner that the external condyle of the humerus is directed forward.

2. An incision, beginning at the anterior border of the acromion, very near its articular connection with the clavicle and extending 6 to 10 centimeters vertically downward, penetrates through the deltoid muscle down to the capsule of the joint and the periosteum (Fig. 805).

3. The margins of the muscular incision are drawn apart with blunt retractors; the tendon of the long head of the biceps is seen lying in its sheath (Fig. 806).

4. An incision along the external side of the tendon opens its sheath; the knife, with its back in the bicipital groove, divides the whole sheath of the tendon and the capsule as far as the acromion.

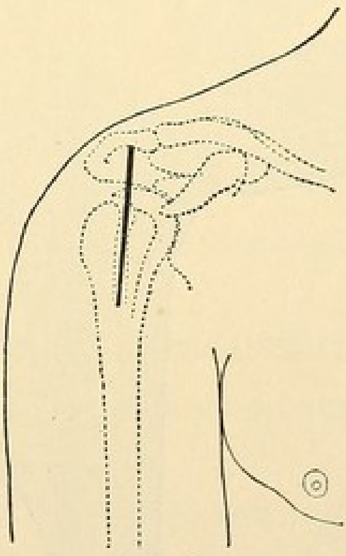


Fig. 805

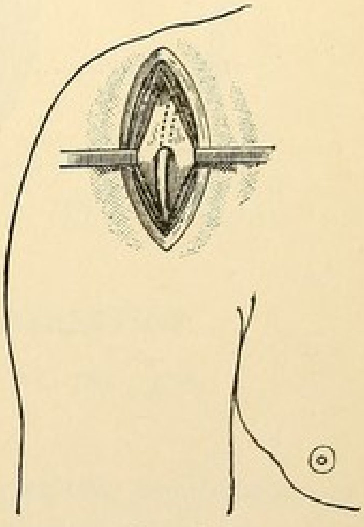


Fig. 806

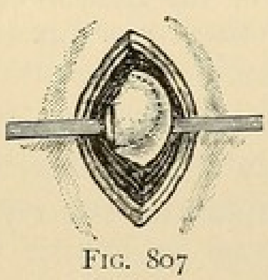


Fig. 807

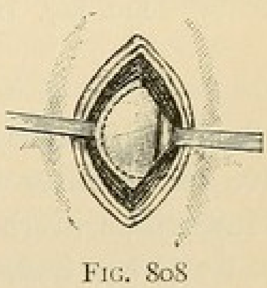


Fig. 808

Von Langenbeck's Resection of the Shoulder Joint

5. The tendon of the biceps is lifted from its groove and drawn outward with a blunt retractor.

6. While an assistant slowly rotates the arm outward a curved incision across the lesser tuberosity of the humerus is made with a strong knife applied vertically to the bone. This incision divides the capsule and the insertion of the subscapular muscle (Fig. 807).

7. The arm is then rotated inward; the tendon of the biceps is drawn inward and buried there.

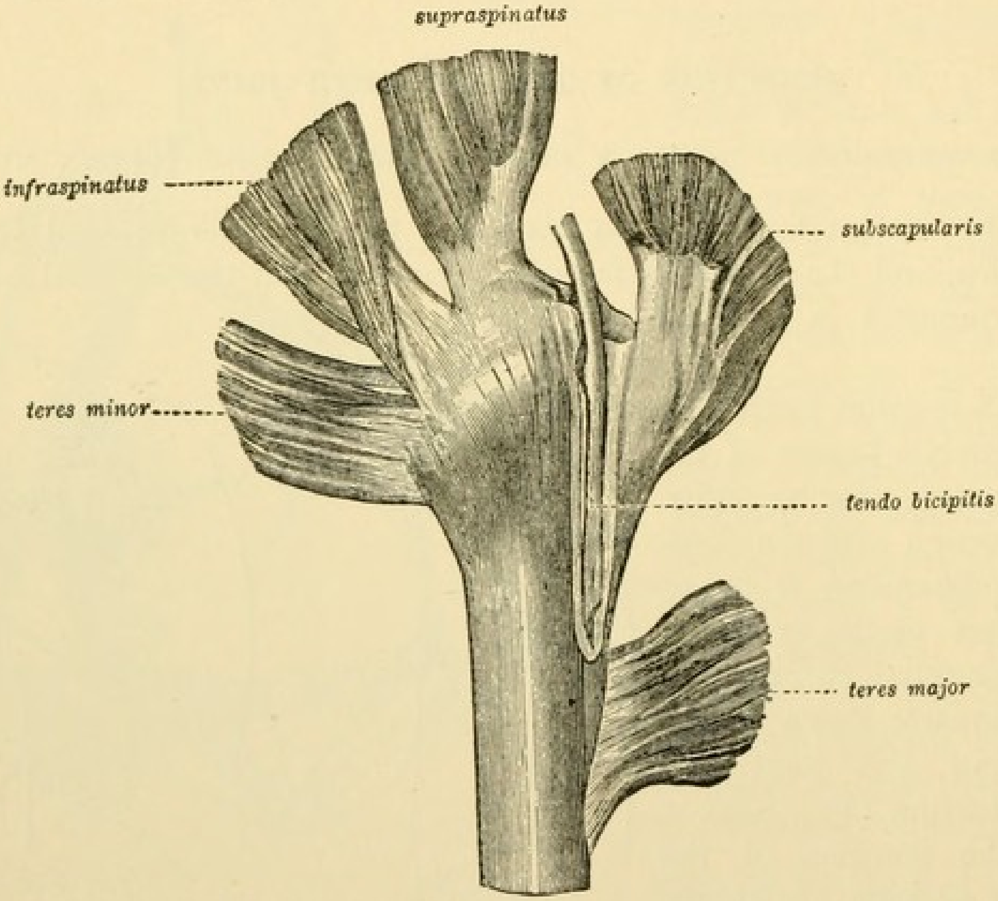


Fig. 809. Insertions of the Muscles of the Greater and Lesser Tuberosity of the Humerus

8. The knife is again carried in a larger circle from the capsular division above the greater tuberosity of the humerus, and divides the capsule with the insertions of the supraspinatus, the infraspinatus, and the teres minor muscles (Figs. 808, 809).

9. The head of the humerus is forced out of the wound by pressure from below, grasped with strong forceps (best of all, *Farabœuf's* forceps — Fig. 810), and after the posterior portion of the capsule is divided, it is excised with a metacarpal saw (Fig. 811).

10. When the head of the humerus has been separated from the diaphysis by a bullet, it must be seized with a sharp bone hook and extracted (see Fig. 779). If the head is crushed into several pieces, the fractured portions can be grasped singly with forceps and enucleated with a blunt-pointed knife or a probe-pointed knife.

11. After this method of operating, in most cases a *flail joint* with displacement of the humerus toward the thorax is formed, or a poor and defective articular connection with the coracoid process is established. Free active motion is more likely to be restored if the connections of all muscles surrounding the articulation with the capsule and the periosteum of the diaphysis are carefully preserved during the operation. This is effected by

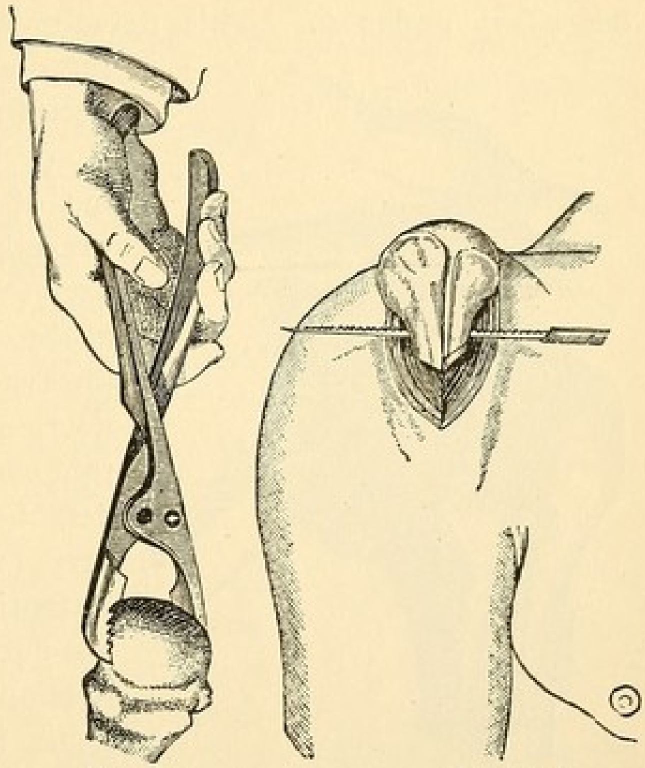


FIG. 810 FIG. 811
SAWING OFF HEAD OF SHOULDER

THE SUBPERIOSTEAL OR SUBSCAPULAR RESECTION

BY VON LANGENBECK'S ANTERIOR LONGITUDINAL INCISION

1–4. As in the foregoing operation.

5. Along the internal border of the bicipital groove, the periosteum is divided with the scalpel and carefully reflected with a small elevator from the spine of the lesser tuberosity of the humerus as far as the lesser tuberosity (Fig. 812).

6. With the knife and tenaculum forceps, the tendon of the subscapular muscle (Fig. 809) is freed from the bone without dividing the connections of the capsule with the detached periosteum. During this procedure the arm must be slowly rotated outward, and during the further progress of detachment the knife must be frequently exchanged for the elevator.

7. The arm is then rotated inward, the tendon of the biceps is raised from its groove and buried inward.

8. The periosteum of the external surface of the neck of the humerus is detached in connection with the insertions of the supraspinatus, infraspi-

natus, and teres minor at the larger tuberosity in the same manner as described under 6. This detachment is somewhat difficult in primary resections, because the periosteum is usually very thin.

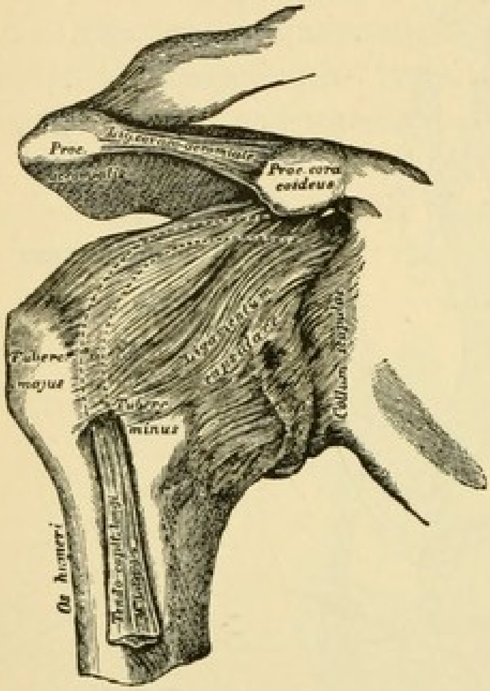


FIG. 812. LIGAMENTS OF THE SHOULDER JOINT

9. The head of the humerus is forced out of the wound, and sawed off as in the preceding operation. If it is deemed necessary to resect only the head of the humerus at the upper extremity of the tubercle (which always yields the best functional result), reflection of the periosteum is superfluous. In this case, the insertions of the muscles are detached from the bone as much as necessary, commencing from the articular cavity. Attention must be paid that the muscles are not cut off transversely, but retain their connection with the bone below. Since the head, however, under these circumstances cannot be forced from the wound, it must be sawed off with a fine metacarpal saw or with the chain saw.

10. After the hemorrhage has been arrested, an opening is cut in the posterior side of the wound in the skin, at the posterior border of the deltoid muscle; through this opening a drainage tube is inserted into the wound. The anterior wound can then be completely united by buried and superficial sutures.

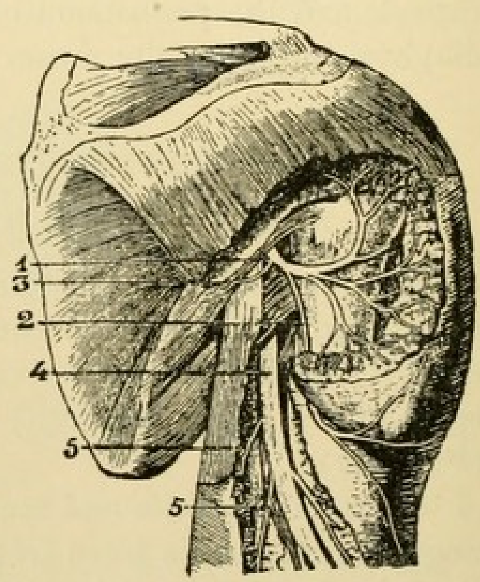


FIG. 814. RAMIFICATION OF AXILLARY NERVE. Posterior view. 1, circumflex nerve; 2, cutaneous nerve; 3, teres minor muscle; 4, radial nerve; 5, ramifications coursing towards the triceps and anconeus

An antiseptic dressing is applied and retained by a bandage, the tours of which fasten the arm, flexed at the elbow, to the side of the chest in the manner of a mitella, which suffices for the fixation of the limb.

In order better to protect the deltoid muscle and the branches of the *circumflex nerve* (axillary, Fig. 814), and consequently avoid paralysis of this muscle, the joint should be opened.

BY OLLIER'S ANTERIOR OBLIQUE INCISION

1. With the knife directed toward the head of the humerus, the incision is made to correspond with the course of the fibres of the deltoid, from the external border of the *coracoid process obliquely* downward and outward across the lesser tuberosity and as far as the shaft of the humerus, dividing all of the soft tissues down to the bone (Fig. 814).

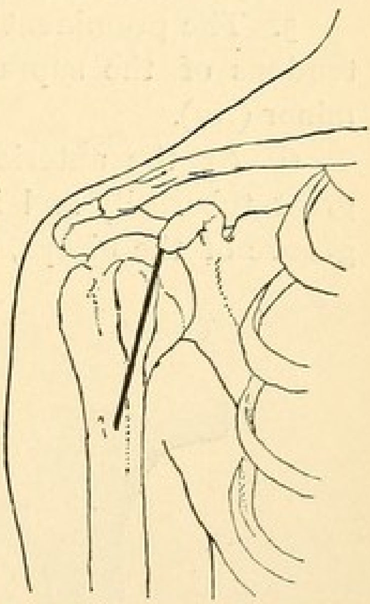


FIG. 814. OLLIER'S RESECTION OF THE SHOULDER JOINT

2. The lesser tuberosity and the bicipital groove are immediately exposed, and can be easily cleared of the attached soft tissues. Next, the arm is rotated inward, and the greater tuberosity is detached. On the whole, the procedure is the same as described in the preceding operation.

Since from an anterior incision only the head of the humerus can be removed conveniently (**decapitation**), while the other portions of the articulation, especially the glenoid cavity, can be inspected or resected in a somewhat unsatisfactory manner, it is better in all cases in which *a more extensive disease* of the whole articulation necessitates free access to *all* its parts, to expose the articulation of the shoulder by

KOCHER'S POSTERIOR CURVED INCISION

1. External incision from the acromioclavicular articulation over the eminence of the shoulder to the middle of the spine of the scapula and in the form of a curve downward toward the posterior axillary fold. Division of the acromioclavicular articulation (Fig. 815, *c*). Longitudinal incision through the fascia at the posterior border of the deltoid muscle. The inferior portion of it is exposed and forcibly drawn forward; the fibres inserted farther on at the crest are divided.

2. The insertion of the cucullaris (trapezius) is detached from the spine of the scapula upward, and the supraspinatus is raised with the elevator; the infraspinatus is detached downward until the external border of the spine can be encircled.

3. After an elevator has been placed under the neck of the acromion for protection, the crest (*sc*) is divided with a chisel (from above downward) (Fig. 815); an injury of the subscapular nerve coursing beneath the supraspinatus and infraspinatus muscles should be guarded against.

4. After division of the bone, the acromial portion is rolled forcibly forward with a sharp bone hook, and dislocated in the acromioclavicular articulation (Fig. 816), whereby the deltoid muscle (*d*) is elevated from the muscles of the scapula.

5. The prominent head of the humerus is now exposed, covered by the tendons of the supraspinatus and infraspinatus (*ss*, *is*) and of the teres minor (*tm*).

6. At the anterior border of the insertions of these muscles (on the great tuberosity and its spine), and at the posterior border of the palpable groove of the biceps, a longitudinal incision is made over the bone, dividing

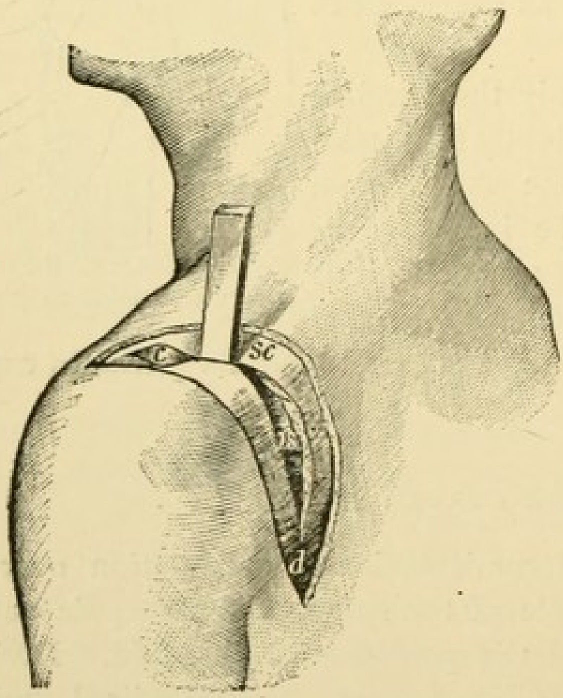


Fig. 815

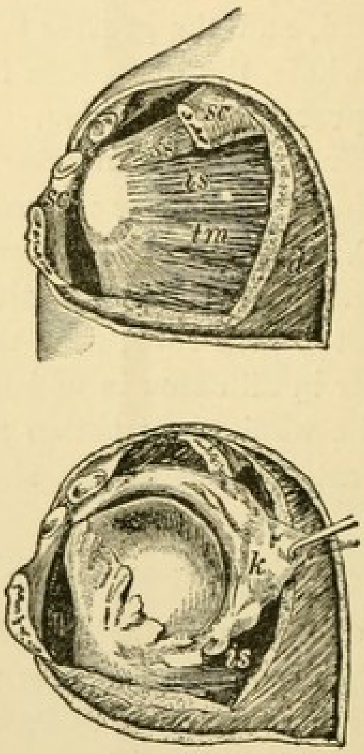


Fig. 816

Kocher's Resection of the Shoulder Joint

above the capsule (*k*) over the head of the humerus, and exposing the tendons as far as the superior margin of the glenoid cavity.

7. The insertions of the supraspinatus and infraspinatus and teres minor muscles are detached from the greater tuberosity and drawn backward; the tendon of the biceps, exposed in the bicipital groove, is drawn forward; the arm is rotated outward.

8. The insertion of the subscapular muscle, now appearing to view, is detached anteriorly and posteriorly from the lesser tuberosity; the vessels passing below the teres minor and the axillary (circumflex) nerve must be protected.

9. When the head has been completely exposed and forced out from the wound, an excellent view of the interior of the joint is obtained, especially of the glenoid cavity. All diseased portions can be easily recognized and removed; if necessary, the head can be resected. Finally, the chiselled-off portion of the acromion is united again with the scapula by bone suture.

This procedure also enables the surgeon by a partial resection to preserve intact the anterior capsular portion, the subscapular muscle and the coraco-humeral ligament; thereby the frequent partial dislocation toward the coracoid process is avoided.

If the articular portion of the scapula alone is injured, while the head of the humerus has remained intact, it is necessary only to make

VON ESMARCH'S RESECTION OF THE ARTICULAR SURFACE AND NECK OF THE SCAPULA

1. A curved incision encircling the posterior border of the acromion and dividing the fibres of the deltoid muscle from it exposes the posterior superior surface of the capsule of the joint (Fig. 817).

2. From the middle of the same, the knife penetrates as far as the posterior superior border of the glenoid process of the scapula, divides in a sagittal direction the articular capsule between the tendon of the supraspinatus and infraspinatus muscles as far as the middle of the greater tuberosity, and at the same time the skin and the deltoid muscle in the direction of its fibres.

3. While the soft parts are forcibly drawn apart with retractors, from the border of the glenoid process the operator detaches the tendon from the long head of the biceps and the capsule, in connection with the periosteum of the neck of the scapula, all around to such an extent that the articular end can be removed with the metacarpal saw, or the fractured portions of the comminuted bone can be liberated with the knife.

4. The after treatment is the same as in resection of the shoulder joint.

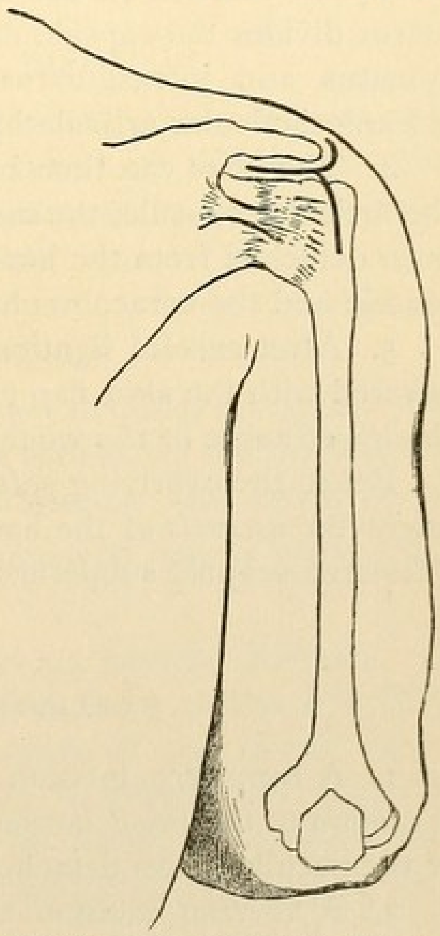


FIG. 817. VON ESMARCH'S RESECTION OF THE ARTICULAR SURFACE AND NECK OF THE SCAPULA

RESECTION OF THE SCAPULA BY VON LANGENBECK'S ANGULAR INCISION

This operation is performed only in the case of tumors; the muscles covering the scapula are *not* preserved (**extirpation of the scapula**).

1. One line of the angle takes its course on the upper side, the other over the centre of the scapula downward; the skin flap formed thereby is detached from the underlying tissues in the direction of its base, and turned outward.

2. Next, the insertions of the rhomboid muscles and of the levator anguli scapulæ are detached from the internal border, those of the cucullaris (trapezius) and deltoid from the acromion and spine, the omohyoid from the superior border, the teres major and minor from the external and inferior border. While the bone is elevated at its middle border from the thorax, the knife detaches it with shallow sweeps from its base (serratus magnus and subscapular muscles).

3. An incision in the form of a horseshoe across the head of the humerus divides the capsule of the shoulder joint, the insertions of the supraspinatus and infraspinatus muscles on the greater tuberosity, and the acromioclavicular articulation.

4. The bone can then be elevated outward; and after the remainder of the articular capsule, the insertions of the biceps and triceps muscles, have been detached from the border of the glenoid cavity, and the pectoral minor muscle and the coracobrachial from the coracoid process, it is removed.

5. After careful ligation of all the bleeding vessels, the large wound is covered with the skin flap and sutured, and a drainage tube is inserted into the lower angle of the wound.

But if the overlying soft parts must be preserved, for instance, in operations for *necrosis* of the bone, this can be readily done by removing the sequestered scapula subperiosteally.

OLLIER'S SUBPERIOSTEAL RESECTION

1. A *transverse* incision is made over the spine of the scapula from the acromion to the inner border, penetrating down to the bone; the insertions of the cucullaris are detached with knife and elevator.

2. A *vertical* incision takes its course along the inner border of the scapula, exposing the median insertion of the supraspinatus and infraspinatus muscles (Fig. 818).

3. By blunt dissection, the soft parts of the fossa infraspinata are displaced outward; then, in the same manner, those of the fossa supraspinata are detached from the bone and retracted upward and outward.

4. While the bone is elevated from the thorax, the underlying soft parts are detached with the raspatory as far as its anterior border and the neck.

5. Next, as described above, the operator divides the acromioclavicular articulation from below; likewise, the articular capsule and the muscular insertions; finally, the insertions of the muscles and ligaments of the coracoid process; it is easier, however, to remove this process by detaching it from the scapula with the saw.

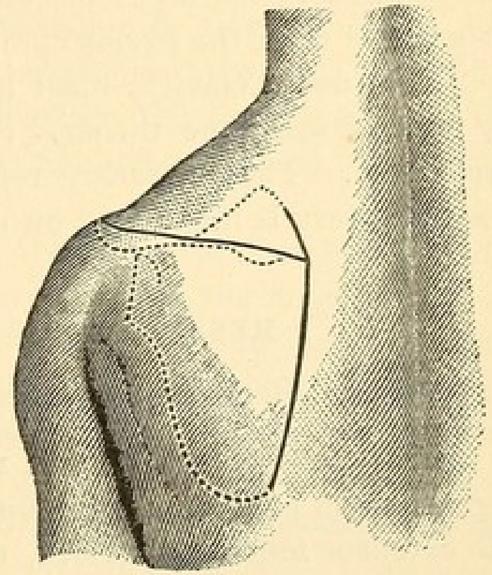


FIG. 818. OLLIER'S RESECTION OF THE SCAPULA

PARTIAL RESECTION OF THE SCAPULA

This operation must be adapted to each individual case. Portions of the spine and the acromion can be chiselled or sawed off through a simple incision; likewise, the flat portion of the scapula can be removed, leaving the articulation intact (**amputation of the scapula**).

RESECTION OF THE CLAVICLE

This can be made very easily by an incision extending along the whole length of the bone, from which the periosteum is reflected toward both sides. The operation is facilitated by dividing the periosteum transversely on both sides, |——|. Next, the middle portion to be removed can be easily excised with the metacarpal or chain saw.

Resection of the articular extremities offers no especial difficulty. The *sternal end* is divided by a longitudinal incision down to the articulation; the bone is sawed through at the external angle of the wound upon an elevator *very carefully* inserted subperiosteally to protect the large veins lying directly behind it; the short portion is drawn forward, detached at its posterior and inferior surface from the soft parts adhering to it, and finally the articular capsule is divided.

In resecting the *acromial end*, an incision is made from the extreme end of the clavicle to about the coracoid process; at its inner border, an elevator is inserted behind the bone, and the latter is divided; next, the acromioclavicular articulation is disconnected, and finally the portion of bone is enucleated from the periosteum.

If the *whole* clavicle must be removed, the operation can be facilitated by sawing the bone through in the middle, and by extirpating each half separately. The *temporary* resection of the clavicle for ligating the subclavian artery is mentioned on page 261.

RESECTIONS OF THE LOWER EXTREMITIES

RESECTION OF THE ARTICULATIONS OF TOES

is made according to the same rules as those which have been laid down in the resection of fingers, with *longitudinal incisions* extending *laterally* along the extensor tendon (Fig. 819, 1 and 2). Of frequent necessity is the

ARTHRECTOMY OF THE ARTICULATION OF THE GREAT TOE

in inflammations, tuberculosis (and in some cases of *hallux valgus*). Ferdinand *Petersen's* broad opening furnishes a very good survey. Instead of a longitudinal incision made at the median side of the articulation, he divides

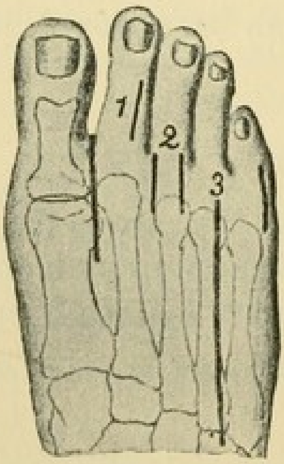


Fig. 819

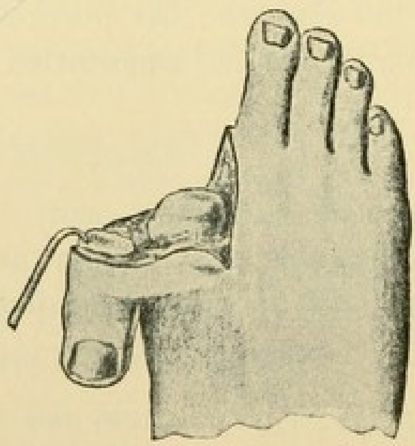


Fig. 820

Petersen's Arthrectomy of the Articulation of the Great Toe

1, 2, resection of the articulations of the toes; 3, resection of the metatarsus

the web between the first and the second toes as far as the neck of the condyle of the metatarsus and a little nearer toward the great toe (Fig. 819). The two toes are forcibly reflected, and the first articulation of the toes of the metacarpus is opened. With resection incisions, the soft parts are detached in a dorsal and plantar direction by preserving the insertions of the muscles and tendons until the toe can be more and more extended, and finally be turned over completely (Fig. 820). The articulation is then exposed. All vestiges of disease can easily be removed, all proliferations of the bone can be nipped off with the forceps, etc. Finally, the toe is reposed in its natural position and the skin wound is completely closed by a few sutures.

In the same manner, the articulation of the little toe can be opened. The resection of a metatarsal bone is made as in that of the fingers, from a longitudinal incision passing over the bone and extending beyond the next articulations (Fig. 819, 3). For the removal of all metatarsal bones an incision is used as in Fig. 703. The articular surfaces of the tarsal bones and the toes can be vivified for the purpose of producing a firmer coalescence, in case the surgeon is not content with the simple disarticulation, which is made similar to Fig. 704.

RESECTION OF THE ANKLE JOINT SUBPERIOSTEALLY BY VON LANGENBECK'S BILATERAL INCISION

1. After the foot has been placed upon its inner side, an incision 6 centimeters long is made vertically along the posterior border of the fibula downward, turning at the tip of the external malleolus, next along its anterior border $1\frac{1}{2}$ centimeters, and penetrating everywhere down to the bone (**hook-shaped incision**, Fig. 821).

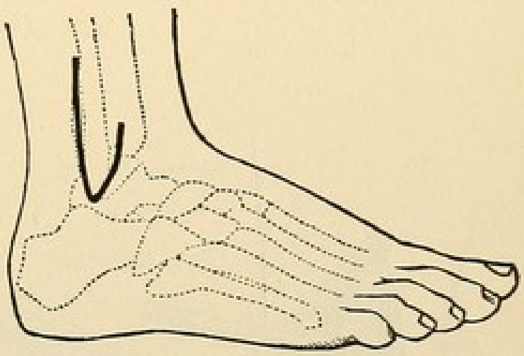


FIG. 821

2. With the raspatory and the elevator, the periosteum, in connection with the skin, muscles, and sheaths of the tendons, is detached at the anterior and posterior surface from the bone until the metacarpal or chain saw can be inserted behind the fibula at the upper end of the incision (Fig. 822). The tendon sheath of the peroneus longus muscle must be preserved if possible.

3. The fibula is sawed through; the sawed-off portion is grasped with bone forceps, gradually drawn forward more forcibly (Fig. 823), and detached from the interosseous ligament; finally, from within and above, the posterior ligament of the external malleolus (the inferior, very firm end of the interosseous ligament, Fig. 824), and the three strong accessory ligaments

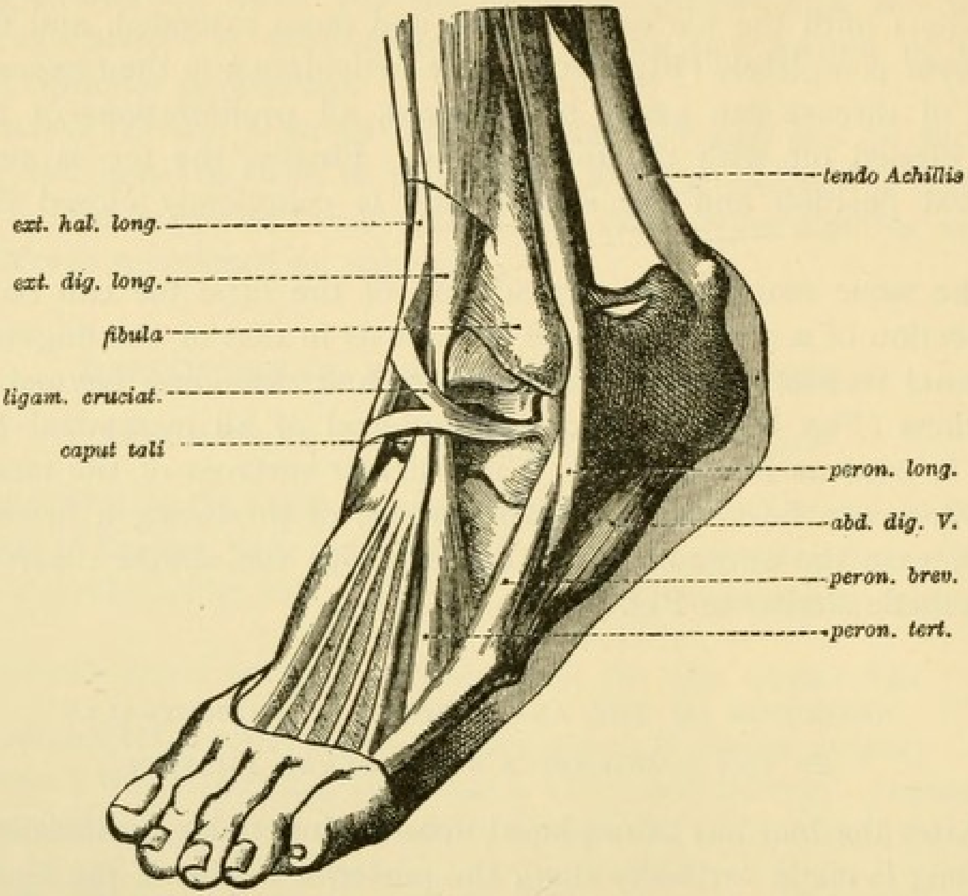


FIG. 822. EXTERIOR SIDE OF THE LEFT ARTICULATION OF THE FOOT (according to Henke)

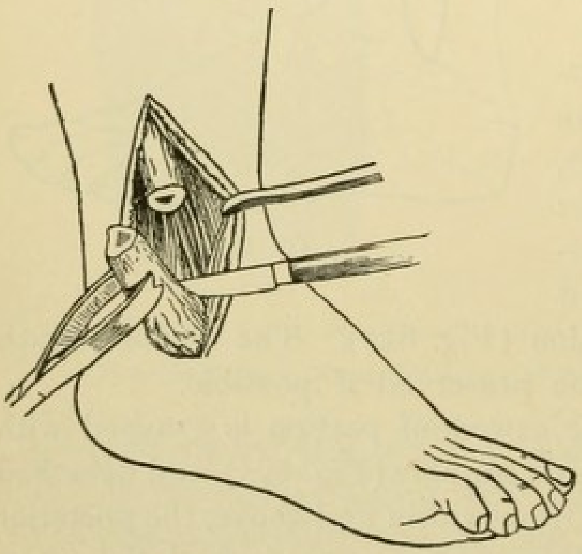


FIG. 823. DISARTICULATION OF THE LOWER EXTREMITY OF FIBULA

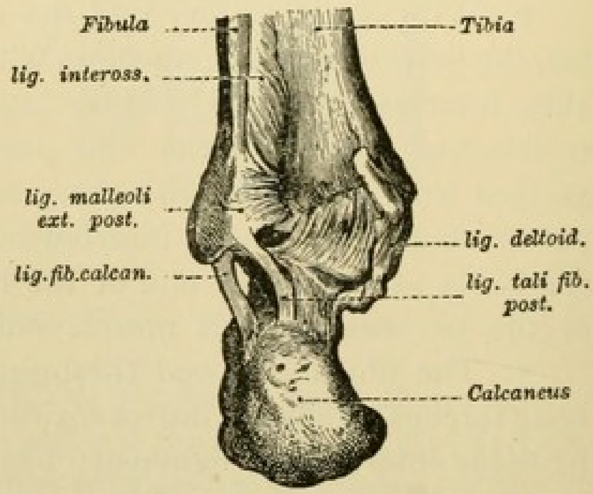


FIG. 824. LIGAMENTS OF THE ANKLE JOINT (Posterior side)

(Fig. 825) (the talofibular ligaments and the calcaneofibular ligament) are cut close to the malleolus.

4. The foot is then placed upon its external side; around the inferior border of the internal malleolus a semilunar incision 3 to 4 centimeters in length is made (Fig. 826), and from its middle a vertical incision 5 centimeters long ascends upward over the inner side of the tibia (**anchor incision**).

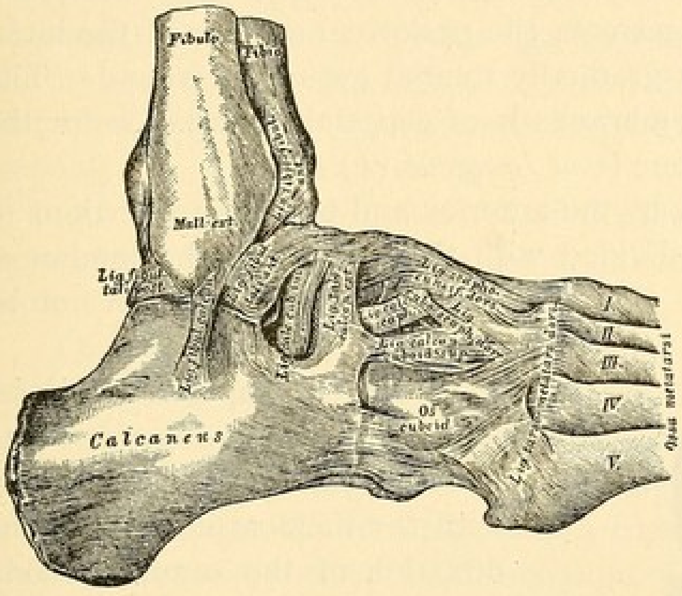


Fig. 825. Ligaments of the Ankle Joint (Outer side)

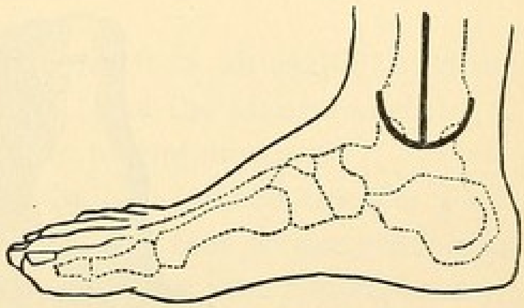


Fig. 826. Incision upon the Internal Malleolus (Anchor incision)

5. The incisions penetrate through the periosteum down to the bone. The periosteum is elevated *with the skin* from the inner surface in the form

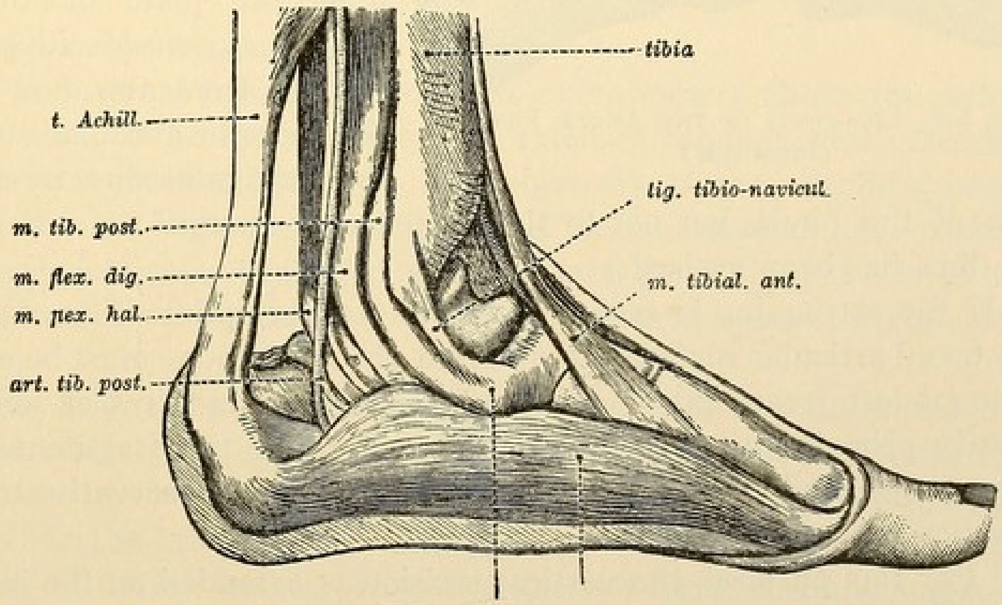


Fig. 827. Inner Side of the Ankle Joint (according to Henke)

of two triangular flaps (Fig. 827), *with* the tendinous sheaths of the dorsal flexors from the anterior surface, *with* the tendinous sheaths of the plantar flexors from the posterior surface of the tibia, and, finally, the deltoid ligament is cut off from the margin of the malleolus (Fig. 828).

6. At the upper end of the longitudinal incision, the tibia is sawed through with the metacarpal saw or the chain saw (in an oblique direction on account of the limited space); the sawed-off portion is grasped with bone forceps; and, while the elevator retracts the periosteal surface of the interosseous ligament from above, it is gradually rotated out of the wound. The protection of the interosseous membranes is of especial importance for the subsequent regeneration of the bone (*von Langenbeck*).

7. The bone is then held only by the anterior and posterior insertions of the articular capsule. They are divided with the knife, but the tendon of the tibialis posticus must not be injured.

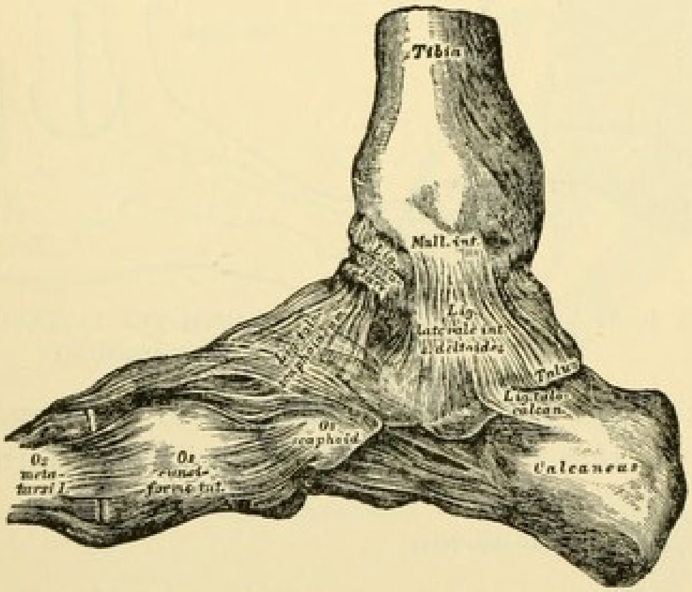


Fig. 828. Ligaments of the Ankle Joint
(Inner side)

8. If the superior *articular surface of the astragalus* is to be removed, the excision is made with the metacarpal saw; in the direction of the semilunar skin incision, the trochlear surface is sawed off from before backward, while the plantar surface is pressed firmly with both hands upon the plate of the table. (*Von Langenbeck* advises sawing off from the first incision the superior articular surface of the astragalus directly after the division of the fibula, but not to the detached bone until the articular end of the tibia has been excised.)

9. If the astragalus is severely comminuted or splintered as far as and into its tarsal articular surfaces, or diseased, the whole bone must be removed.

(The modern treatment of comminuted gunshot fractures of joints does not justify primary resection or even extraction of the fragments. Such injuries are repaired in a most satisfactory manner by conservative treatment under strict antiseptic precautions.)

10. For this purpose, the vertical incision is extended on the inner side from the tip of the internal malleolus in a downward convex curve and parallel with the tendon of the tibialis posticus as far as the tuberosity of the scaphoid bone; the tendon of the tibialis anticus and the anterior tibial

artery are retracted outward, the tibionavicular ligament (Fig. 827) and the astragaloscaphoid ligament (Fig. 828) are divided, and the joint is opened over the scaphoid bone from above inward.

11. On the outer side, the incision is carried from the tip of the external malleolus horizontally over the sinus tarsi; its firm masses of ligaments are divided (the anterior talofibular ligament and the external and internal astragalocalcaneal ligaments (Figs. 825 and 828), and, finally, by rotating the bone out of the joint with the elevator the remaining portions of the articular capsule.

12. After careful ligation of all the bleeding blood vessels, a short drainage tube is inserted on both sides as far as the division of the bone, and the wound is united by the suture.

13. If the entire astragalus is to be removed, it is advisable to drive in a long nail through the os calcis into the tibia from the plantar surface, to effect fixation between the bones at a right angle to one another.

14. After applying the usual dressing, the limb is placed upon a *Volkmann* splint with the foot placed at a right angle; in cases where great suppuration necessitates a frequent change of dressings, the interrupted or arch splints (see Figs. 225, 229, 234) will meet the additional indications.

Opening of the ankle joint by

KÖNIG'S TWO ANTERIOR LATERAL INCISIONS

is also applicable in many cases.

1. The internal incision begins 3 to 4 centimeters above the ankle joint over the tibia, to the inner side of the extensor tendons, and extends along the *anterior* malleolar border to the tuberosity of the scaphoid bone; the external incision begins at the same level as the internal, and extends over the *anterior* malleolar border to the sinus tarsi (joint line) at a level with the astragalonavicular articulation. The articulation is opened directly by these incisions.

2. The bridge of soft parts formed between these two incisions is elevated from the underlying bones, tibia, and astragalus with the knife and the elevator, and the anterior synovial bursa is extirpated, if it is diseased.

3. While the bridge flap is strongly elevated with a blunt retractor, the foot being in dorsal flexion, the entire anterior field of the articulation can be well inspected, and diseased portions are removed with the chisel or the sharp spoon. The astragalus can easily be extirpated. If the removal of the malleolar ends is necessary, first the external lamellæ are detached

with a broad chisel applied obliquely; next, the articular end of the tibia is removed with the chisel, and, finally, also the astragalus, or at least its trochlear surface, is chiselled away or sawed off.

4. By strong extension of the foot, the posterior capsular wall becomes, finally, accessible for extirpation.

For a better **inspection** of the articular cavity, such methods are practical, which, after the division of the soft parts, permit **inversion** of the foot sufficiently so that the articular surface of the astragalus and the tibia can be surveyed with one glance. For this purpose, the articulation is opened by

KOCHER'S EXTERNAL LATERAL TRANSVERSE INCISION

1. An external incision is made at a level with the line of the ankle joint from the outer border of the extensor tendons (*Ec*) in a curve across the tip of the external malleolus as far as the tendon of Achilles (Fig. 829).

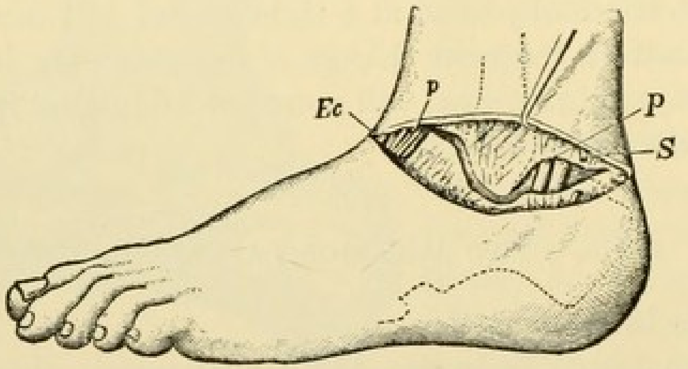


FIG. 829

2. After division of the fascia, the extensor tendons and the peroneus tertius (*p*) are drawn inwardly. The capsule of the joint and the ligaments are detached from the anterior border of the tibia and the fibula and closely around the external malleolus.

3. At the posterior border of the malleolus, the sheath of the peroneus muscles is opened upward as far as and over the line of articulation; the tendons of the peronei (*P*) are forcibly retracted backward, or, if sufficient space is not created thereby, divided (and subsequently united by suture). The external saphenous nerve (*S*) passing behind these tendons must be protected as far as possible.

4. Next, the posterior wall of the sheath of the extensor tendons and the capsule (*k*) on the anterior and posterior border of the tibia are detached as far as the internal malleolus.

5. The foot can then be *dislocated* by a strong lever movement across the internal malleolus toward the median line, so that the internal border of the plantar surface lies in apposition to the inner side of the leg, and is directed upward (Fig. 830).

6. If from the projecting tip of the internal malleolus the ligaments are carefully detached, all parts of the articulation can be freely inspected, and all diseased parts can be removed, and the astragalus can easily be resected. If the astragalus is to be saved the operator has to guard against opening the astragalocalcaneal articulation on the posterior and lateral circumference of the astragalus.

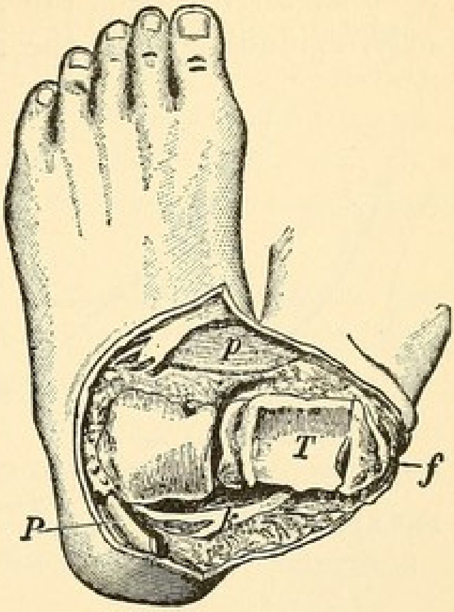


FIG. 830. KOCHER'S RESECTION OF THE ANKLE JOINT

BY GIRARD'S EXTERNAL OBLIQUE INCISION

1. The *external incision* begins on the external side vertically above the tip of the external malleolus between the tibia and the fibula, and descends obliquely downward as far as and over the tip of the malleolus, meeting an oblique incision extending from the external border of the tendon of Achilles, past the tip of the external malleolus to the tendon of the peroneus tertius (Fig. 831).

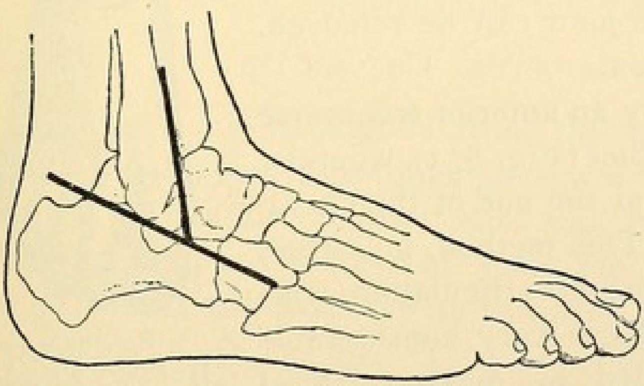


FIG. 831. GIRARD'S RESECTION OF THE ANKLE JOINT

2. The tendons of the peroneus longus and brevis are exposed and divided between two silk ligatures; the skin flaps are dissected back until the ankle joint and the astragalus are exposed.

3. The capsule of the joint is divided and detached with the ligaments so that the foot can be strongly supinated.

4. The astragalus can then be extirpated without any difficulty, and, if necessary, the foot can be adducted sufficiently to expose the joint cavity freely, when all diseased tissue can be removed through the large gaping wound.

5. Finally, the foot is replaced into its normal position, the divided tendons are united by sutures, the cavity of the wound is drained, and the external incision is sutured.

Lauenstein opens the ankle joint by a long **curved incision** on its outer side, extending from the middle of the fibula over the external malleolus, across the heads of the extensor brevis digitorum and behind the tendon of the peroneus tertius in front, to a level with the astragalonavicular joint (Fig. 832).

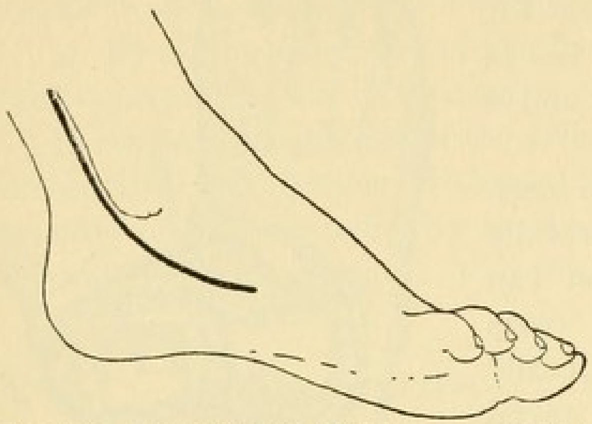


FIG. 832. LAUENSTEIN'S METHOD OF OPENING ANKLE JOINT

The skin is dissected off in front and behind, the fascia at the anterior border of the fibula is divided, the ankle joint is opened in front of the external malleolus. After elevation of the extensor tendons, the ligamentum cruciatum is divided, and the anterior capsular insertion is detached as far as and over the middle of the tibia.

Next, the fascia is divided on the posterior border of the fibula, and the sheath of the peroneal tendons, which, together with the other muscles, is drawn backward with a blunt retractor. If next the talofibular and calcaneofibular ligaments are divided, the surfaces of the ankle joint can be conveniently separated by strong supination, and all visibly diseased parts of the joint can be removed. *Kocher* uses recently a similar incision.

Hueter exposed the ankle joint **by an anterior transverse incision** from one malleolus to the other (Fig. 833), whereby all tendons and nerves are divided; at the end of the operation, these are united by sutures. This method, it is true, affords a very good survey of the diseased articulation, *especially of the astragalus*, but it produces very considerable accessory injuries, which are avoided by making lateral incisions.

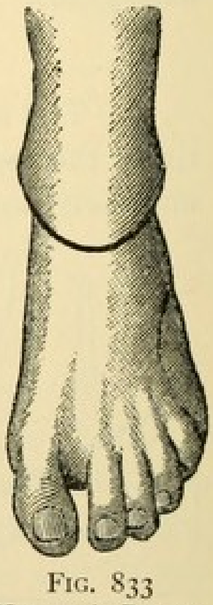


FIG. 833 HUETER'S RESECTION OF ANKLE JOINT

RESECTION OF THE ASTRAGALUS

can be made by one of the incisions for resection of the ankle joint; it is simpler and more conservative, however, if the astragalus alone is to be extirpated, to make

VOGT'S ANTERIOR LONGITUDINAL INCISION

over the ankle joint parallel with the extensor tendons as far as the astragalonavicular articulation (see Fig. 822).

1. Subcutaneous cellular tissue, fascia, and crucial ligament are divided; the extensor tendons, separated in a bundle, are elevated and drawn forcibly toward the median line; the extensor brevis digitorum is incised and retracted.

2. After division of the capsule and detachment of the insertions of the ligament, the neck and head of the astragalus are exposed by a transverse division of the astragalonavicular ligament.

3. A transverse incision is now made from the longitudinal incision, extending to the tip of the external malleolus, and the soft parts are divided in layers down to the astragalus without injuring the peroneal muscles.

4. After division of the anterior and posterior astragalofibular ligament and the ligaments of the sinus tarsi, with the foot strongly supinated, the astragalus can be turned very much outward by traction with resection forceps, and after detaching the internal lateral ligament and the connection with the os calcis, it can be removed.

5. After disarticulation of the bone all diseased portions can be inspected and removed from the articular cavity; the wound of the skin is sutured, and since the articulation of the os calcis very well fits into the bifurcated upper articular surface of the joint, the patient subsequently walks very well in spite of the missing astragalus.

RESECTION OF THE OS CALCIS

BY OLLIER'S EXTERNAL ANGULAR INCISION

1. The incision extends from the external border of the tendon of Achilles, beginning 2 centimeters above the external malleolus, down to the inferior margin of the os calcis, and, turning from here at a right angle, forward along the inferior border of the os calcis as far as the base of the metatarsus (Fig. 834).

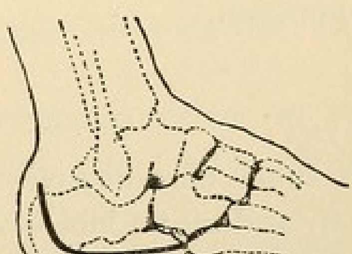


FIG. 834. OLLIER'S RESECTION OF THE OS CALCIS

2. Under protection of the peroneal tendons the incision is extended everywhere through the periosteum down to the bone; then the soft parts are elevated everywhere on its outer, lower, posterior, and inner surfaces. Next, the connection of the bone with the cuboid and astragalus is divided, and finally the ligamentous connection with the scaphoid and the cuboid bone.

3. The wound of the skin can be sutured in its whole extent. A drainage tube is inserted in its most dependent angle or into a buttonhole cut expressly for this purpose.

GUÉRIN'S SPUR INCISION

encircles first the plantar surface of the heel in the form of a curve; a small vertical incision extends from the transverse incision in the median line and ascends over the tendon of Achilles (Fig. 835).

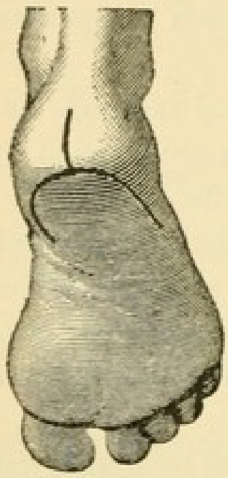


FIG. 835. GUÉRIN'S SPUR INCISION

Kocher excises the os calcis from a similar incision, which extends from the tuberosity of the fifth metatarsal bone parallel to the plantar surface around the heel and extending upward on the inner side in the form of a right angle along the internal border of the tendon of Achilles (Fig. 836). *Landerer* makes a *posterior median incision* from the tendon of Achilles across the heel into the plantar surface. On the whole, the procedure is the same as described on the preceding page.

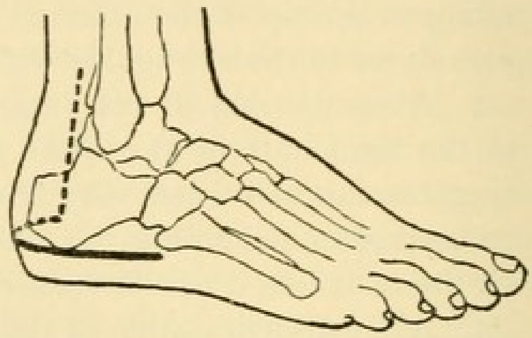


FIG. 836. KOCHER'S RESECTION OF THE OS CALCIS

In inflammations and in necroses it is rather easy to detach the periosteum everywhere; but if the operation is performed for tubercular foci it is simpler and just as useful to scrape out thoroughly with the sharp spoon the spongy softened bone tissue, and to leave in position only a thin cortical layer together with the periosteum. The success of this operation is very good if the whole cavity is allowed to be filled with blood at the end of the operation.

TARSECTOMY

RESECTION OF THE REMAINING TARSAL BONES

in tubercular diseases. This must be made in an entirely atypical manner, and by an incision which affords free access to the diseased bones and ligaments; it must aim at the complete removal of every vestige of disease.

Bardenheuer proceeds as follows: *A transverse incision* across the dorsum divides all soft parts and tendons down to the bone. The tendons, however, leading to the great toe can be saved in most cases. After the bones have been sufficiently cleared, they are divided transversely in front and behind the diseased part, together with the periosteum, with the saw or with the hammer and chisel, and detached from the soft parts of the plantar surface. Any remaining *articular surfaces* must be vivified to expedite the healing process. The large wound is then packed with iodoform gauze; the resected surfaces are brought in contact later, or the external wound is at once sutured, and the bone surfaces are held firmly pressed against each other by the dressing. After healing has taken place, it is true the foot is somewhat shorter, but very well adapted to walking (see also Fig. 704).

The posterior parts of the tarsus can be made accessible also by a median incision, according to *Landerer*. *Obalinski* forms a way *from before* by *splitting* the part of the foot in front of Chopart's joint between the third and fourth metatarsus and by extending the two halves.

OSTEOPLASTIC RESECTION AT THE TARSUS

ACCORDING TO MICULICZ-WLADIMIROFF

In extensive injuries of the posterior part of the tarsus as far as the ankle joint, as well as in large defects or ulcers of the skin on the dorsum of the foot, the anterior part of the foot can be saved by this operation, and union between the resected bones is secured in talipes equinus position, so that the patient can walk on the heads of the metatarsal bones. It is made in the following manner:—

1. A transverse incision, beginning at the internal border of the foot in front of the tuberosity of the scaphoid bone, and ending at the external border behind the tuberosity of the fifth metatarsal bone, divides the soft parts of the plantar surface down to the bone (Fig. 837).

2. A second transverse incision made above the os calcis from the posterior border of the internal malleolus to the posterior border of the external malleolus divides the tendon of Achilles, together with the other soft parts, on a level with the tibiotarsal articulation.

3. The ends of these two transverse incisions are connected by two incisions extending on both sides obliquely from behind, above, forward, and downward, penetrating directly down to the bone.

4. With the foot in the hyperextended position the posterior portion of the capsule and the lateral ligaments of the tibiotarsal articulation are divided.

5. The astragalus and os calcis are carefully freed from the soft parts of the dorsum of the foot, and disarticulated at Chopart's joint.

6. The malleoli, with the articular surface of the tibia, and subsequently also the articular surfaces of the scaphoid and cuboid bones, are sawed off (Fig. 838).

7. All divided vessels, especially the posterior tibial artery and the peripheral ends of the external and the internal plantar arteries, are carefully ligated.

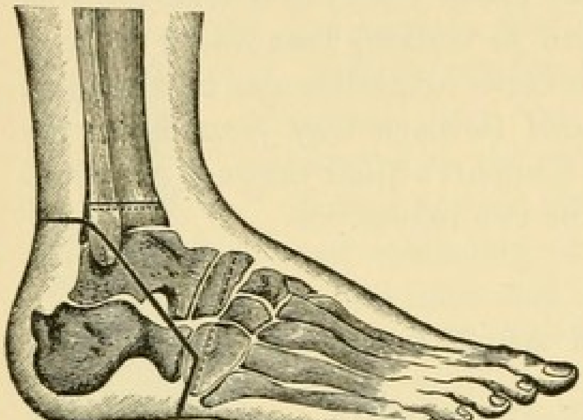


Fig. 837

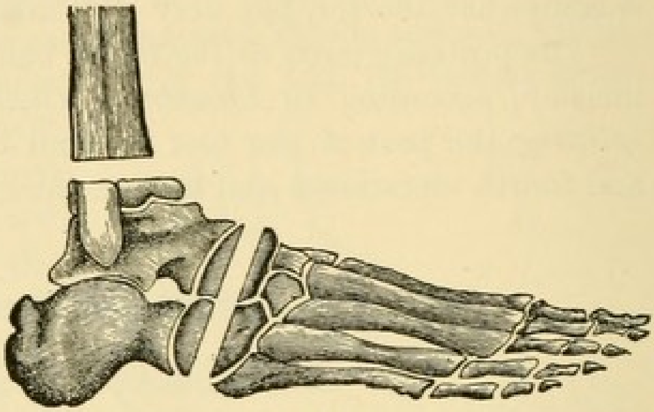


Fig. 838

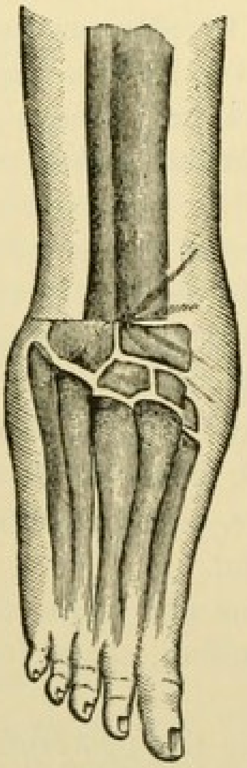


Fig. 839

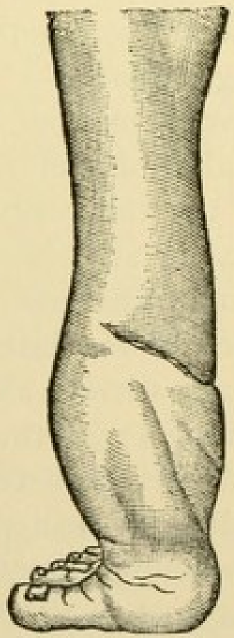


Fig. 840

Mikulicz-Wladimiroff's Osteoplastic Resection of the Astragalus

8. The foot is placed in a strong equinus position, the sawed surfaces of the cuboid and scaphoid bones are brought in contact with the resected surfaces of the bones of the leg, to which they are fastened, either at once with strong catgut sutures, or after the union of the wound, by long steel nails driven in obliquely (Fig. 839).

9. The tendons of the plantar flexors are divided subcutaneously, so that the toes can be placed in rectangular dorsal flexion.

10. With deep catgut sutures the abundant soft parts of the dorsal surface are brought together in folds, and next the margins of the wound are united by superficial sutures, leaving sufficient space for drainage. Figure 840 shows the appearance of the stump.

If the surgeon desires to make this extensive tarsectomy on account of disease of the tarsus (the skin being healthy), then the skin of the heel need not be sacrificed, if a long external curved incision is made, from which all parts can be made accessible.

OPERATIONS FOR CLUBFOOT

The treatment for clubfoot by *mechanical appliances* requires perseverance and conscientiousness, as well on the part of the surgeon as on that of the patient. Mild cases can be improved gradually during the first years of life by applying *splints* (*Little*, *König's* plastic splints). Under some circumstances the deformity must be *forcibly* corrected by compressing the bones on the outer side, and by lacerating the ligaments or bone insertions on the inner side of the foot. This is done by a forcible pronation (lowering of the internal border of the foot), followed by dorsal flexion and abduction. The foot yields with a distinct cracking noise. With the foot held in the corrected position, a plastic splint is applied for 2 to 3 weeks. This treatment is essentially aided by massage and active and passive movements. In some cases it is necessary to perform *tenotomy of the tendon of Achilles and of the supinators*. In the great majority of cases, with some patience and repetition of this procedure, even in difficult cases, success may be obtained. Concerning Tenotomy according to *Phelps* see page 292. In chronic or recurrent clubfoot of adults, the surgeon, however, is often obliged to attack the bone itself: by the simple or cuneiform osteotomy on the external side of the tarsus, osteotomy of the tibia and fibula above the ankle joint (see page 308), extirpation of the astragalus (see page 428), or of the cuboid bone, or of several tarsal bones.

Prince made **cuneiform excision of the tarsus** (**tarsectomy**) through a transverse T-incision over the most prominent part on the external side. The soft parts are divided down to the bone, and close to the retracted margins of skin a straight chisel is driven obliquely through the ankle joint toward the interior side, so that, after removal of the wedge-shaped piece of bone, the front part of the foot can be placed in the normal (abducted) position (Fig. 841).

Phelps obtained the same result in an opposite manner by dividing all tense resisting structures at the *internal border and plantar side of the foot.* (Phelps insists that all resisting structures should be divided until the foot can be brought in proper position. He does not hesitate to cut nerves and blood vessels in the line of incision, or to open the tarsal joints.)

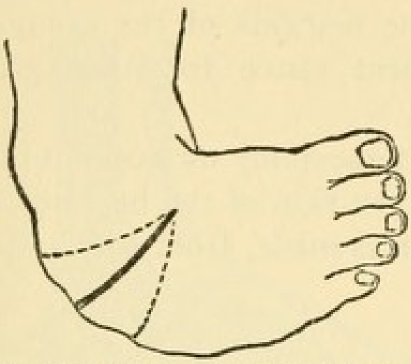


Fig. 841. Cuneiform Tarsectomy

1. After a previous tenotomy of the tendon of Achilles, a transverse incision is made at the internal border of the foot, parallel to the astragalo-navicular articulation.

2. Division of the plantar fascia, of the flexor longus digitorum, of the flexor longus hallucis, of the abductor hallucis, and if necessary of the flexor brevis digitorum pedis. These are drawn forward one after the other with a strabismus hook and divided (Fig. 512).

3. Sometimes the division of the deltoid ligament and the chiselling through of the neck of the astragalus are necessary.

4. The foot is placed in its normal position; the wide gaping wound is tamponed; and immediately a plaster of paris dressing is applied, under which the wound must heal by granulation with a broad cicatrix.

During the after treatment passive movements and massage are made daily, and the foot is kept in its corrected position by strips of adhesive plaster, subsequently by a rubber tube.

OPERATIONS FOR FLATFOOT

In flatfoot good results are obtained by restoring the arch of the foot to normal by manual force, and by fixing the foot in the corrected position by removable plastic dressings, followed by passive motion and massage. It is absolutely necessary that patients treated in this manner should wear shoes or boots, the inner margin of the sole of which has been raised, and are supported by a metallic sole which supports the feeble plantar arch. In the wearing of common shoes, this can also be effected by *inserting layers of soft rubber.* In aggravated cases, *Trendelenburg's* supramalleolar **osteotomy** (page 146), or

OGSTON'S ARTHRODESIS OF THE ASTRAGALONAVICULAR ARTICULATION

is indicated.

1. The foot is placed upon the external side, and the articulation between the astragalus and the scaphoid bone is located. It lies a little farther in front than in the normal foot.

2. The external incision is made parallel to the plantar surface, beginning at the inner side, 3 centimeters in length and a finger's breadth below the tibia down to the bone.

3. From the gaping articulation, the astragalonavicular ligament, together with the capsule of the soft parts, is detached from the scaphoid bone and turned downward.

4. With a small flat gouge, the cartilage and the thin layer of bone are cut off from the two articular surfaces, until the surfaces in a normal position of the foot can be brought in accurate contact; in old cases, the lower eminence of the astragalus must also be removed.

5. With a fine drill, two perforations are made from the scaphoid bone into the astragalus about 2 to 3 centimeters deep, the first penetrating on the upper and inner side, the second on the lower internal side of the scaphoid bone.

Two ivory pegs of the thickness of ivory knitting needles are driven into these perforations. The projecting ends of the pegs are nipped off with the bone-cutting forceps, and the wound sutured over them.

To secure firm, bony consolidation between the bone surfaces it is necessary to confine the patient to bed from 3 to 4 months.

RESECTION OF THE KNEE JOINT

BY TEXTOR'S ANTERIOR CURVED INCISION

1. With the knee flexed at a right angle, an incision (Fig. 842) is made from the posterior border of one epicondyle to the other in a curve extending to the tuberosity of the tibia, dividing directly the ligament of the patella and the anterior wall of the capsule of the joint.

2. Under increased flexion of the leg, the two lateral ligaments and next the crucial ligaments (Fig. 843) are cut off from the femur; the joint is then opened widely.

3. By careful incisions always directed toward the bone, the posterior capsular wall is detached from the femur (Fig. 844). By incisions made care-

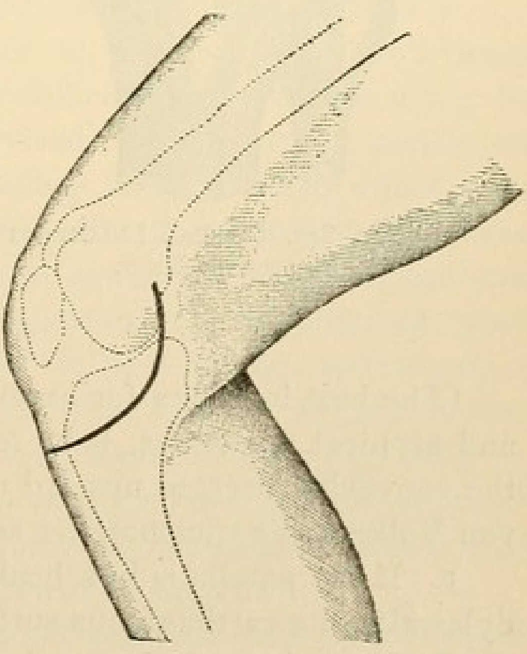


FIG. 842. TEXTOR'S RESECTION OF THE KNEE JOINT

lessly in a backward direction, the large blood vessels in the popliteal space may be injured.

4. The articular surface of the femur is forced forward, and, as far as it is covered by cartilage, sawed off parallel to its articular surface.

5. In the same manner the articular end of the tibia is sawed off without injuring the fibular articulation, which, as a rule, has no connection with the knee joint.

6. The patella is detached and cut off from the extensor tendon. The upper recess of the synovial sac (bursa extensorum) must be carefully dissected out, if diseased.

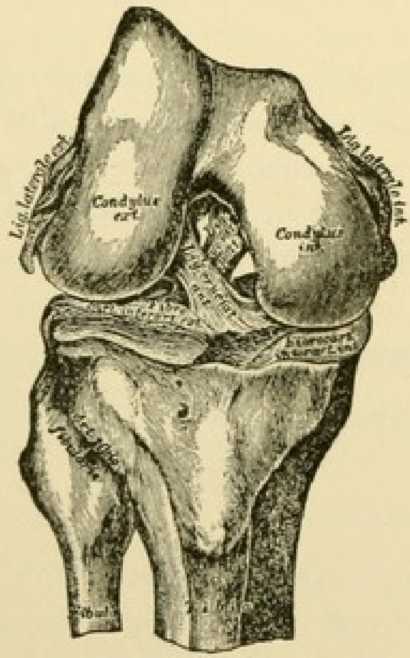


FIG. 843. CRUCIAL LIGAMENTS OF THE KNEE

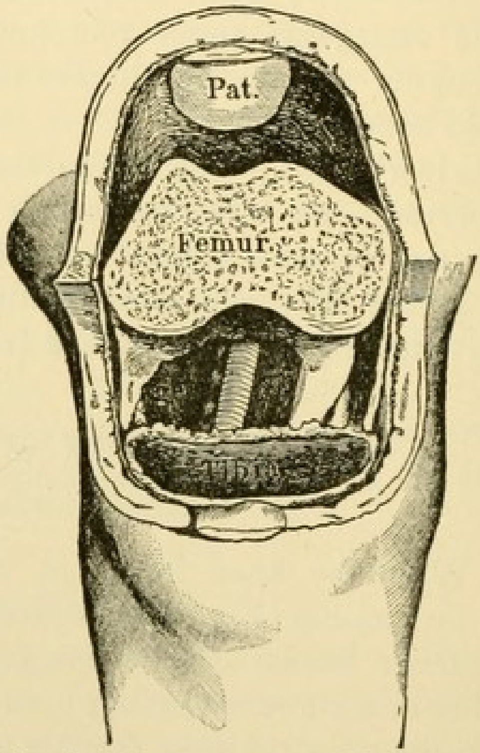


FIG. 844. POSITION OF THE POPLITEAL ARTERY AND VEIN BEHIND THE SURFACE OF THE WOUND

(The best incisions for exposing the knee joint for arthrectomy, typical and atypical resections, is by making Hahn's curved external incision with the convexity directed upward reaching the upper border of the patella and von Volkmann's transpatellar section.)

7. If the patella is in a healthy condition it can be nailed upon the condyles after its cartilaginous surface has been sawed off.

8. Since, in typical resection of the knee joint, it is of prime importance to secure bony consolidation with the limb in a useful position, the sawed

surfaces of the bone must be coaptated accurately upon each other, in which position they must be properly immobilized.

9. For this purpose, with a fine *bone drill* (Fig. 567), with a perforation at the point, both bone ends can be perforated obliquely at several corresponding places, and strong catgut ligatures or silver wire can be drawn through the perforations with the drill, with which the bone ends are approximated and held in proper position.

10. According to Hahn, it is preferable to nail the bone ends, by inserting, after the union of the wound and before applying the dressing, long nickel-plated or silver-plated *steel nails* (Fig. 571) (of which various sizes must be on hand) on both sides of the femur through the skin and by driving them obliquely through both bones with the hammer (Fig. 845).

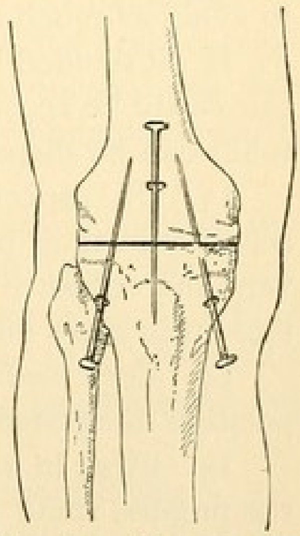


Fig. 845. Nailing the Resected Knee

(Direct fixation of the resected ends by suturing, or bone or metallic nails, is seldom necessary if the wound is closed by buried and superficial sutures and a proper fixation dressing is applied.)

11. If the wound heals by primary intention, bony consolidation is firm where the dressings are removed in the fourth or fifth week; the nails, having become loose in the meantime, can be extracted by slight rotary movements without great difficulty, and the small punctured openings heal in a few days.

Especial care must be bestowed upon the *sawing* and *coaptation* of the bone ends, as mentioned above. In order to secure a firm anchylosis, various methods (described on page 146) of using the saw have been devised. The *straight* sawing off with subsequent nailing in most cases offers good prospects of success. But if, according to *Kocher*, the articular ends are sawed off with a small saw in a *light curve*, the nailing can be obviated, since a lateral dislocation is less to be apprehended. *Helferich*, likewise, in resections for angular anchylosis, sawed out a *curve-shaped* wedge (Fig. 846).

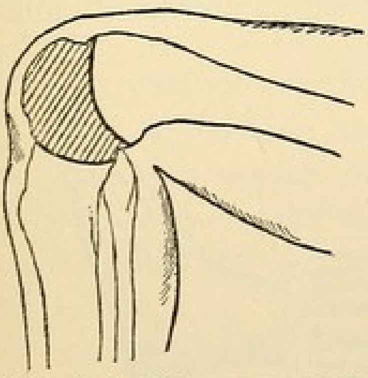


Fig. 846. Helferich's Method of Sawing out a Curve-shaped Wedge

(The first one to suggest and practise concavo-convex section of the articular ends in resection of the knee joint was Professor Fenwick, of Montreal, Canada.)

(The step bone section and impaction of the resected ends are not applicable to this joint, as they require too much loss of healthy bone tissue.)

If the sawed surfaces are of unequal size, the *posterior* edges must be fitted to each other, because a projecting sharp bone edge in the popliteal space might cause erosion (wearing away) of the popliteal vessels.

12. For *drainage* of the resected knee joint, two short drainage tubes should be inserted, one on each side, into the angle of the wound, and a third tube, which is introduced in front into the eminence of the bursa extensorum (upper synovial recess).

By the use of deep (buried) catgut sutures, which are applied before the closure of the external wound at various places, the operator endeavors to avoid as much as possible dead spaces in the depth of the wound.

If all divided blood vessels, which, in a careful and bloodless operation, can easily be recognized as such, have been most carefully ligated, drainage tubes can be dispensed with and *the angles of the wound can be left to gape.*

13. Of especial importance are **the dressings**, which hold the bones securely in their position, compress the wound equally on all sides, and prevent the entrance of bacteria. When they fulfil these indications they can remain in *place* until the wound has healed, from 5 to 6 weeks.

14. Very useful is a *pad dressing* (see page 43), which is applied in the position illustrated in Fig. 44, as follows: —

15. First, in all places where the soft parts can be deeply depressed with the fingers, small pads or gauze compresses are applied, and over them a moderately large cushion, encircling on all sides the whole region of the knee joint.

Below the dressing, the leg is enveloped with aseptic cotton as far as the malleoli, and above as far as the elastic constrictor at the base of the thigh; the dressing and the cotton are then firmly bandaged with a sterilized gauze bandage.

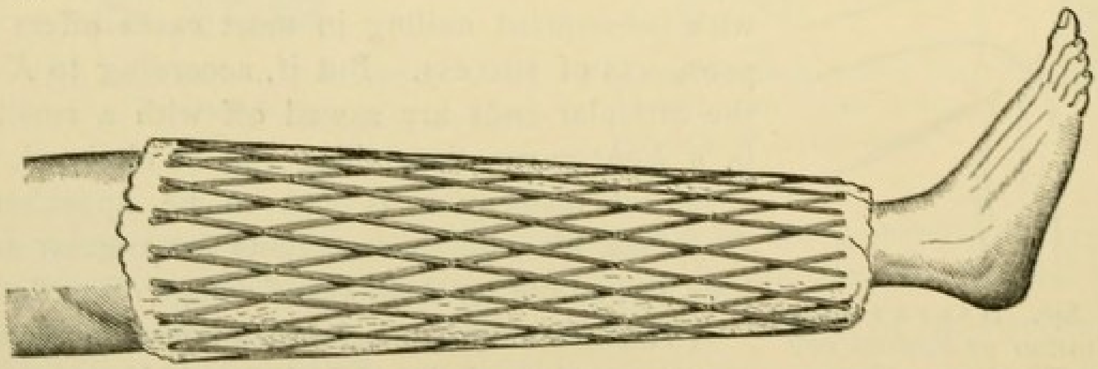


Fig. 847. Flower-pot Trellis as a Splint applied after Resection of the Knee Joint

16. Over this inner dressing, a well-disinfected flower-pot trellis is applied (Fig. 847), and fastened upon it with gauze bandages. This gives such firm-

ness to the dressings that the limb can be raised at the heel without affecting the position of the resected bones.

17. Over this, a large external cushion is applied, encircling the whole internal dressing, and is fastened with moist starched muslin bandages.

18. Next, the limb is very carefully placed upon a flat splint (see Figs. 155, 160, 163, 222), on which the padding must be so distributed that the parts not bandaged are well supported, and especially in a way that does not subject the heel to harmful pressure; it is then fastened with moist muslin bandages, after the constrictor has been removed.

19. At the same time, the leg is raised perpendicularly to diminish the blood supply at the seat of operation, and after the patient has been carried to his bed, the elevated position is maintained for several hours. By due attention to details the loss of any considerable quantity of blood can nearly always be prevented (compare pages 232–233).

If, however, the bleeding vessels have not been carefully ligated, the blood which oozes out may, several hours after the extremity has been lowered, penetrate the dressings and appear at the posterior surface. (This can be seen at once in fenestrated wire splints (Figs. 160, 164), while with tin splints (Fig. 155) it does not become visible until it has reached the superior posterior border of the splint.)

In such a case, the outer dressing must be changed without delay.

After division of the outermost bandage, the leg is lifted out of the splint; the external large cushion is removed and replaced by a new one, and the limb is again placed on the repadded splint.

(In such cases the advantage of the inner wire splint is especially obvious, since it enables a change of dressing without causing pain to the patient and without changing the relative positions of the resected bones.)

In cases where, aside from a disease of the bones, an extensive capsule of the joint is extensively involved, especially the bursa extensorum, it is advisable to make the resection by

E. HAHN'S CURVED INCISION

with the convexity directed upward.

The incision extends from the inner side of the line of articulation in a curve upward, divides the tendon of the quadriceps above the patella, and ends at the outer border of the line of the joint (Fig. 848).

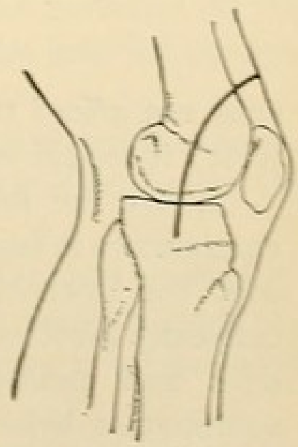


Fig. 848
Hahn's Curved Incision for Resecting the Knee Joint

The *upper recess* of the articular capsule is directly exposed after the flap has been turned down, and can be extirpated with ease. It is advisable to proceed here as carefully as in the extirpation of a malignant tumor, and to enucleate the capsule from its surrounding parts, if possible, " in toto."

To *protect* the tendinous *extension apparatus* of the knee, after the division of which a perfect union rarely occurs, it is advisable, more especially in children, to expose the articulation by

VON VOLKMANN'S TRANSVERSE INCISION THROUGH THE PATELLA

1. The incision extends transversely from the anterior surface of one epicondyle across the centre of the patella to the other, and opens the articulation on both sides of the patella, which is at once sawed or cut through upon the forefinger placed under it; its halves are drawn upward and downward with retractors.

2. After division of the lateral and crucial ligaments, the articular end of the femur is sawed off; next, the articular surface of the tibia is forced forward into the wound, then cut around with a strong scalpel and resected.

At the completion of the operation, the bone surfaces are placed in apposition, and the patella fragments are united with catgut. In 14 days they are firmly united. In more extensive resections and in diffuse infiltration of the soft parts, it is necessary to make on both sides of the transverse incision two small longitudinal incisions (|—| incision).

VON LANGENBECK'S SUBPERIOSTEAL RESECTION

BY A CURVED LATERAL INCISION

does not afford the same advantages of inspecting the interior of the knee joint; it should be made use of only in *injuries* of the joint.

1. On the *inner side* of the extended joint, a *curved incision*, 15 to 18 centimeters in length, is made, beginning 5 to 6 centimeters above the patella over the internal margin of the rectus femoris muscle, extending with its convexity directed backward over the posterior border of the internal epicondyle, and ending at the internal side of the crest of the tibia 5 to 6 centimeters below the patella (Fig. 849).

2. In the upper part of the wound lies the vastus internus, under which the tendon of the abductor magnus presents itself; in the lower part, the tendon of the sartorius muscle is visible; neither of these tendons must be injured (Fig. 850).

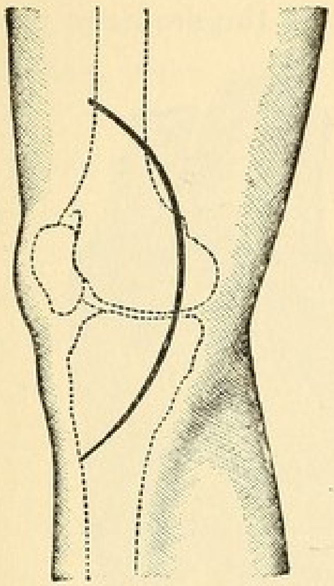


Fig. 849

Von Langenbeck's Curved Incision for Resection of the Knee Joint

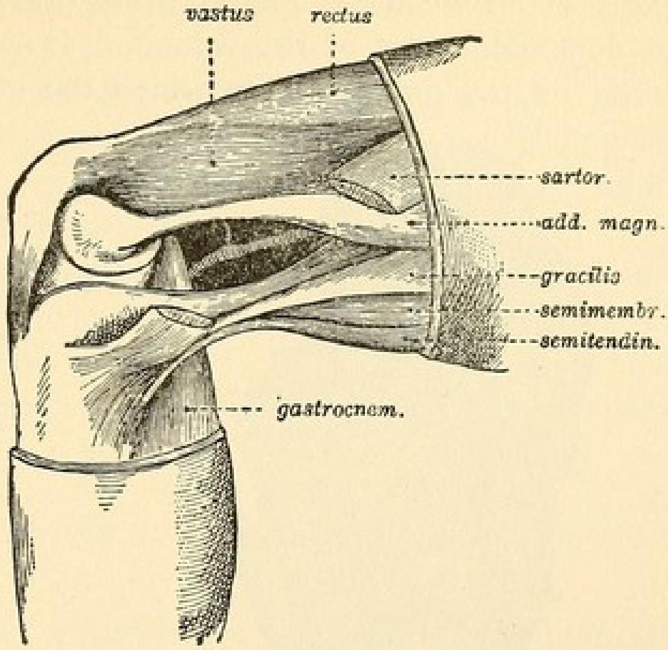


Fig. 850

Interior Side of the Knee Joint

3. The internal lateral ligament is divided in the line of the joint; the internal capsular insertion is detached from the anterior border of the internal condyle as far as and beneath the vastus internus; likewise the internal alar ligament, from the anterior border of the tibia to the median line (Fig. 851).

4. The knee is flexed; and while it is slowly extended, the patella is dislocated outward by strong direct pressure.

5. The crucial ligaments are divided; in detaching the posterior crucial ligament from the intercondyloid eminence of the tibia, the internal condyle must be rotated forward.

6. The external lateral ligament, together with the neighboring capsular portions, is detached by a semilunar incision, made a few lines below the epicondyle of the external condyle (Fig. 852).

7. The articulation gapes widely; the posterior capsular wall is divided; the articular ends of the femur and the tibia are brought forward from the wound one after the other, and as much as appears necessary is excised with the saw.

8. If the patella is to be removed, the border of its cartilaginous surface must be circumscribed with the knife, and then freed with the raspatory and the elevator from its periosteum, so that the latter remains in connection with the ligament of the patella and the extensor tendon.

Before the wound is united, a large drainage tube is inserted into the most dependent part of the wound. It is well to make a small counter opening on the outside, from which the other end of the drainage tube is

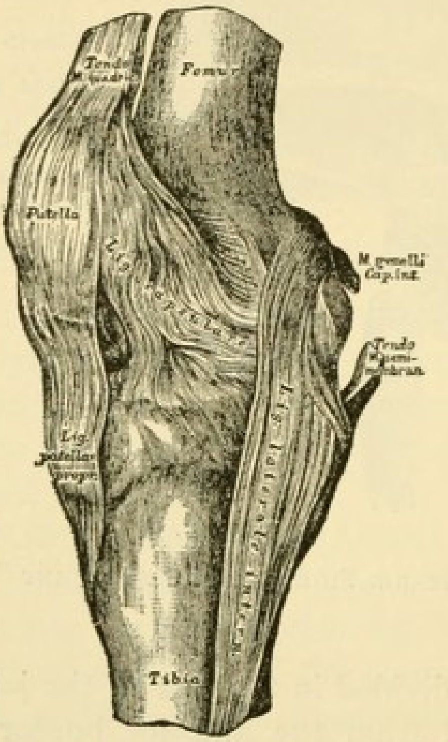


FIG. 851. LIGAMENTS OF THE RIGHT KNEE JOINT (Interior side)

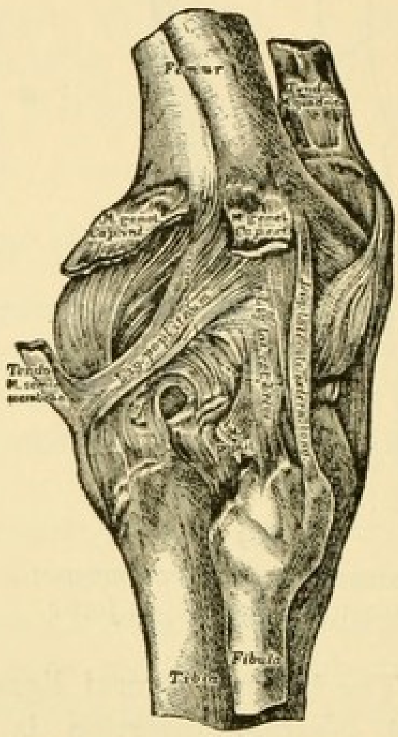


FIG. 852. LIGAMENTS OF THE RIGHT KNEE JOINT (Exterior side)

allowed to project, and to carry a drainage tube through the upper bursa of the articular capsule.

The knee joint is opened in a similar manner by

HUETER'S INTERNAL LONGITUDINAL INCISION

1. With a strong knife, the knee being extended, a longitudinal incision is made from the superior border of the inner condyle along the anterior border of the lateral ligament, across the head of the tibia, to the insertion of the sartorius muscle. The soft parts are divided down to the bone; a few fibres of the vastus internus muscle are divided in the upper angle of the wound.

2. The lateral internal ligament is divided by a transverse incision, and the articular capsule is thereby opened.

3. Next, the capsular insertion is detached from the anterior part of the internal condyle to the superior border of the articular surface with a probe-pointed knife, and the vastus internus is elevated from the bone.

4. After the internal alar ligament has been detached from the anterior border of the tibia, it is easy to dislocate the patella outward.

On the whole, the procedure is as described above on page 441, 4 to 8.

When, after the *extirpation of the capsule alone*, the bone being fairly healthy, there is hope of preserving a *movable* joint for the patient (**arthrectomy**, see also page 389), it is above all important to leave the *tendon of the quadriceps uninjured.* The transverse incision through the patella effects this only in part; hence, it is better to detach with the chisel the tuberosity of the tibia with the patellar ligament obliquely from below upward, to turn it upward, and finally to unite it again with the tibia. Bony union nearly always sets in in this place. Furthermore,

KOCHER'S EXTERIOR CURVED INCISION

is to be recommended.

1. External incision a hand's breadth above the patella, beginning at the vastus externus and extending vertically downward two fingers wide along the external margin of the patella in a flat curve to the spine of the tibia (Fig. 853).

2. Division of the fascia lata and the border of the vastus externus in the upper angle of the wound; in the lower angle the spine of the tibia is detached superficially with the chisel and reflected backward, together with the ligament patellæ.

3. Upon the external condyle the articular capsule is divided longitudinally, and thereby the bursa extensorum is opened.

4. Next, the external meniscus is detached from the crucial ligaments, and the articular capsule, together with the periosteum, is dissected off from the external condyle of the tibia.

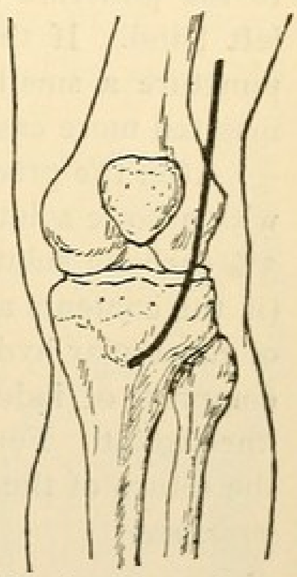


FIG. 853. KOCHER'S ARTHRECTOMY OF THE KNEE JOINT

5. On the internal condyle, the operator proceeds with the meniscus and the articular capsule in a like manner, while the patella is drawn laterally with sharp hooks, so that finally it can be inverted in an inward direction.

6. The knee is more and more flexed, the insertion of the crucial ligaments is detached on the tibial surface so that they remain in connection with the menisci.

7. The required operation can then be made. If, *a priori*, the bone appears to be diseased to a greater depth, the insertions of the ligaments

are chiselled off subcortically with one stroke and are reposed to the place where they are to be sawed off. If only a synovial arthrectomy is required, dissect off the articular capsule (if possible unopened) connectedly from femur, tibia, and patella.

8. Finally, the capsule is carefully sutured, if it can be preserved; the wound of the skin is closed by deep and superficial sutures; or the cavity of the wound is *packed* with iodoform gauze to be united later by secondary suturing 48 hours after the operation.

PUNCTURE OF THE KNEE JOINT

in serous or bloody extravasation (*hydrarthros and hemarthros*), is made at the superior border of the patella. On either side, a medium-sized trocar is inserted in such a direction that it comes to lie transversely between the patella and the condyles of the femur. With the left hand the effusion or extravasation from the superior bursa and on the side lying opposite to the puncture should be forced and pressed toward the canula by the left hand. If the skin is very thick, it is better to make at the point of puncture a small incision with the knife, in order that the trocar may be inserted more easily.

After the products of effusion have been removed, the joint is washed out with a boric solution until the escaping fluid is clear; next, an injection of 3% carbolic solution (in hydrarthros) is made, or a 1 °/₀₀ sublimate solution (if the contents are purulent) (or a 10% emulsion of iodoform if it is a case of tubercular hydrops). The puncture in the skin is then sealed with a small compress of iodoform gauze, and a compressive bandage is applied with a knee splint. For the purpose of increasing the pressure which is to prevent the return of the effusion, a rubber bandage is applied over it with *moderate pressure*.

DRAINAGE OF THE KNEE JOINT

1. In *pyarthrosis*, to be able thoroughly to irrigate the joint with antiseptic solutions and to secure free drainage for the accumulated pus, it is sufficient in milder cases to make incisions 2 to 3 centimeters long on *both sides* of the patella and to insert into them short drainage tubes, which are cut off at a level with the skin, and are kept in position by a suture or by a safety pin.

2. After the joint has been thoroughly washed out through these drainage tubes with sodium chloride solution and then with 1 °/₀₀ of sublimate solution, an efficient compressive antiseptic dressing is applied; this dressing, by equable continuous pressure, forces all secretions out of the joint into

the absorbent dressing; the limb is then immobilized in the same manner as after a resection.

3. When the temperature of the body is reduced to normal, and when the pain has subsided, the dressings can remain in place for several days; otherwise, the dressings must be changed every day, and the antiseptic irrigation must be repeated.

4. In more serious cases, the *upper recess* of the joint, the bursa extensorum, must be drained separately by incisions on both sides above the patella; and if the bursa has already been perforated, and the pus has penetrated beneath the quadriceps muscle, this part of the abscess cavity must also be drained by adequate incisions and the insertion of a large transverse tubular drain on a level with the upper limits of the deep-seated phlegmonous abscess.

RESECTION OF THE HIP JOINT

BY ANTHONY WHITE'S POSTERIOR CURVED INCISION (1818)

1. The patient is placed on his healthy side; the incision begins at the middle between the anterior superior spine of the ilium and the great trochanter. It is carried in a curve over the tip of the latter and about 5 centimeters downward along its posterior border (Fig. 854).

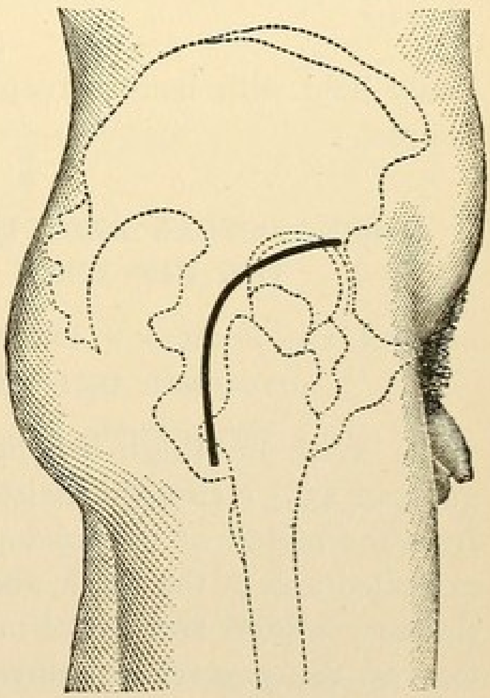


FIG. 854. RESECTION OF THE HIP JOINT (A. White's curved incision)

2. With a strong short knife, the tendinous insertions of the gluteus medius and minimus, of the obturators, of the pyriform and the quadratus femoris muscles (Fig. 855), are detached from the trochanter; and the muscular masses are drawn apart with retractors until the posterior superior surface of the neck of the femur and of the acetabulum is exposed.

3. A deep incision along the border of the cartilaginous limbus (border) of the acetabulum opens the joint; the femur is flexed and adducted; with a smacking noise, the head of the femur is twisted out from the acetabulum.

4. With a narrow knife, entered from behind outward into the acetabulum, the ligamentum teres is divided in the direction of its insertion into

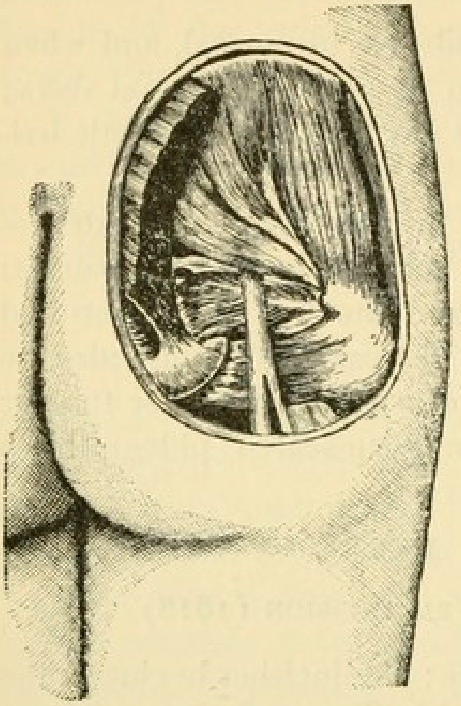


Fig. 855. Posterior Side of the Hip Joint, Muscles, and Sciatic Nerve

the head of the femur, and the latter is then delivered entirely from the acetabulum.

5. With a strip of zinc, placed behind the neck of the femur, the soft parts are retracted; the neck of the femur is sawed through with a metacarpal or chain saw, while the head of the femur is firmly held with bone forceps (Fig. 856). (See the following operation for the rest.)

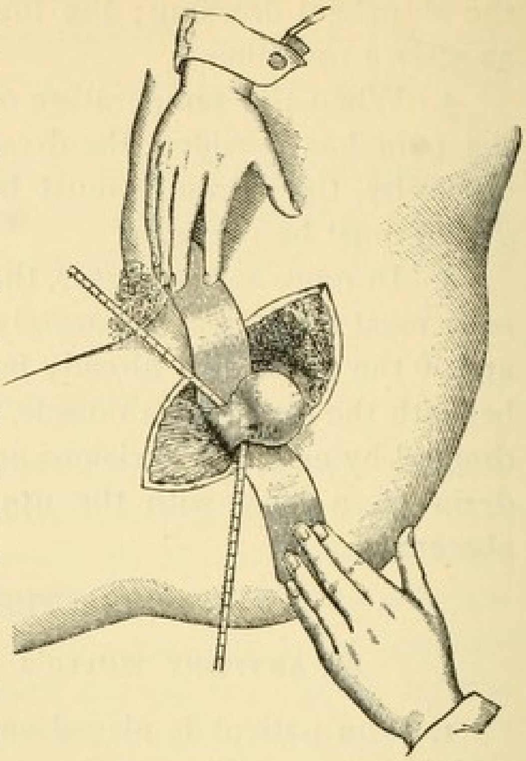


Fig. 856. Resection of Hip Joint. Sawing off head of femur with chain saw (Reflection of soft parts by a strip of tin)

SUBPERIOSTEAL RESECTION OF THE HIP JOINT

BY VON LANGENBECK'S EXTERNAL LONGITUDINAL INCISION

1. With the thigh half flexed (at an angle of 45°), a straight incision is made from the middle of the trochanter in the extended axis of the thigh, about 12 centimeters behind and above in the direction of the posterior superior spine of the ilium (Fig. 857).

(Temporary osteoplastic resection of the trochanter major should always be performed as a preliminary help to resection of the hip joint, as this part of

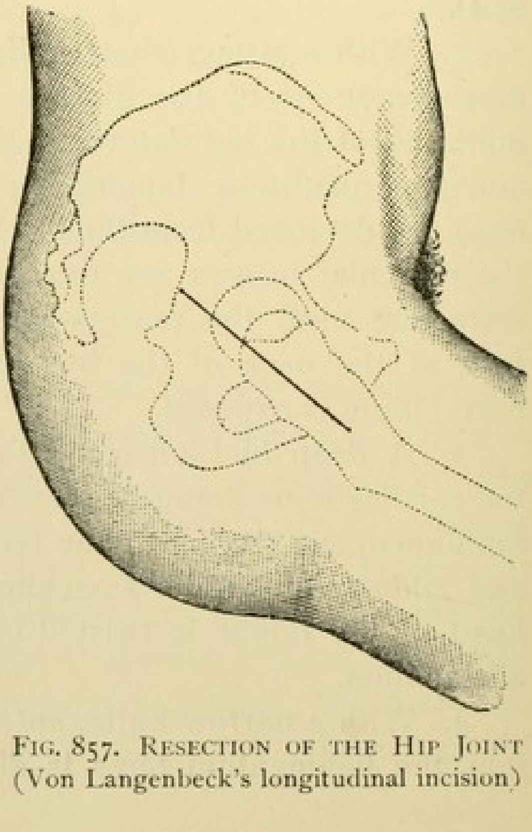


Fig. 857. Resection of the Hip Joint (Von Langenbeck's longitudinal incision)

the femur is seldom the seat of disease, and its preservation adds much to the functional result of the operation. After completion of the resection, it is united with the shaft of the femur by a number of buried heavy catgut sutures.)

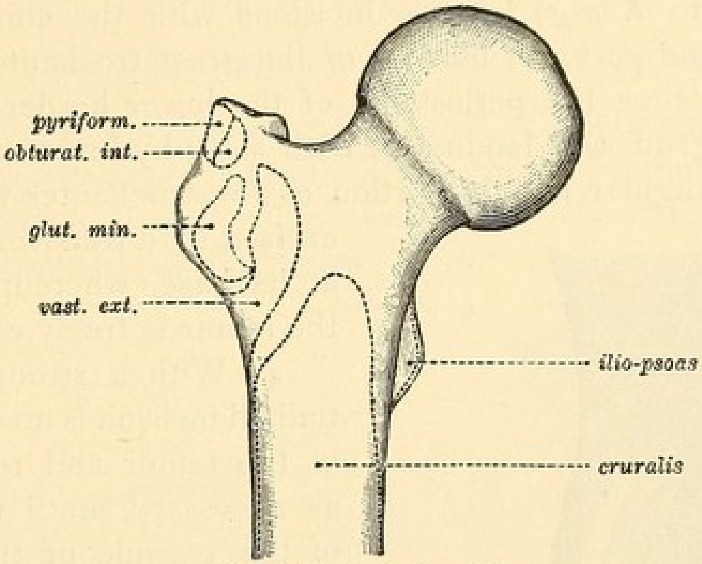


FIG. 858. Anterior side

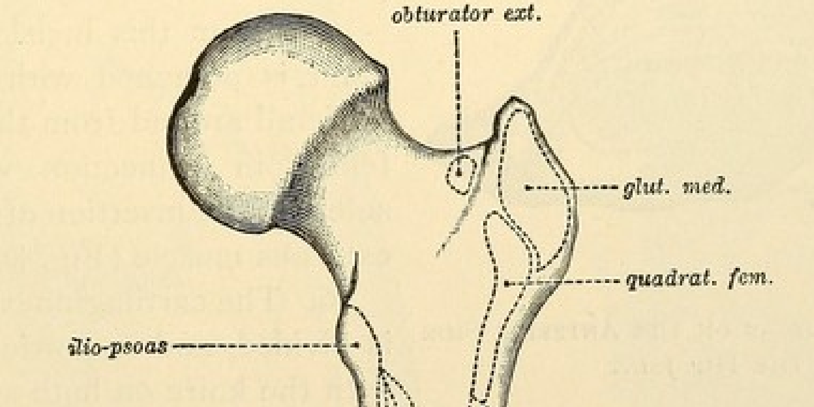


FIG. 859. Posterior side

INSERTIONS OF MUSCLES ON THE UPPER END OF THE RIGHT FEMUR

2. The incision penetrates between the bundles of fibres of the gluteus maximus muscle, and divides the femoral fascia and the periosteum of the trochanter.

3. While the margins of the wound are well retracted, all the muscles inserted on the trochanter (on the anterior surface, gluteus minimus, pyriform, obturator internus, and gemelli, Fig. 858; at the posterior surface,

gluteus medius and quadratus femoris, Fig. 859) are detached with the knife from the same; but their connection with the femoral fascia and the periosteum should be carefully preserved.

This tedious step of the operation can be greatly facilitated by detaching (according to *König*) by two incisions with the chisel the corticalis of the anterior and posterior borders of the great trochanter, without dividing at the same time the periosteum of the lower border of the incisions and by breaking off the lamina on both sides by lever movements of the chisel. The triangular middle portion of the trochanter which remains is excised by a transverse chisel section at its base, whereupon the neck of the femur is freely exposed.

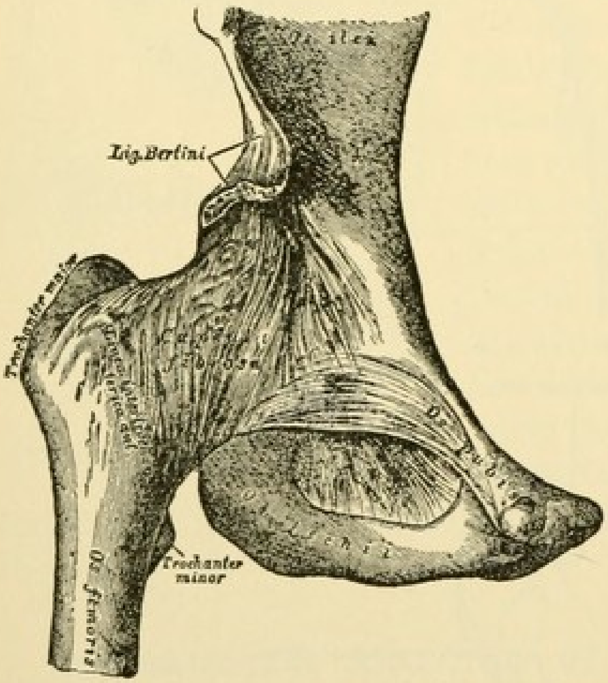


Fig. 860. Ligaments on the Anterior Side of the Hip Joint

4. With a strong knife a longitudinal incision is made upon the neck of the femur and repeated as often as necessary, until the tough fibres of the capsule of the joint and the periosteum are completely divided.

5. From this incision the periosteum is detached with elevator and knife all around from the neck of the femur, in connection with the capsule and the insertion of the obturator externus muscle (Fig. 860).

6. The cartilaginous labrum (rim) is divided, and a portion is removed with the knife on both sides.

7. The femur is then adducted and rotated inward, half of the head of the femur then escapes from the acetabulum with a smacking noise.

8. A long narrow knife is introduced into the acetabulum from behind and outward, and divides by an incision made inward and forward toward the head of the femur the tense ligamentum teres, whereupon the whole head of the femur is completely dislocated and can be sawed off as described above.

9. If the neck of the femur has been shot off, the head must be grasped and removed with the resection forceps or a sharp resection hook.

10. If the great trochanter is injured at the same time, a portion of it with the neck of the femur is removed by making the bone section obliquely.

11. After hemorrhage has been arrested, a large drainage tube is inserted

into the acetabulum, and fastened in the middle of the wound. The remaining part of the wound is closed by sutures. In operations for tuberculosis it is necessary to tampon the deep wound and aim at healing by granulation. In such cases the wound is closed only in part.

BY KOCHER'S POSTERIOR LONGITUDINAL INCISION

1. The incision extends from the base of the external surface of the great trochanter to the anterior border of the tip of the trochanter obliquely upward and forward, and then in the direction of the fibres of the gluteus maximus muscle upward and backward (Fig. 861, 2).

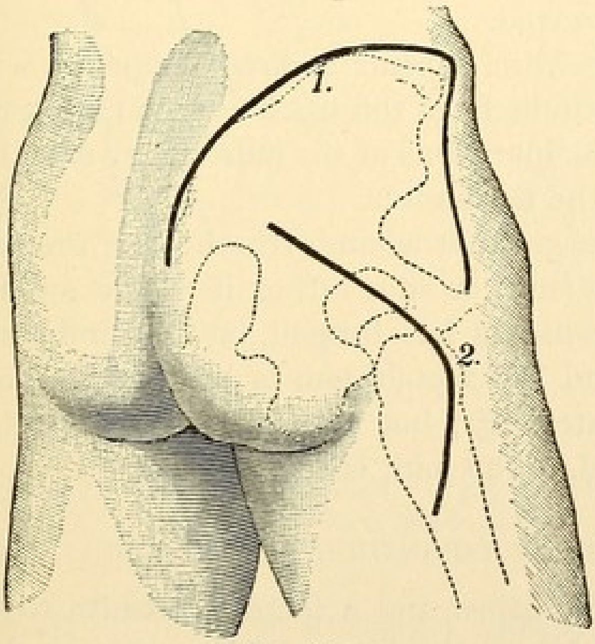
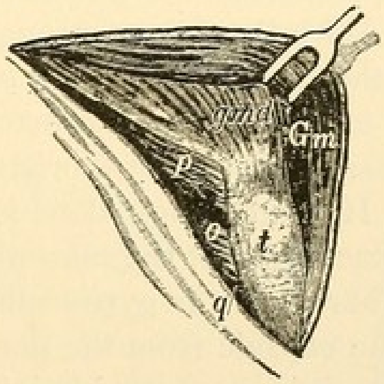


FIG. 861



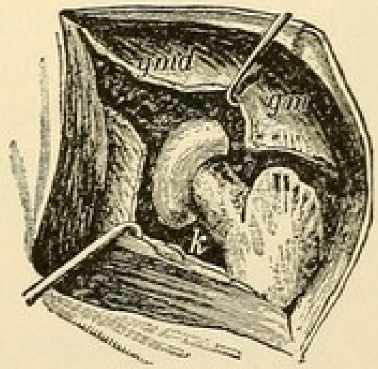


FIG. 862

KOCHER'S RESECTION OF THE HIP JOINT. 1, resection of the ilium; 2, resection of the hip joint

2. On the external surface of the great trochanter (*t*), the fascia of the gluteus maximus muscle is divided, and the periosteum, together with the insertion of the gluteus medius muscle, is exposed.

3. After division of the fibres of the gluteus maximus (*Gm*) and of the adipose layer under it, along the inferior border of the gluteus medius muscle (*gmd*), the superior border of the pyriform muscle (*p*) is reached. If the latter is drawn downward, the posterior surface of the capsule at the posterior acetabular rim is exposed; in front the gluteus medius is elevated

from the bone at the superior border of the tendon of the pyriform muscle, and the upper margin and external surface of the trochanter are cleared (Fig. 862).

4. Along the anterior border of the trochanter, the gluteus medius and minimus are drawn *forward;* at the internal surface, the pyriform, gemelli, the externus obturatur (*o*), and the periosteum are drawn together in a *posterior* direction.

5. After the whole posterior surface of the head, neck, and trochanter of the femur has been exposed, it is not difficult to dissect free the synovialis, as far as it is diseased, before it is opened, and to detach it from its insertion on the acetabulum and the neck of the femur.

6. With the femur strongly adducted after division of the ligamentum teres, the head is dislocated backward, when the cavity of the joint can be freely inspected and the extent of the disease ascertained. Every vestige of disease can now be thoroughly removed.

7. If arthrectomy alone is required, the capsule is directly opened without detaching first the muscular insertions from the trochanter (*k*) along the upper border of the pyriformis, and the insertions of the muscles are detached with the capsule from the neck and the trochanter.

If in *injuries* of the hip joint (from gunshot wounds) the head or the neck of the femur is comminuted from the front or shot off, or if at the anterior side of the suppurating hip joint an abscess has formed, or if in inflammation the femur alone is implicated and the acetabulum is healthy, the joint can be reached most conveniently anteriorly; but only a limited inspection of the whole joint is thereby obtained. The joint is exposed by

LÜCKE AND SCHEDE'S ANTERIOR LONGITUDINAL INCISION

1. The incision begins immediately below and a finger's breadth to the inner side of the anterior superior spine of the ilium, and is made straight downward for about 10 to 12 centimeters (Fig. 863).

2. The *internal* margin of the sartorius muscle and the rectus femoris is exposed and drawn outward.

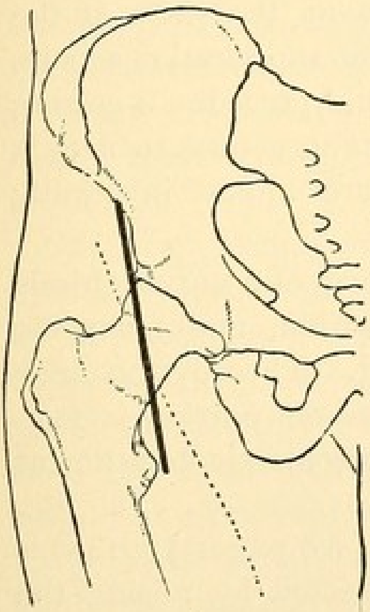
3. Advancing in the loose cellular tissue of the muscular interspace with the finger or forceps, the external border of the iliopsoas is found and drawn outward with a tenaculum.

4. If the leg is somewhat flexed, abducted, and rotated outward, the capsule is exposed.

5. The capsule is opened and incised upward and downward as far as possible with a probe-pointed knife.

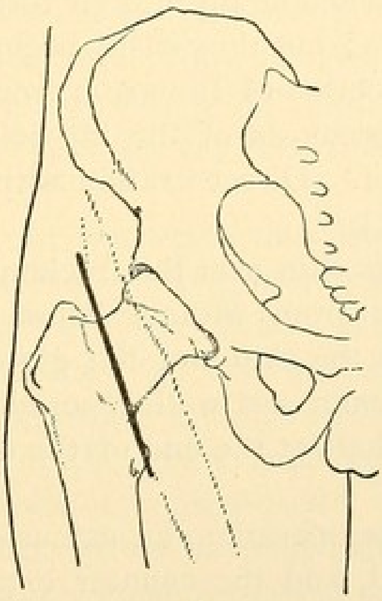
6. The neck of the femur is now isolated with the elevator, and sawed through with a metacarpal saw introduced upon the forefinger perpendicularly to the axis of the bone (from above and the outer side to below inward).

7. The cartilaginous limbus (rim) is divided by short, deep incisions upon the acetabular border, and the head of the femur is extracted with forceps or is lifted out with a spoon (*Löbker's* spoon elevator, Fig. 865), after the ligamentum teres has been divided.



a

Fig. 863



b

Fig. 864

Resection of the Hip Joint. *a*, according to Lücke and Schede; *b*, according to Hueter

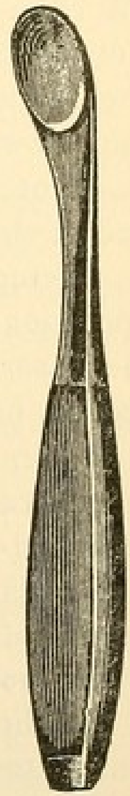


Fig. 865

Löbker's Spoon Elevator

BY HUETER'S ANTERIOR OBLIQUE INCISION

Hueter has modified the procedure just described, so as to make the incision from the middle of the anterior superior spine and the trochanter *obliquely* downward and inward, 10 to 15 centimeters along the *external border* of the sartorious muscle (Fig. 864).

The incision penetrates above directly down to the bone, whereby only the outermost fibres of the externus vastus are divided, but it is made more superficially in the inferior angle of the wound, to avoid the external circumflex artery which passes transversely and closely beneath the trochanter.

It is easier by this method than by the preceding one to remove at the same time the injured *trochanter*.

Drainage of the wound by these methods must be established from the cavity of the wound, as well as through counter openings over the middle of the gluteus maximus muscle, and on the inner side behind the adductors.

Tiling made the *longitudinal incision* over the anterior border of the trochanter, in order to preserve the insertions of the glutei muscles, chiselled off from this incision the trochanter in connection with the periosteum and the muscular insertions, and had them drawn backward; the capsule was then detached in front, and with the femur rotated outward the trochanter minor was chiselled off and the head of the femur dislocated. The detached trochanters are fastened again in their former position on the shaft at the end of the operation; but they easily become necrotic if suppuration sets in.

(Temporary resection of the great trochanter should precede all cutting operations for tuberculosis of the hip joint. It is unnecessary to detach the lesser trochanter. Direct fixation with catgut sutures almost invariably secures bony union.)

Ollier divides the skin over the trochanter in the form of a curve, chisels the latter obliquely from without below to above within, and turns the detached piece with the skin and the glutei backward. Thereby the neck and head of the femur are well exposed. The sawed-off portion is fastened again to the shaft at the end of the operation (**osteoplastic detachment of the trochanter**).

At the end of the operation, an extension dressing (see pages 50, 148) is immediately applied, and the counter extension is effected by raising the foot of the bed.

In the after treatment it is very important to secure the leg in *extension* and abduction to guard as well as possible against undue shortening and its result, descent of the pelvis on the same side. The extending force need not be especially great, since from too much traction a useless, loose, and freely movable joint may form, whereas only a very *moderate* motion of the new joint is desirable, which yields the best functional result. The sawed-off neck of the femur has also been firmly impacted into the vivified acetabulum, and thereby osseous anchylosis and a shorter period of healing have been effected.

In changing the dressings, the patient is placed upon a pelvic support, while the extension dressing remains in action; or, still better, *Hase-Beck's* apparatus for raising a patient in bed is used, if one is at hand.

As soon as the wound is healed, the patient is allowed to leave the bed and walk about with a plastic immobilization dressing (tutor), made of plaster of paris or starch.

(The best method of fixation after resection of the hip joint by any of the methods described is a fenestrated plaster of paris splint, including the whole limb and pelvis. The limb must be slightly abducted and rotated outward.)

ARTHROTOMY FOR CONGENITAL DISLOCATION OF THE HIP JOINT

Hoffa forms in children a new acetabulum in the following manner: —

1. After the joint has been opened by *von Langenbeck's* incision (Fig. 857), all soft parts are detached subperiosteally from the great trochanter until the operator succeeds, by flexion of the thigh and by direct pressure, in reducing the head of the femur into the old acetabulum (this is impossible before the opening of the articulation, on account of the strong muscular tension).

2. For *gradual* extension of the shortened muscles (biceps, semimembranosus, and semitendinosus) the femur which is flexed is slowly extended by an assistant; in young children this succeeds in a few minutes; in older children (after the sixth year) *tenotomy* of the tendons in the popliteal space, division of the fascia lata and of the muscles which have their origin from the anterior superior spine of the ilium, must be made in addition. Still, if at all possible, *all muscles should be preserved.*

3. With a sharp spoon (provided with a bayonet handle) the whole floor of the acetabulum, together with the connective tissue and the cartilage, is deeply excavated. The rim of the acetabulum must be carefully preserved.

4. The head of the femur, which sometimes is very much deformed, receives the desired shape, with knife and chisel, and then by strong traction with the hands, or else *Lorenz's* screw extension apparatus, can now be reduced with a clicking sound into the excavated acetabulum, and is kept in abduction position of the leg after the wound has been dressed (tamponade and suture) by a plaster of paris dressing.

In the *adult* it is advisable, according to *König*, to detach a periosteum bone-flap from the pelvis with a chisel, to turn it downward, and unite it with the capsule by sutures. The thigh, of course, must have been rendered movable by a preliminary extension treatment.

Aside from numerous good successes which *Hoffa*, *Lorenz*, and *Schede* had with this operation, sometimes very unpleasant consequences occur (ankylosis, laceration of nerves, etc.). Hence, more recently the bloodless reposition (*Lorenz*) is preferred, which, in children up to the sixth year, has met with very good success. In anæsthesia, the head of the femur is gradually brought down by screw traction until it catches into the acetabulum with a distinct dull sound (*reposition*). Next, the leg in strong abduction, outward rotation, and flexion, is fixated by a pelvic plaster of paris dressing (*retention*). After a few days, the child is allowed to walk in order that through the *functional weight* the head of the femur itself deepens the acetabulum. Only very gradually and carefully should the abduction position be decreased. Concerning the correct position of the head to the acetabulum, nowadays radioscopy gives the best information.

RESECTION OF THE ILIUM

for caries or necrosis is best made *through* a curved incision, extending along the pelvic border (Fig. 861, 1). The soft parts on the outer surface are detached subperiosteally from the ilium, and then as much as necessary is removed from the bone. From this incision also sequestra can be removed from the medullary cavity of the ilium by chiselling the external lamella of bone of the ilium along the crest and turning it downward, so that the medullary cavity is exposed for inspection (*Bier*). *Kocher* has resected even the entire half of the pelvis, together with the head of the femur. The total resection of the sacrum has likewise been attempted. Concerning the partial resection of this bone, for operations on the organs of the true pelvis, see page 780.

OPERATIONS ON THE HEAD

RESECTION OF THE VAULT OF THE CRANIUM

Partial resection of the skull may become necessary: —

1. **In injuries or diseases of the vault: —**

(*a*) For thoroughly cleansing *complicated fractures of the skull* and for disinfecting the cavity of the wound.

(*b*) For removing *depressed portions* of bone dangerous to life and for extracting *fragments of bone*, or *foreign bodies* that have entered the skull.

(*c*) For removing *tumors and sequestra* (*tubercular or syphilitic*) of the cranial vault.

2. **In diseases or injuries of the brain and its envelopes: —**

(*a*) For opening *abscesses*, *foci of cerebral softening*, and *sinus thromboses*.

(*b*) For removing *tumors*, *scar tissue*, and *foreign bodies*.

(*c*) For excising a field of the *cerebral cortex* in *Jacksonian* reflex epilepsy; for removing chronic intracranial *pressure* that is gradually increasing.

(*d*) For arresting *intracranial hemorrhages* — **ligation of the middle meningeal artery**, etc.

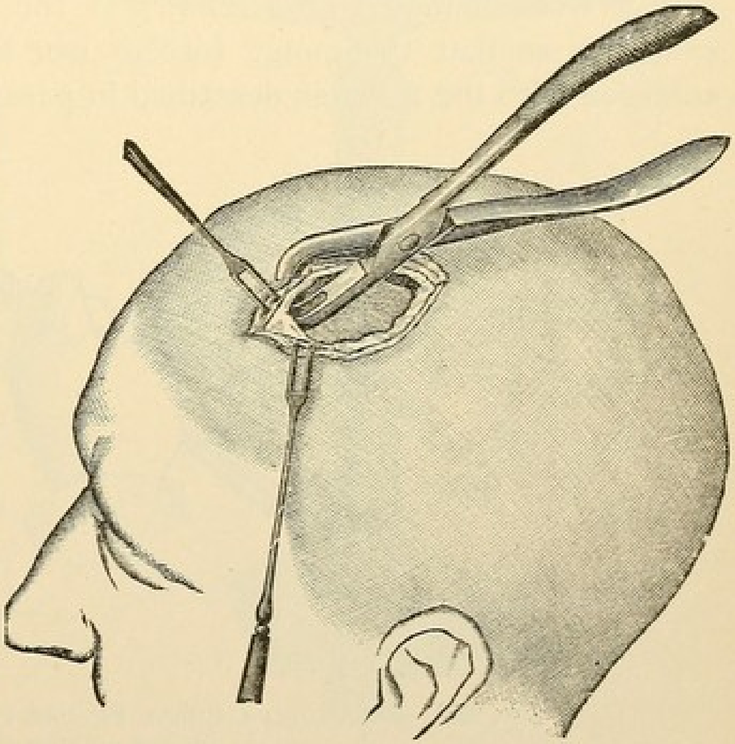


FIG. 866. NIPPING OFF THE OSSEOUS MARGIN OF A FRACTURE OF THE CRANIUM BY MEANS OF LÜER'S RONGEUR FORCEPS

1. In case of *fracture of the cranium*, when there is an outer opening smaller, as usual, than the depressed portion of bone, this opening must be enlarged in order that the fragment may be elevated and if necessary extracted.

This enlargement is best made by using *Lüer's gouge forceps* (Fig. 866) or *Hoffmann's rongeur forceps* (Fig. 867) in cases where the outer opening is just large enough for inserting one jaw of the forceps under the margin of the bone. By means of the forceps, small fragments are broken off from the margins of the defect, and thus the opening is readily enlarged in every direction.

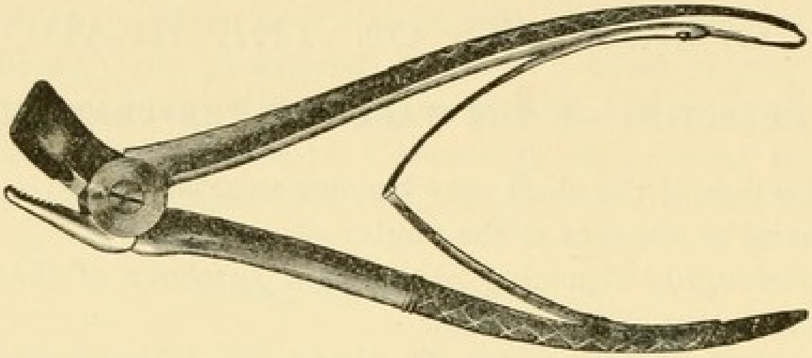


FIG. 867. HOFFMANN'S RONGEUR FORCEPS

2. If, instead of a large opening in the skull, there is only a *small fissure*, which must be *enlarged*, a *gouge* should be used — preferably the common *carpenter's gouge* with a wooden handle. The chisel is applied obliquely upon the margin of the bone and is driven by light short blows with a wooden mallet (Fig. 868). If the fissure has been thus carefully enlarged, so that the gouge forceps can be used, the opening is further enlarged with the same as described in paragraph 1.

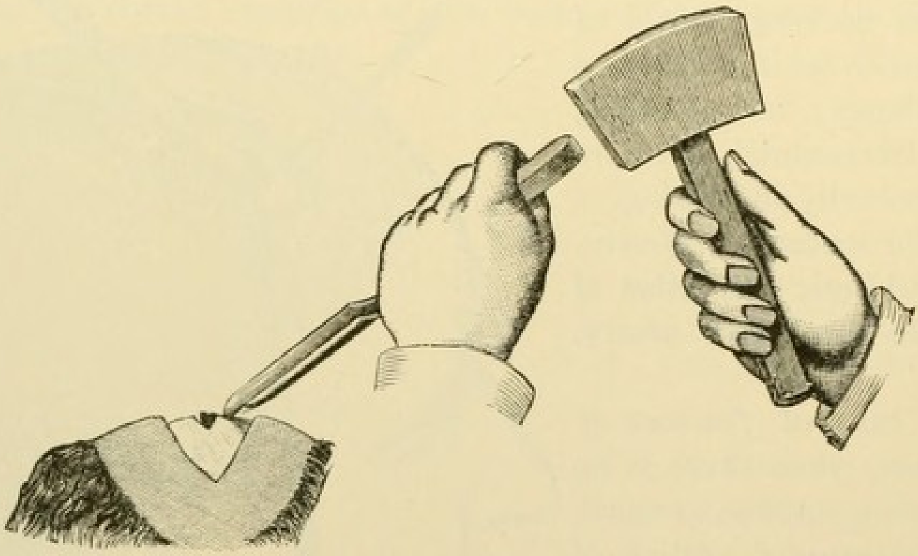


FIG. 868. ENLARGING A SMALL FISSURE FOR REMOVING BROKEN-OFF POINT OF SWORD

As soon as the depressed substance, or the body embedded in the dura mater, is sufficiently exposed, it is raised with the elevator, grasped with dissecting or dressing forceps, and extracted with great care. If it is lodged firmly in the dura mater, it must not be extracted with violence, but must be freed by an incision in the dura. If the depressed portion of bone is not completely broken through at its base it need not be removed.

(Large fragments of the skull can be saved and made useful in the subsequent restoration of the continuity of the skull, even when completely detached, provided the wound remains aseptic.)

If a pointed metallic body, *firmly impacted in the skull* and broken off close to its surface, is to be extracted, by means of small cuts with the gouge (Fig. 868) it can be made accessible from both sides, so that it can be grasped with strong forceps.

In order that no *extraneous matter* may remain in the wound, other foreign substances — such as hair, earth, pieces of cloth, etc., — wedged in the clefts of the fracture, must be chiselled out with the gouge.

Protruding portions of the brain, unless crushed to a pulp, must not be cut off, since during cicatrization they may retract into the cranial cavity. But they should be carefully disinfected.

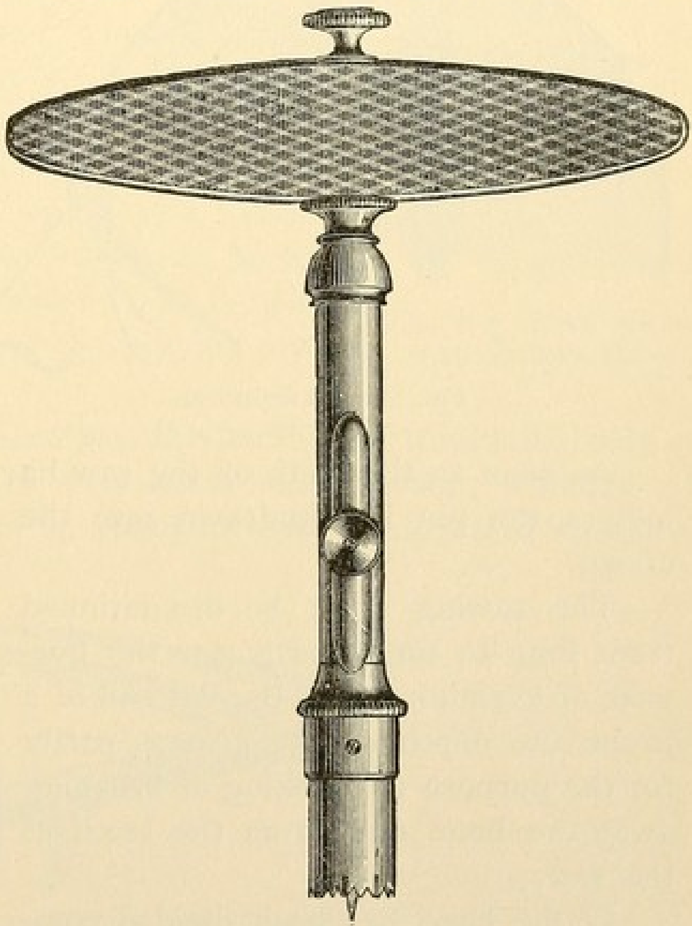


Fig. 869. Hand Trephine

TREPHINING

TREPHINING, THE OPENING OF THE INTACT SKULL,

is performed with instruments made especially for this purpose. With these, a *circular piece* can be sawed out from the bones of the skull — **trephining in a more limited sense** *of the word.*

For this purpose, a *crown saw* is used (*trephine*). The *bow trephine* is operated with both hands, like a carpenter's auger. In most cases, however, the *hand trephine* (*trephine*, Fig. 869), operated with one hand only, is sufficient. With this a piece of bone as large as a five-cent piece can be removed at one time.

(Some American surgeons, chief among them *Roberts*, advocate the use of large trephines with which circular pieces of bone the size of a silver dollar can be removed.)

1. If, at the place where the skull is to be trephined, a wound in the scalp already exists, either enlarge it by an incision penetrating to the bone, or else make a *semicircular incision down to the bone*, and then with the raspatory push back the periosteum together with the flap of the scalp, until the trephine can be applied (Fig. 870).

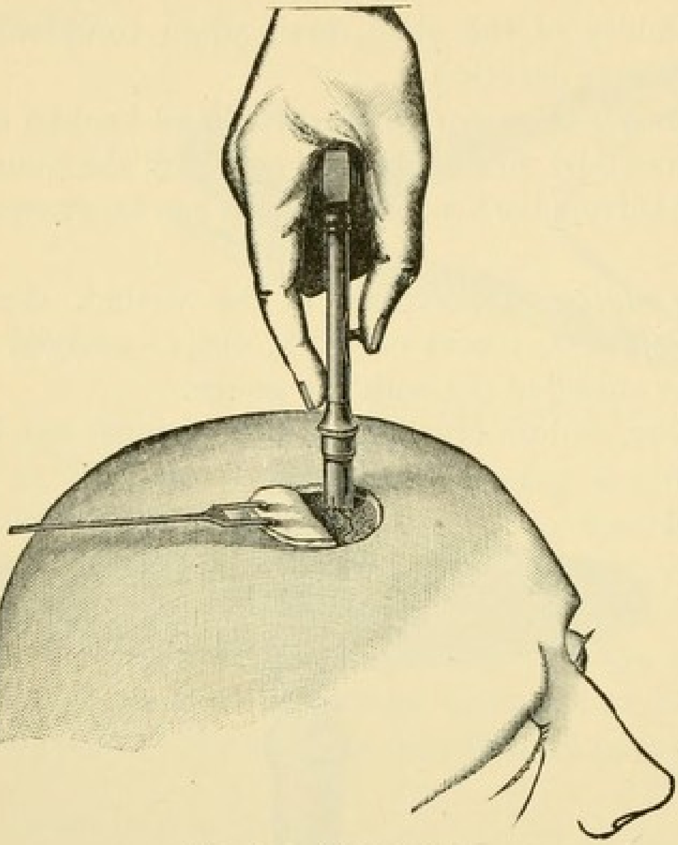


Fig. 870. Trephining

To prevent hemorrhage, the region of the longitudinal and the transverse sinuses and that of the middle meningeal artery are avoided, if possible (Fig. 871).

2. In order that the *manipulation* of the saw may be made more steady, the protracted centre pin, *the pyramid*, of the trephine is allowed to enter the bone. This procedure can be facilitated by *first boring* a hole with a *tire fond*, or a common gimlet.

As soon as the teeth of the saw have penetrated the bone a few millimeters, the pin is withdrawn into the crown.

The sawing must be discontinued from time to time, partly for the purpose of examining with the flat end of a probe the depth of the groove, partly for the purpose of washing or brushing away the bone dust from the teeth of the saw.

If the bone has been divided completely at any place, the teeth must not enter farther. By an inclination of the crown of the saw, they are kept working only on those parts of the internal table which are not yet completely divided.

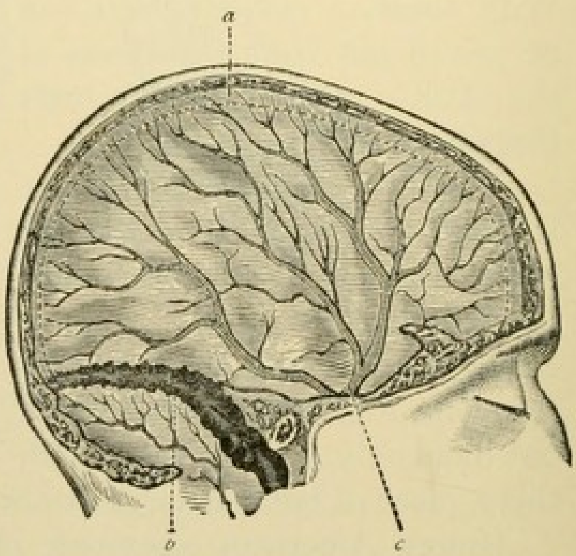


Fig. 871. Blood Vessels on the Inner Side of the Skull. *a*, sinus longitudinalis; *b*, sinus transversus; *c*, art. mening. med.

Previously, however, *a little bone screw*, *Heine's* tire fond (Fig. 872), is inserted into the central hole.

3. As soon as the bone disk has been freed on all sides, it is carefully lifted out by inserting in the upper hole of the bone screw a hook bent at right angles. With this hook, also, it can be ascertained whether depressed fragments of bone are movable (*Roser*); and with it, or with a stronger elevator, or with forceps, the operator attempts to raise or remove them.

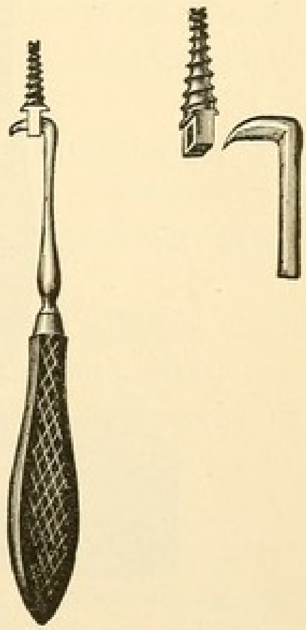


Fig. 872. Bone Screw with Roser's Hook

If, during this operation, *violent hemorrhage* occurs from the abnormally dilated *veins of the diploë*, it is arrested by forcing into the bleeding openings a ball of carbolic wax softened in hot water, or by inserting a thick catgut thread. Hemorrhage from the branches of the *middle meningeal artery* can be arrested by a ball of wax, if it is impossible to grasp the divided artery and ligate it. (Spiking the arterial or venous channels in bone with an aseptic ivory or bone nail or a toothpick is a procedure which in troublesome cases can be relied upon.) Hemorrhage from a *lacerated sinus* is usually arrested by antiseptic tamponade, or by applying a compressive bandage.

Most surgeons, in recent times, employ this method of trephining only in rare cases, *preferring the operation with chisel and hammer*, whereby an opening of any size and shape can be obtained more rapidly and securely.

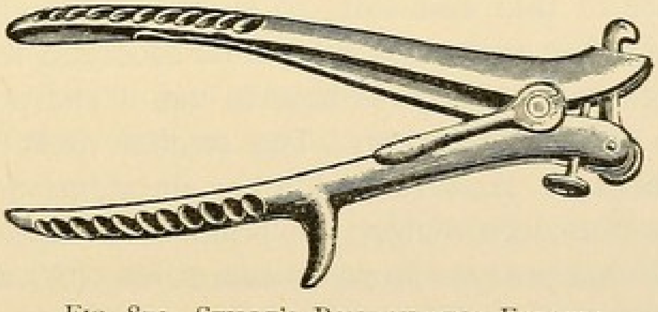


Fig. 873. Stille's Bone-nipping Forceps

Likewise, with *Stille's* "Knochenbeisszange," *bone-nipping forceps* (Fig. 873), a portion of the skull can be rapidly cut all around.

(In this country the bone-cutting forceps of *De Vilbiss* is most popular.)

In hospital work a small rotating circular saw, operated by foot or electromotor, which sets it in very rapid rotation (Fig. 874), is an instrument which lately has come into more general use.

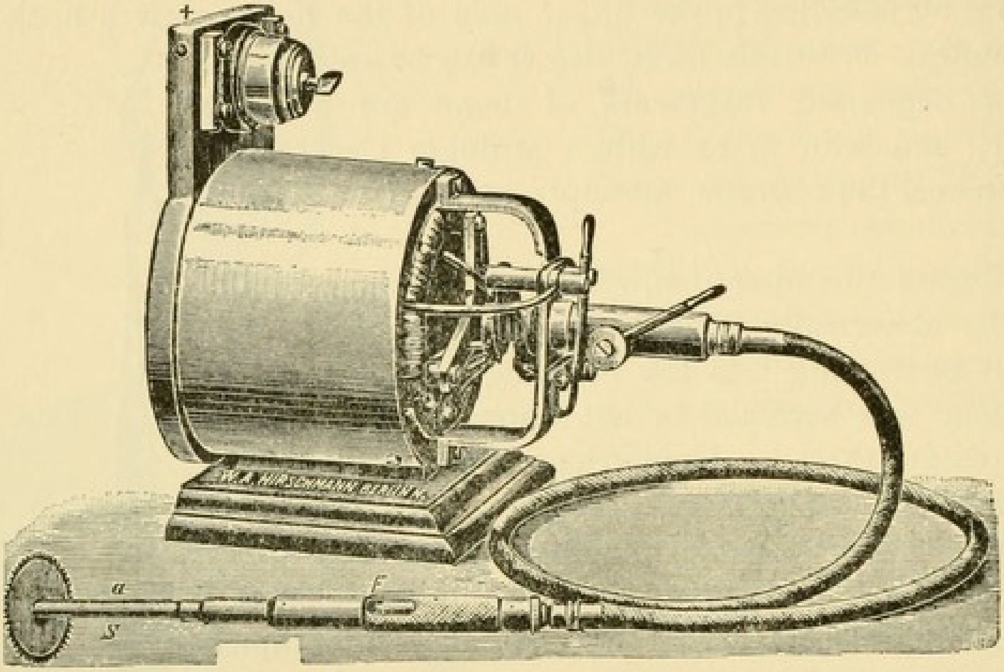


FIG. 874. ROTATING CIRCULAR SAW AND ELECTROMOTOR

TREPHINING FOR INTRACRANIAL DISEASE

should be performed as follows: —

1. After a *curved incision has been made in the soft parts*, the vault of the skull, having been exposed, is opened with chisel and hammer. As it is impossible for the operator to know beforehand whether the cranial bones are thick and dense or thin and soft, he must use the chisel cautiously by short strokes; and, after each stroke, he must ascertain the condition of the bone and the depth reached. It is best to use a sharp gouge of medium size, applied more or less obliquely. The strokes must not be made with too much force, because *fissures* and other unintentional injuries to the underlying parts — the dura mater, the brain — or especially the so-called "Verhämmerung," *injury to the brain by hammering* (*Koch*, *Filehne*), and its consequences might ensue. These dangers are not to be feared when the circular saw is used.

2. When the dura mater has been exposed, it is best opened in the shape of a broad pedunculated flap by making an *incision into the dura* along the margin of the bony opening and about two millimeters in *front* of it; the flap is then *turned up*. If the incision is made thus, any lacerated blood

vessels can be grasped and ligated easily, since the peripheral end cannot recede under the bone (*Horsley*).

3. The surface of the brain is now exposed. After it has been carefully examined as to any changes — such as discoloration, fluctuation, hardness, scars, absence of pulsation — the operation on the brain itself begins with *an incision made exactly vertical to the surface*, since in this manner the blood vessels are least likely to be injured. If hemorrhage occurs, a compress of iodoform gauze is pressed upon it until it is arrested.

4. If a *tumor* is found, a circular incision is made around it in the healthy parts. The tumor is lifted out carefully with a knife, curved on the flat, or a spatula — *Horsley* uses flexible knives of soft iron; and the cavity thus produced is tamponed.

In case of *cortical epilepsy*, the surgeon should try first by a direct faradization of the surface of the brain to locate more definitely the field of the cerebral cortex involved. After this the diseased portion of the cortex is excised superficially. If an *abscess* is found, it is drained toward the opening *without much irrigation.*

The *shock* arising from operating on the cortex can be obviated by *irrigation with hot water.* If, in the neighborhood of a large venous sinus, its injury, together with the entrance of air, is to be feared, the danger can be avoided by double ligation, or by profuse irrigation of the field of operation.

5. The wound of the scalp is sutured, and a drainage tube is inserted. During the first days *the dressings* must be renewed daily. It is advantageous to remove the drainage tube *even after 24 hours;* if, after its removal, during the next few days, there appears any tension of the sutured margins in consequence of retained secretions, a small drainage opening is made with a probe between two of the sutures.

In *profuse hemorrhage* from the brain, *which cannot be arrested*, it is advisable to tampon the whole wound with iodoform gauze from 2 to 3 days; and, at the end of that time, to apply secondary sutures under anæsthesia (*von Bergmann*).

Craniectomy (craniotomy) (*Lannelongue*, *Lane*), the resection of portions of the vault for the purpose of creating more space for the brain, confined by a too premature ossification of the sutures and fontanelles in *idiocy and microcephalus*, has been made in recent times with some degree of justification, but with varying success, when it becomes necessary to remove severe general or more or less localized cerebral affections.

A long *skin incision* is made *along* the sagittal suture, — from the anterior to the posterior limits of the hairy scalp. The periosteum is divided and pushed back on both sides to such an extent that with the chisel and the rongeur forceps (Fig. 867) a strip of bone as broad as the finger can be removed—**craniectomie linéaire**. The dura is *not* opened (Fig. 875). Finally, the skin is sutured over the groove of the bone. If necessary, the same operation may be afterward performed on the other side. If some centres are especially involved, correspondingly large portions of the vault over them (disks) are removed in the same manner, as in resection of the skull, described on page 460. Sometimes it is advisable at the same time to *remove* the *periosteum* to the extent of the portion of bone to be removed for the purpose of preventing a premature closure of the opening by ossification.

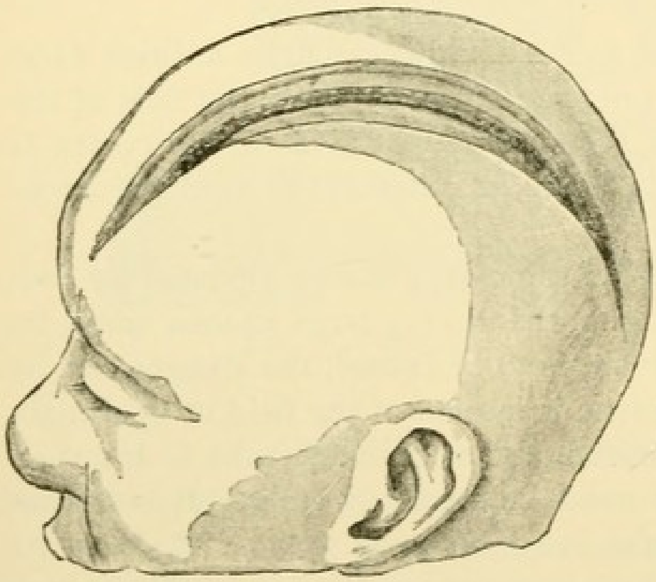


Fig. 875. Craniectomy

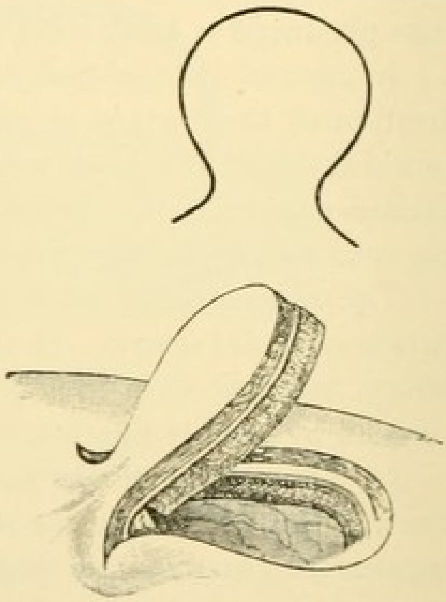


Fig. 876. W. Wagner's Osteoplastic Resection of the Skull

Gersuny made the bone incision around the skull in the same manner as in a post-mortem, so that the whole vault could be raised in such a way as to make the vault of the skull lie movable upon the brain.

After the healing of trephine wounds, although the periosteum has been preserved, the reproduction of bone to fill the opening very rarely takes place. Hence there is left in the skull a soft place covered only by skin and easily exposed to injury. A protector of some hard material should be worn to protect the opening in the skull against injury.

To remedy this defect, various attempts have been made to close the opening with bone.

OSTEOPLASTIC RESECTION OF THE SKULL

The subsequent reposition of the round disks of bone as they fall out of the trephine, and the healing in of the same, have met with success only in rare cases. The procedure, moreover, is accompanied by danger, since retention of secretion in the underlying tissues may easily ensue.

Macewen, therefore, fragmented the sawed-out bone disk into many smaller pieces, with which he filled the wound. Thus, in most cases, he secured healing and reproduction of bone. It is more practical, according to *Senn's* procedure, to use decalcified bone chips, kept ready for use in sublimate alcohol. Likewise the fresh chips of bone obtained by gouging may be used for paving the exposed dura (*autoplasty*). *Gerstein* replaced a large fragment of bone, the result of an injury, and obtained healing with ossification.

The attempt to implant *celluloid plates* into the opening of the skull has also met with good success in some cases (*heteroplasty*).

W. Wagner forms a *bone flap* from the portion of the skull to be opened, and turns it temporarily away from the brain like a door on its hinges. The soft parts are divided down to the periosteum in the form of the Greek letter Ω. At the margin of the somewhat contracting flap of the skin, he incises the periosteum and in the same line chisels through the bone. With a small, fine chisel, he first forms a gutter. This he deepens with a small tolerably thick chisel, with an oblique edge on one side, applying it obliquely with bevelled edge directed toward the margin of the defect. In the two angles only a gutter is gouged, growing deeper from without inwardly; from this the bridge of bone still remaining is divided subperiosteally with a small chisel. The whole piece of bone can then be raised with the elevator and turned downward (Fig. 877). The healing-in into the opening of the temporarily detached piece of bone is fairly well secured by the bridge, and by the uninjured condition of the soft parts covering it. When the

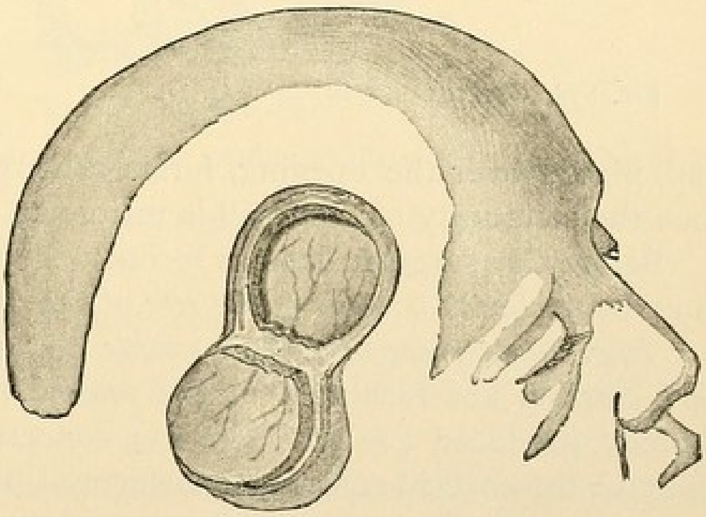


FIG. 877. WAGNER'S OSTEOPLASTIC RESECTION OF THE SKULL

operation is completed the wound is sutured and drained at only one or at both angles.

Müller proceeds in a similar manner by chiselling off only the external table of the skull (*König*), in the form of a flat disk, which he leaves in *vascular connection* with the soft parts that cover it and which is made to cover the cranial defect.

Larger defects of the skull are best covered by the *osteoplastic operation of Müller and König* as follows: —

After incising the skin over the defect in the form of a broad pedunculated flap (*a*), chisel out from the diploë a second reserve flap (*b*), lying near the first and somewhat larger, in connection with the underlying periosteum and a *thin layer of bone*. Preserve between the two flaps a spindle-shaped portion of intact skin, and over this slide the two flaps on their pedicles so that the periosteum-bone flap can be sutured over the defect. Plant the first simple skin flap over the surface of the diploë of the reserve flap. The reserve flap, placed over the opening, forms a bony covering, and in the course of time the continuity of the skull is restored.

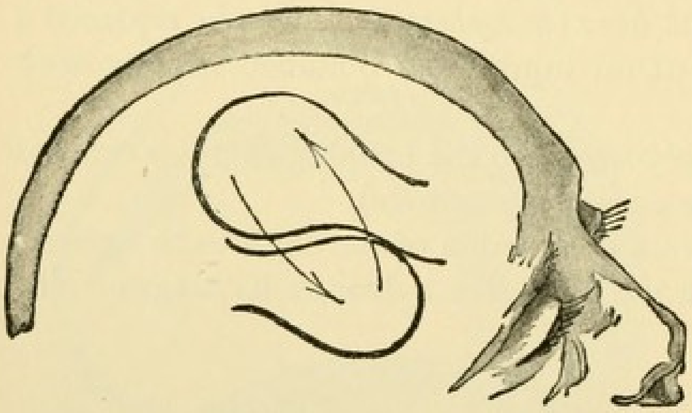


FIG. 878. OSTEOPLASTY IN CRANIAL DEFECTS

Before the surgeon decides to open the skull for intracranial disease, he must be perfectly sure *as to the site* of the diseased portion of the brain.

Important symptoms which enable the surgeon to determine the seat of such diseases are furnished by the *manifestations of irritation or paralysis* thereby produced (*focal symptoms*), concerning the origin of which, especially in the cortical centres, experimental physiology and the experience of surgeons and pathologists shed more and more light. Figure 879 represents the position of the most important motor and sensory cortical areas in relation to the principal convolutions and fissures of the cerebrum.

By a knowledge of the cortical areas (localizations), their distribution on the brain surface, and their position relative to the outer surface of the skull, we are enabled to ascertain the exact place for the opening of the latter.

Since these cortical areas are situated principally in the neighborhood of the **central sulcus** (*sulcus centralis*) and the **Sylvian fissure** (*fossa Sylvii*), the exact location of that portion of the skull under which they are situated is imperative. The position of the other fissures and convolutions can then be judged more or less correctly.

The location of the central fissure (*fissure of Rolando*), according to Thane, is determined in the following manner: —

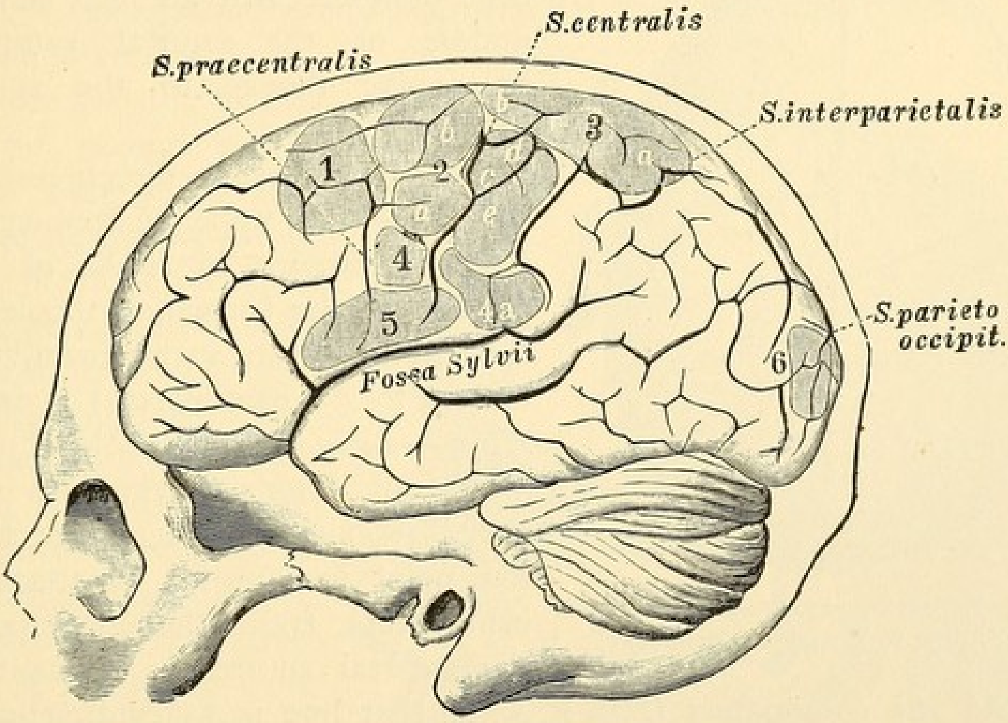


FIG. 879. CEREBRAL TOPOGRAPHY

1, region of the oculomotor nerve. Levator palpebræ; motions of the eyeball; dilatation of the pupils; turning the head to the opposite side
2, upper extremity. *a*, adductors and abductors; *b*, extensors; *c*, *d*, flexors, supinators, and pronators; *e*, muscles of the hand
3, lower extremity. *a*, flexors; *b*, extensors
4, facial nerve, region of the face. *a*, muscles of the mouth
5, speech centre and lingual motions (anteriorly, aphasia; posteriorly, region of hypoglossus)
6, visual centre. See also Tillmanns, II. 1. 70, 122; Keetley, "Index of Surgery," 207, 209; Senn, "Principles," 276

From the root of the nose (glabella) to the inion (occipital protuberance), draw a line over the sagittal suture and divide it into two equal parts. From the middle of this line and 13 millimeters posteriorly from it, the Rolandic fissure begins, running forward and downward at an angle of $67\frac{1}{2}°$. It is about 10 centimeters long (Fig. 880).

Or, according to *Bennet*, draw two parallel lines 5 centimeters apart downward from the sagittal suture and at right angles to it. The anterior line (Fig. 880, *cd*) crosses the anterior margin of the external auditory meatus; the posterior line (*ef*) traverses the posterior margin of the mastoid process. From the upper end of the latter line draw another line obliquely downward and forward, traversing the former line 5 centimeters above the auditory meatus. This oblique line marks the position of the central fissure (Fig. 880, *eg*, and Fig. 881). *Cathart* locates the upper extremity of the central fissure half an inch behind the middle of the sagittal suture, and its course thence to the zygomatic tubercle.

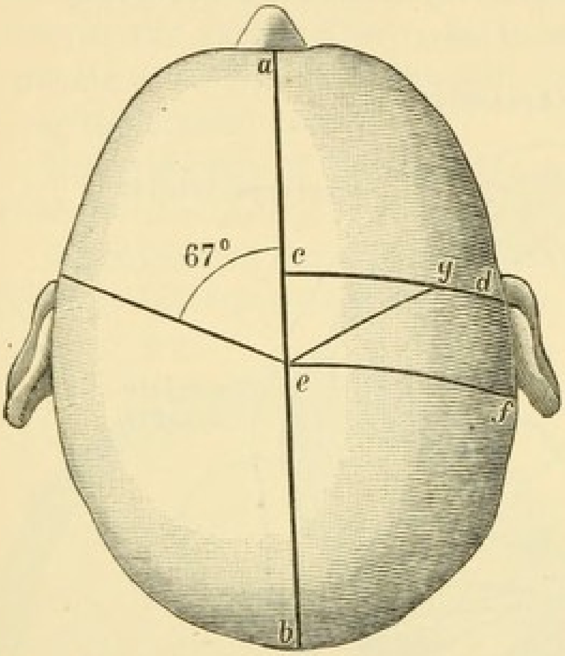


FIG. 880. LOCATING THE SULCUS CENTRALIS (according to Thane and Bennet)

Still more exact directions for ascertaining the upper extremity of the Rolandic fissure in skulls of various sizes in adults (in which the length of the sagittal suture varies from 28 centimeters to 33 centimeters) is found in *Hare—London Lancet*, March 3, 1888—and in *Senn's* "Principles of Surgery," 1890, p. 275. According to them, the point in question is situated $15\frac{1}{2}$ centimeters from the glabella, when the sagittal suture is 28 centimeters long, and $18\frac{1}{2}$ centimeters from it, when that line is 33 centimeters long.

The place of division of the fossa Sylvii into its two branches, near which the cortical areas of the facial and hypoglossal nerves are situated, is found in the middle of the temporal plane at the same point where the trunk of the middle meningeal artery is exposed for ligation (see below).

A large number of **instruments for measuring** these distances have been devised, which are said to facilitate the measurements (*Broca*, *Turner*, *Wilson*, *Horsley*, *Köhler*, *Kocher*). *Köhler*, for example, uses a stirrup of hoop-iron, on which two parallel flexible wires turning to the sides at right angles can be moved to and fro (Fig. 881). Of similar construction is *Horsley's* cyrtometer.

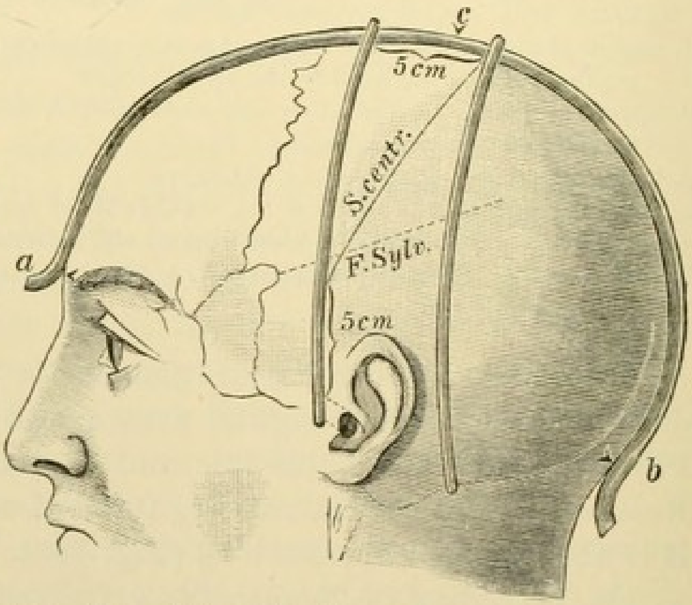


FIG. 881. KÖHLER'S CRANIO-CEPHALOMETER FOR LOCATING THE CENTRAL SULCUS

Kocher has devised an instrument consisting of two elastic steel braces with a scale in centimeters. The instrument may be easily applied by means of an elastic band carried transversely across the skull. The band takes its course from the arch of the eyebrows across at a point above the upper insertion of the external ear to the occipital protuberance; the first elastic brace stands vertical upon it from the glabella to the inion; the second brace, provided with a circular scale, can be moved along the first brace at pleasure and can be fastened to it. If this brace is moved upon the middle portion of the perpendicular brace, at an angle of 60°, two oblique lines can be drawn upon the horizontal line, each of which is divided into three parts. A third line runs obliquely from the posterior third in an anterior direction. For finding its terminal point, the perpendicular arch is divided into three equal parts and its posterior half is divided. From the middle of the points thus ascertained, the line to be sought takes its course downward at right angles, and divides the horizontal line about 1 centimeter behind the anterior oblique line. If the latter is also divided into three equal parts, it has been ascertained that the following points and centres coincide: —

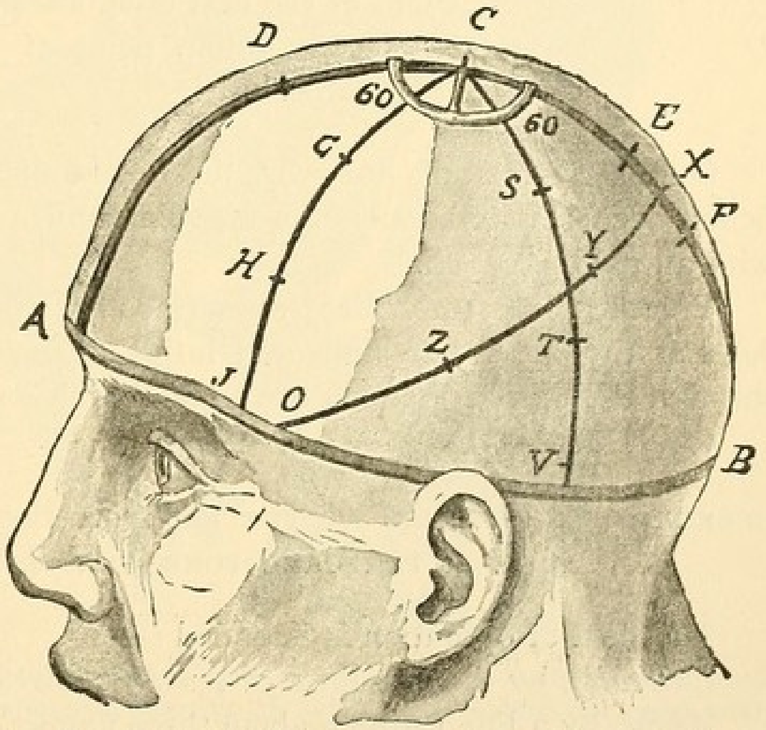


FIG. 882. KOCHER'S METHOD OF LOCATING IMPORTANT CEREBRAL LOCALIZATIONS ON THE VAULT OF THE CRANIUM

J . . . anterior end of the fossa Sylvii.
V . . . boundary between the temporal and the occipital lobes.
C . . . uppermost point of the anterior cerebral convolution in front of the fissure of Rolando.
G . . . boundary between the anterior central convolution and the first and second frontal convolutions.
H . . . boundary between the anterior central and the third frontal convolution.

S . . . interparietal fissure.
T . . . angular gyrus.
X . . . parieto-occipital fissure.
Y . . . angular gyrus.
Z . . . posterior end of the horizontal part of the fossa Sylvii.
Q . . . anterior end of the first temporal fissure.
D . . . first frontal convolution point of crossing of the coronal and sagittal sutures.

On a shaved skull, however, the lines indicated may be drawn with sufficient accuracy by means of a tape line and a cyrtometer, and then traced with an aniline pencil.

Treatment of **cerebral abscesses** (mostly otitic **in the temporal lobe,** *thromboses* of the transverse sinus and infected *fractures of the base* of the skull through the petrous portion of the temporal bone, succeeds best with

OPENING OF THE SKULL AT THE BASE OF THE SQUAMOUS PORTION OF THE TEMPORAL BONE (*von Bergmann*)

The field of operation is bounded : —

Laterally, by the two lines of *Köhler's* stirrup (Fig. 881).

Above, by a line running about three fingers' breadth above the zygomatic arch.

Below, by a line about 1 centimeter above the zygomatic arch (superior anterior surface of the pyramid) — see Fig. 883, *B*.

1. *Skin incision* around the upper portion of the insertion of the external ear to the base of the mastoid process; thence extending from 2 to 3 centimeters in a posterior and upper direction. The incision made at once down to the bone divides the temporal artery, branches of the posterior auricular, the small muscles of the ear, the temporal fascia, and the temporal muscle.

2. With the periosteal elevator the muscular fibres and the pinna are separated from the bone with the raspatory in a downward direction; the skin-periosteal funnel covering the bony meatus is detached above and below toward the tympanum and drawn forward with the whole auricle.

3. In an upper direction, the squamous portion of the temporal bone to the extent of about 2 centimeters is exposed with the raspatory, until the long root of the zygomatic arch (linea temporalis) is exposed; immediately above this, as along a ruler, the skull is chiselled or sawed open in a straight line as far as the mastoid angle of the parietal bone.

4. From this cut, and above it, an opening 2 centimeters high and 4 centimeters long (Fig. 883, *B*) can be chiselled out from the squamous portion. From the superior anterior surface of the pyramid, the dura, together with

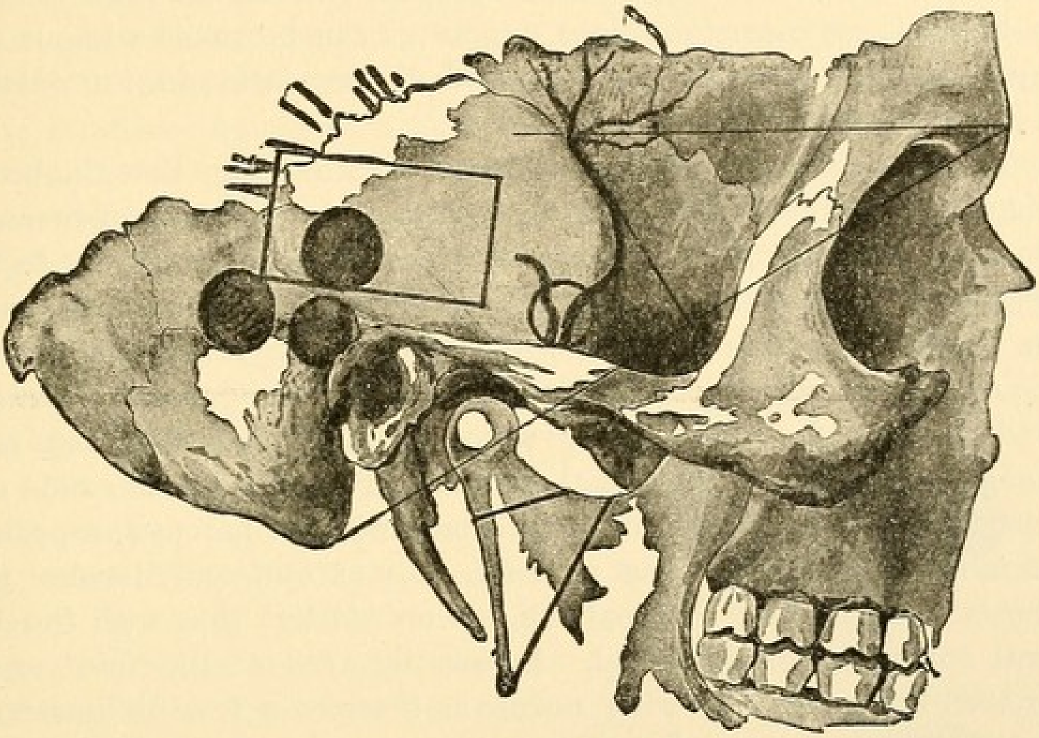


FIG. 883. OPENING THE SKULL AT THE TEMPORAL REGION. *B*, below the localizations for opening the transverse sinus and the mastoid antrum; *S*, locating the middle meningeal artery (Steiner)

the temporal lobe, is separated with the elevator (elevated), until *the region over the tegmen tympani* has been exposed as a starting-point for the removal of the condition mentioned above.

From this point, the *transverse sinus* can be reached by enlarging the opening posteriorly. The sinus takes its course in the tentorium cerebelli, the tangible boundary line between the middle and the posterior cranial fossa; or else it is sought by *chiselling open the mastoid process* (see page 473).

For *diagnostic purposes* especially, but also for removing cerebral pressure and hydrocephalus, the following small operations may serve:—

In diseases of the brain, dangerous to life and indicating the presence of an abscess, *Meinhardt Schmidt* makes an **exploratory perforation of the skull** with subsequent *puncture of the brain* as follows:—

With a pointed knife, an incision about 5 millimeters long is made in the skin down to the bone; the periosteum is pushed back with a chisel or raspatory, and the perforation of the bone is then *very cautiously* begun with a small drill fastened in the trephine bow, or with a hand drill (Figs. 889–890), and the bone is perforated without injuring the dura mater. Through the perforation the long needle of an exploratory syringe is inserted, and by making aspiration at various depths and in different directions search is made for the abscess cavity. Since the puncture leaves little if any scar in the brain, if necessary multiple punctures can be made without fear of any injury to the brain. If the supposed abscess is found, the opening of the skull may follow at once.

(Spitzka has shown by his experimental work on dogs that the brain can be punctured in different directions without incurring any risk of hemorrhage if ordinary care is exercised. Trager first described in detail the technique and diagnostic value of systematic exploration of the brain for abscess.)

The lumbar puncture (*Quincke*, 1891), in *simple serous and tubercular meningitis* — especially in children — and also in subdural *hemorrhages*, is intended to diminish cerebral compression by puncturing *the spinal canal in the lumbar region*, where the spinal medulla terminates in the cauda equina. This little operation can generally be made without narcosis, especially on unconscious or semi-unconscious persons; only exceptionally local or general anæsthesia is required. The patient lies on his left side with the lumbar vertebral column strongly flexed. Below the arch of the third or fourth lumbar vertebra a thin exploring needle is inserted a few millimeters from the median line, in a somewhat oblique inward and upward direction, 2–4–6 centimeters deep, according to the size of the patient and the thickness of the soft parts. From the trickling or flowing out of the fluid the operator recognizes that the subarachnoid space has been reached.

Since the contours of the bones vary in different persons, the operator, in inserting the needle, must be guided somewhat by the sense of feeling.

LIGATION OF THE MIDDLE MENINGEAL ARTERY

Circumscribed arterial extravasations of blood (that is, *circumscribed epidural hæmatomata*) between the vault and the dura mater most frequently take place in the median cranial fossa (*hæmatoma medium* sive temporoparietale). Of much rarer occurrence are the posterior hæmatomata (*hæmatoma posticum* sive parieto-occipitale), which occupy the region under the parietal eminence; most rarely occur the anterior hæmatomata — that is, those lying under the frontal eminence (*hæmatoma anticum* sive frontotemporale) — *Krönlein.*

The seat of these extravasations depends above all on the place where the middle meningeal artery has been lacerated (trunk, anterior, or posterior branch); sometimes the vessel is lacerated in several places. In such cases, as a rule, diffuse hæmatomata originate, which spread over the whole surface of the cranial hemisphere involved.

For exposing the trunk of the middle meningeal artery, the cranial capsule must be opened in the middle of the temporal fossa, *perpendicularly over the highest anterior convexity of the zygomatic arch* (suture between the malar and the temporal bone), at a place where a line drawn *3 centimeters above and parallel to the zygomatic arch* divides another *line drawn perpendicularly 2 centimeters behind the ascending (or frontal) process of the malar bone.*

Vogt determines these lines by drawing one a thumb's breadth behind the nasal process of the malar bone, and the other horizontally two fingers' breadth above the zygomatic arch. At the point of crossing of these two lines lies the trunk of the artery (Fig. 884).

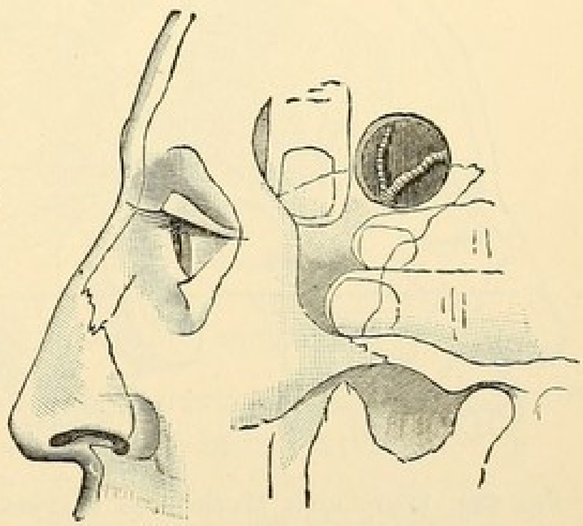


FIG. 884. VOGT'S METHOD OF LOCATING THE MIDDLE MENINGEAL ARTERY

In case of an intact skull, the operator exposes the seat of ligature by a *curved incision with the base directed* downward by dividing the temporal muscle, after it has been laid bare, in the direction of its fibres, and by dividing the underlying periosteum, and detaching it with the raspatory from the underlying parts on both sides. The bone can then be resected with the trephine or with the chisel; its *extreme thinness* in this place, however, is to be considered (squamous portion of the temporal bone, wings of the sphenoid). The artery embedded in the dura mater must be ligated at two points by passing a needle armed with a catgut ligature around it. (Direct ligation is always difficult and sometimes impossible.)

According to *Kocher*, the anterior *and posterior branch* of the middle meningeal artery is best found by trephining *directly over the middle of the zygomatic arch* the squamous portion of the temporal bone, the walls of which are very thin at this place (see also Fig. 883).

1. *External incision* from the frontal process of the malar bone obliquely downward to the extreme posterior end of the zygomatic arch, and then upward to the anterior margin of the ear (*temporal incision*, Fig. 929).

2. After the division of the tough *temporal fascia*, and after the ligation of the superficial temporal artery, the operator penetrates along the

posterior margin of the temporal muscle down to the bone, and in *an anterior direction* elevates from the bone with the raspatory the muscle together with the periosteum.

3. Resection of the thin portion of the squamous portion is made with the chisel or the trephine; ligation of the branches of the artery which are exposed.

If the supposed hæmatoma is not found in this place, a slightly curved grooved director or a (tube) catheter should be introduced between the bone and the dura mater, with which explorations for it are made; but, in any event, the skull *should be trephined once more at another place*, preferably under the *parietal eminence* (posterior hæmatoma).

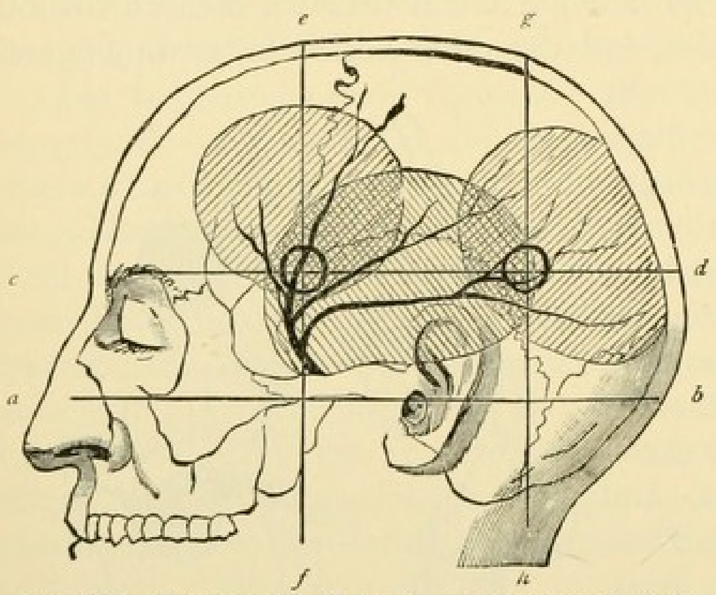


FIG. 885. KRÖNLEIN'S METHOD OF TREPHINING THE MIDDLE MENINGEAL ARTERY

Krönlein gives the following rule for determining the two locations where trephining is to be made: —

Draw a line (Fig. 885, *cd*) through the supra-orbital margin in a posterior direction and parallel to the horizontal line of the head (opening of the ear, line of the infra-orbital margin, *Virchow's* German horizontal, *ab*). In this line the two openings are said to lie, the anterior from 3 to 4 centimeters behind the zygomatic process of the frontal bone (*ef*); the posterior at the point where the horizontal line crosses a vertical line drawn directly behind the mastoid process (from 3 to 4 centimeters behind the external auditory meatus, *gh*).

In a *diffused hæmatoma*, a second opening made by trephining is also very useful for removing the adherent coagula and for draining thoroughly the large cavity between the bone and the dura.

According to *Steiner*, the two locations for trephining are determined as follows: —

Draw a line from the middle of the glabella to the apex of the mastoid process and add a perpendicular upon the middle of this line. Where this perpendicular crosses a line passing through the middle of the glabella and drawn horizontally around the skull, lies the anterior inferior parietal angle and the *anterior* branch (Fig. 886; Fig. 883, *S*). The point where the horizontal line crosses a perpendicular ascending directly in front of the

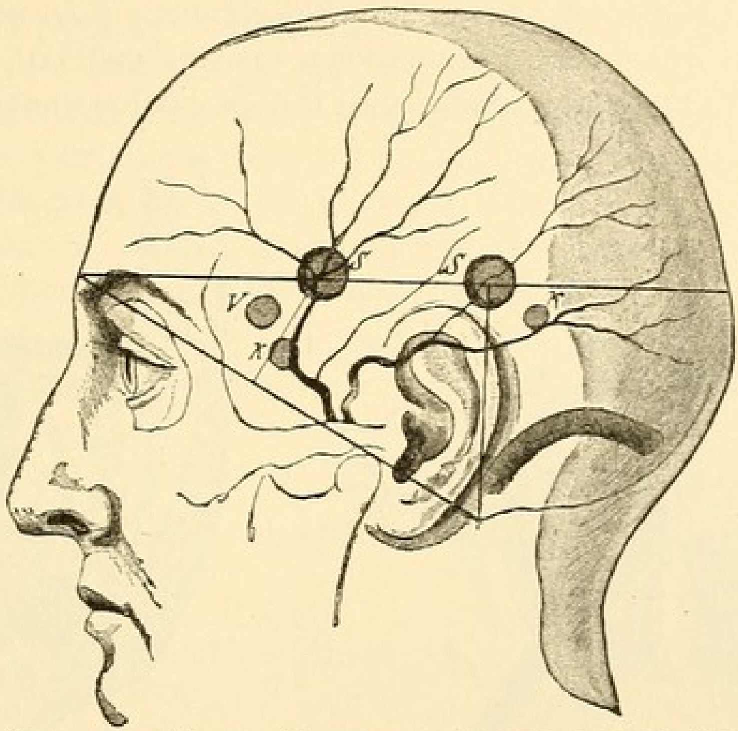


FIG. 886. COURSE OF MIDDLE MENINGEAL ARTERY AND ITS LOCALIZATIONS FOR TREPHINING. According to Steiner (*S*), Vogt (*V*), and Krönlein (*K*)

mastoid process — the pinna is turned up in an anterior direction — indicates the opening for trephining for the *posterior* branch of the artery.

OPENING OF THE MASTOID PROCESS IS NECESSARY

(*a*) In an acute (*acute infectious osteomyelitis*) and chronic inflammation (*tubercular ostitis, caries and necrosis* of the mastoid antrum and cells, originating in most cases from suppuration in the middle ear (*otitis media*).

(*b*) In *tumors* — pearl-tumors (*Virchow*), branchiogenous cystomata, cholesteatomata (*Müller*).

1. *External incision* from 3 to 5 centimeters long, taking its course 1 centimeter behind, and parallel (in a curve) to the insertion of the auricle. The posterior auricular artery remains uninjured.

2. The periosteum is detached with the raspatory.

3. The exposed anterior wall of the mastoid antrum is now removed by chiselling (Fig. 887). This is best done *very carefully* with little gouges from 2 to 8 millimeters broad, always directing the blows of the hammer obliquely from behind and above in a forward and downward direction, nearly in the direction of the osseous auditory meatus. The strokes should

never be made in a posterior direction (transverse sinus!), nor horizontally inward (dura mater!), nor too deeply in an anterior direction (facial canal!). Proceeding in this manner, the surgeon chisels away a *broad* **funnel-shaped** *excavation*, from which pus, granulations, caseous material, sequestra, etc., are removed with the sharp spoon until the excavation shows smooth walls.

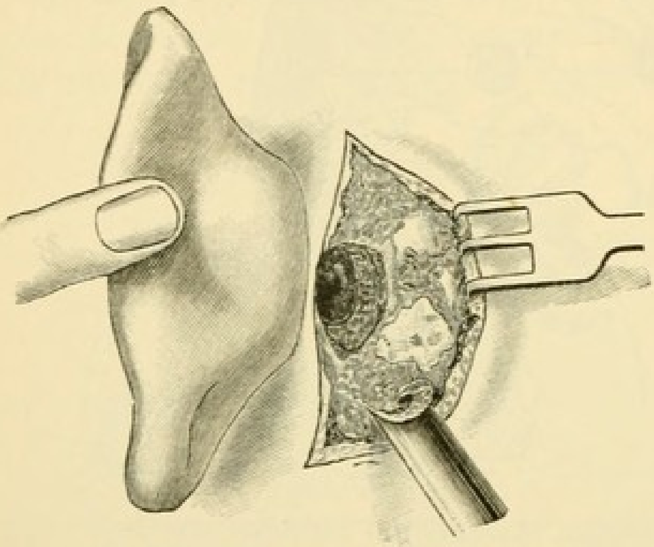


FIG. 887. OPENING MASTOID PROCESS

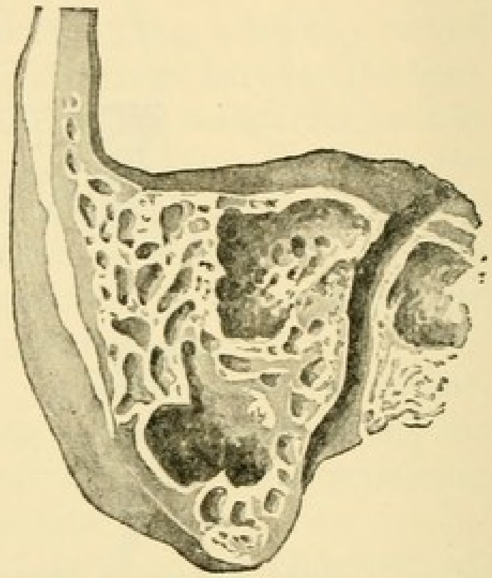


FIG. 888. MASTOID PROCESS OPENED, showing antrum mastoideum, mastoid cells, and facial canal

4. Next, *the posterior wall of the osseous auditory meatus* is removed with a chisel; the auditory meatus itself is thoroughly disinfected, and the shallow alveus thus produced and everywhere easily exposed to view is tamponed with iodoform gauze.

Violent hemorrhages during the operation may arise from the transverse sinus or from the veins of the diploë. These are arrested by tamponade; spongy granulations which bleed excessively must be scraped out quickly.

The *after treatment* consists in drainage, irrigations, and permanent tamponade, in order to prevent a too premature closure of the cavity.

In chronic suppurations, *Stacke* exposes the lateral chambers of the antrum (attic, aditus ad antrum), as follows: —

1. The external ear and the membranous auditory meatus are detached together and drawn forward after the latter has been divided near the tympanum.

2. The malleus and the remainder of the tympanum are removed: a small S-shaped bent raspatory is inserted high in the attic, and the thin osseous external and inferior wall of the cupola is chiselled out completely.

3. The incus is removed and the raspatory is carried backward, and upon it is chiselled off enough of the margin of the tympanum and of the posterior upper wall of the auditory meatus to enable the probe to be inserted with ease into the antrum.

4. Next, the portion of bone covering the antrum exteriorly is chiselled off, so that the antrum, together with the meatus, presents a large *shallow concavity*. (The middle wall of the antrum must not be touched with the chisel, on account of the labyrinth and the facial nerve.)

After all diseased parts have been removed by dividing the meatus longitudinally, a square flap is formed and applied over the osseous concavity as a permanent covering for the bone defect between the meatus and the antrum.

OPENING OF THE FRONTAL SINUS (SINUS FRONTALIS)

may become necessary: —

(*a*) For the removal of *collections of fluid* after inflammation of the same.

(*b*) For the removal of *tumors* (osteomata, polypi) and sequestra.

1. The *external incision is made vertically* over the eminence of the most prominent part of the swelling, or *a flap* is formed with the base directed upward.

2. After the division of the thin muscular layer (frontal, orbicular, and corrugator muscles), the periosteum is divided and reflected laterally with the raspatory.

3. The *anterior wall* of the frontal sinus then exposed is removed, either with a chisel or a trephine, to an extent varying according to its thickness and the nature of the disease; very thin walls can be divided with a strong knife.

For *protecting* the branches of *the facial nerve*, *Kocher* makes *the external incision* at once down to the bone. This incision is in *the form of a curve*, corresponding to the shaved-off eyebrow; the frontal and the supra-orbital nerves and the supra-orbital artery are divided; the facial nerve is not divided. If necessary, an ascending median incision is added.

Fig. 889 Drill Borer

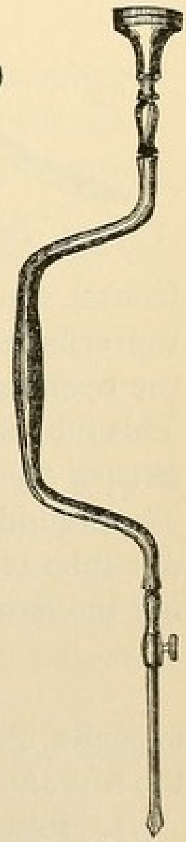


Fig. 890 Bone Drill

If the opening is intended merely for *diagnostic purposes*, a perforation made with a *bone drill, an auger* (Figs. 889, 890), or even a trocar is sufficient. If the operation is performed for tumor, after sufficient exposure, it is extirpated, and the incisions of the periosteum and the skin are carefully sutured.

In collections of fluids which have originated from retention after the communicating canal with the nose has been occluded, it is necessary to provide a sufficient outlet for the same in a downward direction by draining the

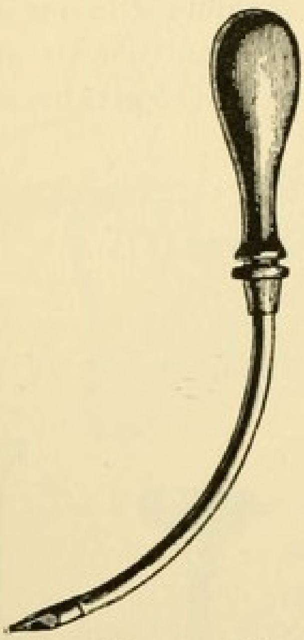


Fig. 891. Drainage Trocar

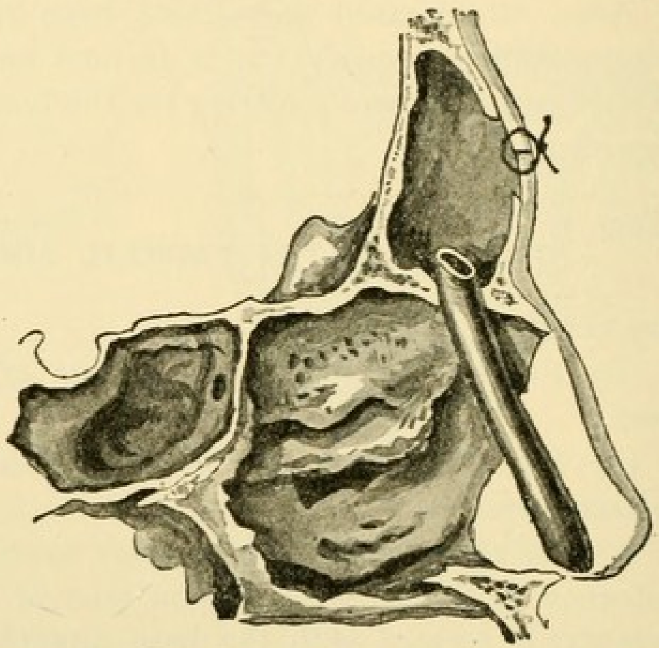


Fig. 892. Drainage of Frontal Sinus

frontal sinus. With a *drainage trocar* (Fig. 891), or with strong forceps, the cribriform plate is perforated *in the direction of the nasal cavity*, and the opening is enlarged so that *a very thick drainage tube* can be inserted. This tube is conducted out either *through the nostril* (Fig. 892), or still better, *toward the pharynx*, so that it appears to view just behind the soft palate. The wound of the skin can then be closed entirely by suturing; the drainage tube is removed *as soon as the canal is well established*, thereby obviating the danger of relapse.

RESECTION OF THE MAXILLA

is made almost exclusively *for removing tumors* which originate either from the *alveolar process* (*epulis*) or from the body of the *upper jaw* itself.

1. **Resection of the alveolar process**, in cases of small, well-limited tumors, is best made rapidly with a single cut of a *very strong large gouge forceps;* else the diseased portion is chiselled out *in the form of a wedge.*

In most cases of neoplasms occupying the molar region it becomes necessary to enlarge the opening of the mouth by a transverse division of the cheek (Fig. 933), in order to obtain the necessary space. In case of a more extensive disease and a more irregular limitation of the tumor, *the chisel and the metacarpal saw must be used.*

In case of larger tumors the upper jaw may even be removed by means of an **intrabuccal incision** along the buccal fold, provided the skin has not become involved. The cartilaginous portion of the nose is also detached by an incision, and all the soft parts are then forcibly drawn upward (similarly as in Fig. 1129). If, after the removal of the tumor, the temporarily detached portions are replaced again in proper position, scarcely any disfiguration results from the operation (*Knapper-Rotgans*).

2. **Resection of the whole upper jaw.** Since this is a very bloody operation, and as *aspiration of blood* into the lungs — broncho-pneumonia ("schluck" pneumonia) — is especially to be feared, the operation may be performed: —

(*a*) Under *partial* anæsthesia. First, a morphine injection of from 0.02 to 0.03 gr. is administered, and the patient is placed under partial anæsthesia, so that he loses sensibility to pain, though he still obeys requests and coughs up blood that may have gravitated into the larynx.

(*b*) By performing preliminary *tracheotomy*. *The trachea is plugged with Trendelenburg's tampon-canula or Hahn's compressed sponge canula*, in which case the larynx may also be plugged from the wound in an upward direction.

(*c*) With the *head hanging down* (*Rose*). In this case, however, the hemorrhage is considerably greater.

(*d*) By ligating the external carotid *immediately* before the operation (*Kocher*). By this means the operation is made less bloody and easier.

If the operation is performed under partial anæsthesia, it is of prime importance *to postpone opening the cavity* of the mouth until the very last, in order to postpone as long as possible the blood from flowing into it. Hence, during the first part of the operation the patient may be allowed to lie on his back; but when the cavity is to be opened, he is requested *to sit up with his head bent forward.* The operation then takes the following course: —

1. The nares are plugged firmly from behind with a *Bellocq's* canula (see Fig. 1111).

2. **External incision.** *The division of the soft parts* has been made in very different ways by surgeons. Figure 893 gives a systematic view of the principal methods of incision.

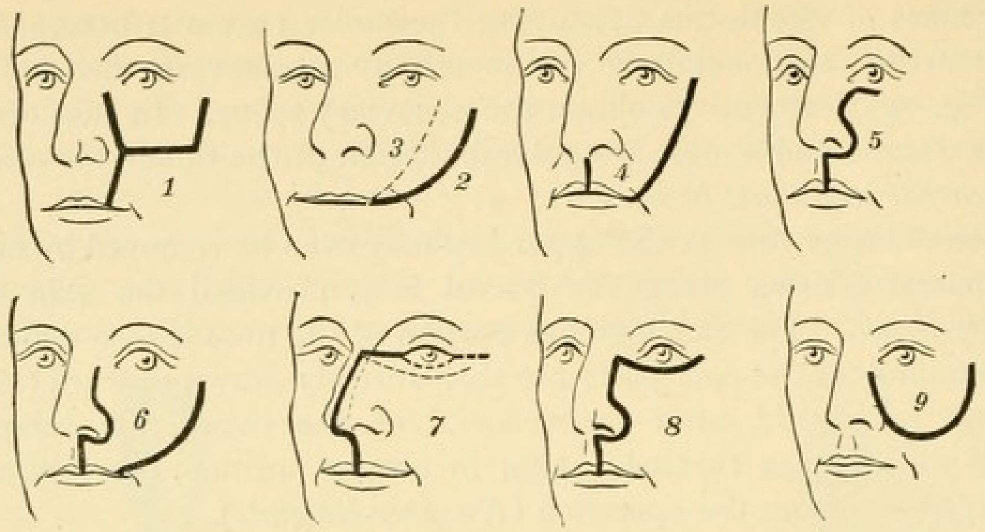


FIG. 893. 1, Gensoul; 2, Velpeau; 3, Syme; 4, Malgaigne; 5, Nélaton; 6, Fergusson; 7, Dieffenbach; 8, Weber; 9, Von Langenbeck

The best and most useful *external incisions* are the following: —

(*a*) *Dieffenbach's incision* divides the skin of the bridge of the nose and that of the upper lip in the median line. From the upper end of the incision a transverse incision is made to the inner angle of the eye; and if necessary, the outer angle of the eye is also divided as far as the malar bone. (Gives much space, disfigures little.)

(*b*) *O. Weber's incision* begins below the inner angle of the eye, is carried perpendicularly downward to the ala of the nose, encircles it as far as the septum, and divides the upper lip in the median line. From its upper end a slightly curved incision is made along the lower orbital margin. (Disfiguration very slight.)

(*c*) *Von Langenbeck* makes a curved incision with the concavity basis directed upward, which, beginning at the anterior margin of the nasal bone, extends to the duplicature of the mucous membrane of the cheek, whence it ascends to the malar bone.

FIG. 894. KOCHER'S EXTERNAL INCISION

For the purpose of furnishing a protection for the nerves and muscles as much as possible, Kocher makes a skin-incision similar to Weber's, which divides the upper lip near the filtrum, and extends from the nostril around the ala to the height of the inner angle of the eye. Another transverse incision is made toward the first incision from the lower margin of the orbicular muscle of the eye across the insertions of the levator labii superioris and the zygomatic muscles; this incision is carried in an oblique and downward direction (boundary of the superior and inferior facial region) (Fig. 894).

3. The flap formed by one of these incisions is *dissected off* from its *attachments* so that the diseased upper jaw is freely exposed.

4. **Disarticulation of the bone.** After the periosteum has been reflected on the lower orbital wall, the eyeball is drawn upward with blunt retractors (or *Wagner's Hollow-Elevator* — Fig. 919); with a semicircular needle (*Heyfelder*), a chain saw is carried through the inferior orbital fissure along the posterior surface of the malar bone and out of the zygomatic fossa; the malar bone is then sawed through (Fig. 895 *a*).

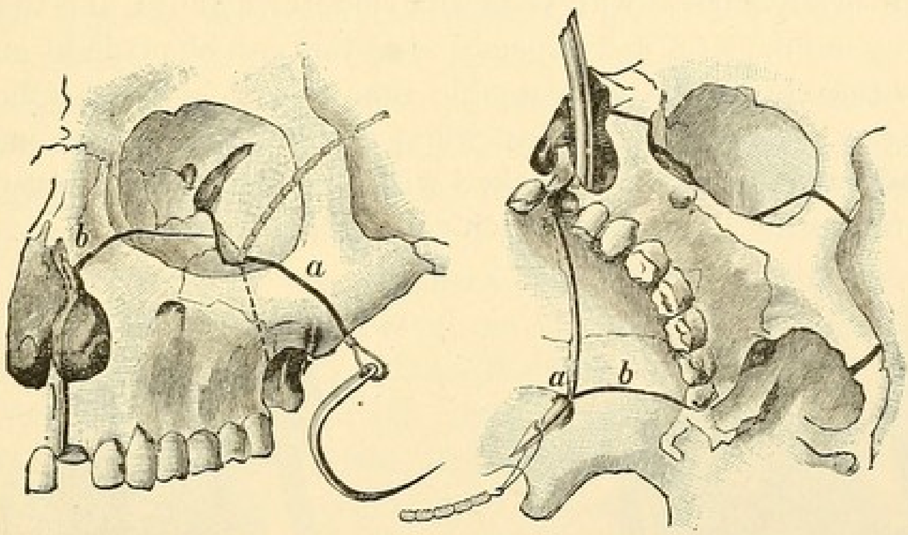


Fig. 895 Fig. 896

Saw Incisions for resecting Upper Jaw

5. Next, from the anterior nasal aperture the nasal and the orbital process of the superior maxilla (*processus nasalis et orbitalis maxillæ superioris*) is divided with bone-cutting forceps — or metacarpal saw — as far as the inferior orbital fissure (Fig. 895 *b*).

The nasal tampon is then removed, and the patient is placed in a sitting position, with his head slightly bent forward.

6. From the nose a long drainage trocar is pushed along the *posterior margin of the hard palate* through and into the cavity, and by means of this a wire or chain saw is drawn through the cavity of the mouth and the nares (Fig. 896 *a*).

7. A *middle upper incisor is quickly extracted;* and, after *division of the muco-periosteal covering of the palate* in the median line the *skin incision* is completed through the whole thickness of the upper lip.

8. The *hard palate is divided* with a chain saw close to the median line (vomer); then with a knife or the thermocautery the soft palate is divided transversely from the margin of the hard palate (Fig. 896 *b*).

9. The upper jaw, remaining attached only to the palate bone, is loosened by forcing a chisel or elevator into the saw incision of the malar bone; it is then grasped with strong forceps, and is *rotated outward* with a vigorous jerk and extracted (Fig. 897).

10. The *internal maxillary artery* (or its branches), *spheno- and pterygo-palatine*, *infra-orbital*, in case it is not already torsioned by the forcible rotation of the bone, is ligated in the depth of the large cavity of the wound. After the hemorrhage has been arrested the whole cavity of the wound (Fig. 898) is firmly packed with (*adhesive*) iodoform gauze, and the skin over it is carefully united. (A more speedy operation can be made by substituting for the saw the chisel. Much valuable time is lost by the application and use of the saw. Less blood is lost when a chisel resection is made. The large wound cavity should be packed with iodoform gauze moistened with compound tincture of benzoine, which can remain for a week.)

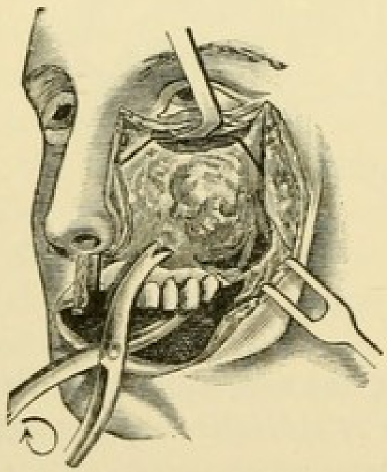


Fig. 897. Rotating outward the Upper Jaw, divided by Sawing

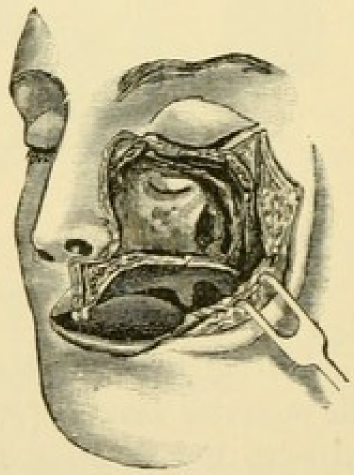


Fig. 898. Cavity of the Wound after Resection of the Upper Jaw

After the operation it is especially important to protect the patient from the imminent danger of pneumonia. Therefore, during the first days, it is best to keep him in bed in a sitting position; or he may lie on the operated side or on the stomach. The mouth should be carefully cleansed; food and drink should be administered in a cup with a nozzle or through a glass tube.

After the healing of the wound, which generally takes place in a surprisingly short time, the patient is provided with a plate for the missing teeth and the palate to take the place of the whole bone removed. During the entire operation the surgeon may use for dividing the bone, instead of the chain saw, the wire saw (*Gigli*), the metacarpal saw, Liston's bone-cutting forceps, or a chisel, with any of which the operation can be performed just as rapidly and satisfactorily.

According *to the extent of the disease* the saw incisions must be varied. On account of the subsequent disfiguration of the face — a matter that should enter into careful consideration — it is advantageous to preserve as much as possible of the malar bone, or, at least, of its periosteum (Fig. 895).

If the muco-periosteal covering of the hard palate is not diseased, it is cut all around — according to *von Langenbeck* — along the inner margin of the alveolar process, and reflected with the elevator toward the median line: the connection with the soft palate is divided. Then the palatal plate is sawed through. The covering of the palate thus preserved, which hangs down like a curtain in the middle of the cavity of the mouth, is sewed to the mucous membrane of the cheek, separating the mouth from the cavity of the wound.

If, in the removal of less extensive tumors, it should be possible to preserve even the hard palate, the upper jaw, after it has been exposed by *von Langenbeck's* flap incision, *is sawed off by an incision*, which is carried horizontally above the roots of the teeth, from the alveolar process, in the same manner as in temporary resection of this bone (see this and Fig. 900).

In more serious cases, however, the surgeon is often compelled to saw out the whole malar bone (Fig. 896), the soft palate, the palatal process of the other side, and even both jaw bones at the same time.

Resection of both upper jaws was first made by *Heyfelder* (1841). Velpeau's incision is best adapted to this operation (Fig. 893, 2). On both sides the skin of the face is dissected off in an upward direction, and the operator saws from one malar process through the orbit and root of the nose into the other orbit and the malar process of the other side; the palate need not be sawed through. With *Dieffenbach's* external incision each jaw may be removed separately.

In case the surgeon operates for necrosis of the jaw (**phosphorus necrosis**), the removal of the necrosed portion is comparatively easy in proportion to the size of the sequestra.

Dumreicher proceeds as follows: After having extracted all loose teeth he detaches the muco-periosteal covering with the elevator from the alveolar process from the anterior as well as from the inferior surface of the upper jaw; next, *he chisels out a wedge from the bone*, the base of which measures from two to three centimeters at the base of the alveolar process, and with strong dressing forceps extracts all the loose portions of the upper jaw from the cavity thus produced in the superior maxillary bone; those portions which are not yet completely separated on all sides are subsequently removed. Moreover, the wide opening in the cavity of the jaw permits thorough disinfection.

III. **Osteoplastic, or temporary, resection of the upper jaw** (*von Langenbeck*, 1861) is performed for the removal of non-malignant *fibrous* or *cavernous tumors*, which originate from the base of the skull, fill the naso-pharyngeal space, and force themselves into the *antrum of Highmore* or through the sphenomaxillary fossa *into the temporal fossa* (*retromaxillary tumors*).

By *reflecting upward a portion* of the upper jaw, *which has been sawed through but which remains in connection with the soft parts*, the tumor is completely exposed, so that it can be cut off from the base of the skull with knife and scissors; next, this portion of the upper jaw is replaced and the skin is sutured over it.

Von Langenbeck proceeded as follows: —

1. **An external incision** is made down to the bone *in the form of a curve* from the external angle of the nostril to the middle of the zygomatic arch (Fig. 899, 1).

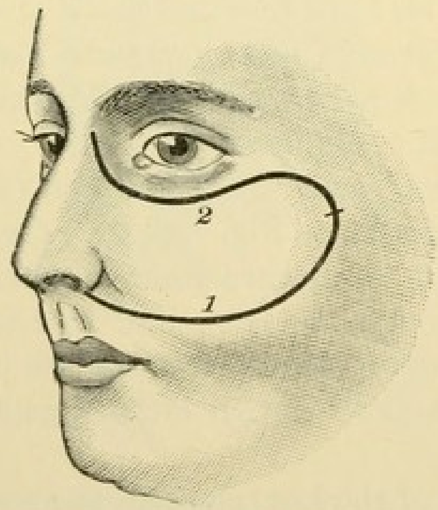


Fig. 899. External incision

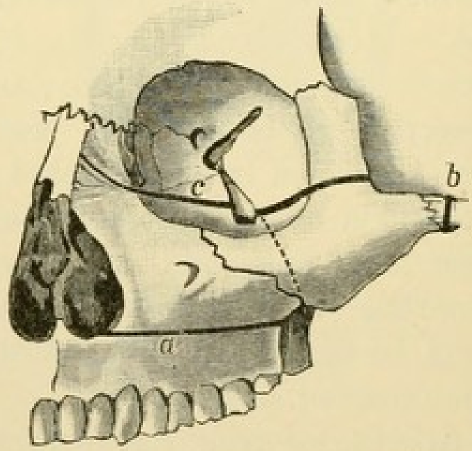


Fig. 900. Dividing bone by sawing

Von Langenbeck's Osteoplastic Resection of the Upper Jaw

2. *Separation of the insertion of the masseter muscle* from the lower margin of the malar bone; *division of the buccal fascia.*

3. After the lower jaw has been pressed downward by a gag inserted at the angle of the mouth on the healthy side, the right index finger is forced into the *sphenomaxillary fossa* between the tumor and the upper jaw and then through the distended sphenopalatine foramen as far as the nares; along the finger an elevator is carried, and on it a fine metacarpal saw is

introduced into the pharynx. The left index finger, introduced from the mouth into the pharynx, catches the point of the saw.

4. **Horizontal division (by sawing) of the upper jaw** above the alveolar process as far as and into the pyriform aperture (Fig. 900 *a*).

In operations on the right upper jaw, the left index finger is forced into the maxillary fossa, and the operator saws toward it from the nasal passage.

5. **External incision** down to the bone in the form of a curve from the root of the nose along the lower orbital margin, meeting the first skin incision at the zygomatic arch (Fig. 899, 2).

6. After the external lower angle of the orbit and the angle between the temporal and the frontal processes of the malar bone have been freed from the soft parts, the *zygomatic arch is* **sawed through** in the middle from within outward (Fig. 900 *b*); next, *the frontal process of the malar bone as far as and into the inferior orbital fissure*, *the orbital plate of the upper jaw as far as the lachrymal bone* closely below the lachrymal fossa, and finally the middle of *the nasal process of the upper jaw* as far as the nasal bone are divided with a metacarpal saw (protection of the organs which constitute the lachrymal duct — Fig. 900 *c*) (Simon).

7. By means of an elevator inserted under the malar bone, the *sawed-out piece of the upper jaw is lifted up toward the median line*, *like the lid of a box.* The sutural connection between the nasal bone and the upper jaw, in most cases, breaks during this manœuvre.

8. With a broad elevator, the tumor, now laid bare, is lifted out of the sphenomaxillary fossa, and the base is detached from the under surface of the skull with a knife, scissors, or thermo-cautery. Finally, the resected portion of the upper jaw is replaced into its former position, and the wound of the skin is closed by means of careful suturing.

For the better protection of the branches of the facial nerve, *O. Weber placed the nutritive bridge* of the upper jaw, which must be turned up, *externally upon the zygomatic arch*, and by nicking it on the line of its suture with the zygomatic process of the temporal bone, he turned the zygomatic arch over *in an outward direction.* The external incision has already been described on page 30; the saw incisions are in other respects the same as in the preceding method (Figs. 901, 902).

Osteoplastic resection of both upper jaws (*Kocher*)—*for the removal of nasopharyngeal polypi and retropharyngeal tumors.*

This operation, being very bloody, is best made with the head in Rose's position. As a preliminary step the external carotid is ligated and morphium-chloroform narcosis is administered through the tracheotomy wound.

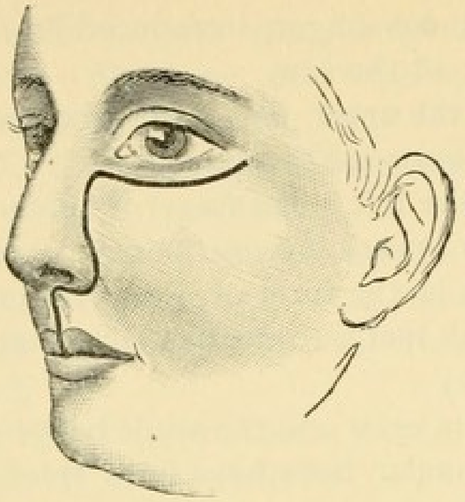


FIG. 901. External incision

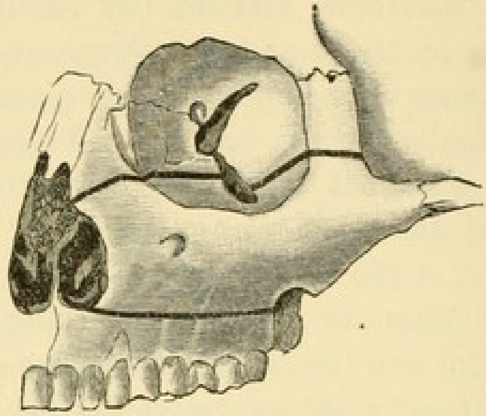


FIG. 902. Division of bones

O. WEBER'S OSTEOPLASTIC RESECTION OF THE UPPER JAW

1. The *external incision* divides the upper lip near the median line from one nostril downward. Next, the mucous membrane on the upper side — where it is reflected — above the alveolar margin is divided transversely down to the bone, and the *upper lip is forcibly pushed toward the forehead* (Fig. 903 - - - - -).

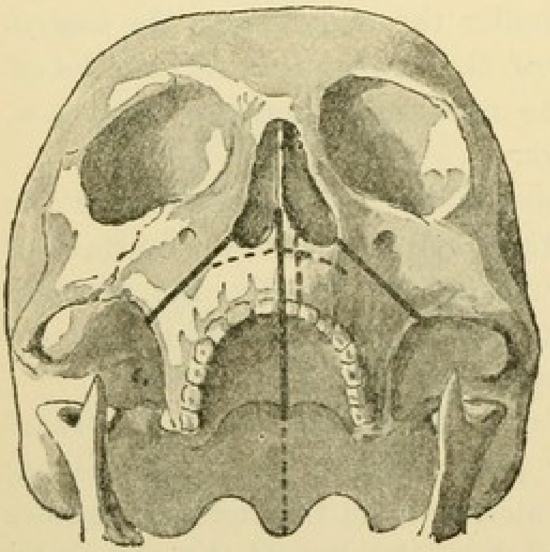


FIG. 903. KOCHER'S OSTEOPLASTIC RESECTION OF BOTH UPPER JAWS
- - - - - external incisions
——— bone incisions

2. The two bodies of the upper jaw on a level with the lower nasal spine *above the alveolar margins* are *transversely* divided one after the other; by this means, the antra of Highmore are opened. After a temporary tamponade, follows: —

3. The *median division*, with the chisel, *of the alveolar process* and of the hard palate (Fig. 903 ——). With strong sharp hooks, it is possible *to draw* the two halves of the upper jaws *wide apart.* The external wall of the antrum of Highmore breaks, but the pterygoid process of the sphenoid remains uninjured. After the division of the mucous membrane of the floor of the nares, if it is still uninjured, after the vomer has been forced aside, and after obstructing portions of the turbinated bones have been removed, the nares, the nasopharyngeal cavity, the base of the skull, and the roof of the nares can be very satisfactorily inspected.

4. The tumor can now be attacked with knife, the thermo-cautery, etc., during which procedure *the longitudinal division of the soft palate* and of the uvula may sometimes become necessary for better exposure. This incision is afterwards sutured. The two halves of the upper jaw are turned back into their former position, in which they are held by means of a silk bone suture applied closely above the alveolar process; lastly, the wound of the lip is sutured.

Concerning the temporary resection of the nasal process of the upper jaw and resection of the malar bone, see below.

IV. **Opening of the antrum of Highmore** is to be made:—

1. In *empyema* (suppuration) of the same, resulting from periostitis of the roots of the teeth and eomyelitis of the upper jaw.

2. In *hydrops* after closure of the outlet into the nasal passage, and for the removal of mucoid polypi which have *undergone cystic degeneration.*

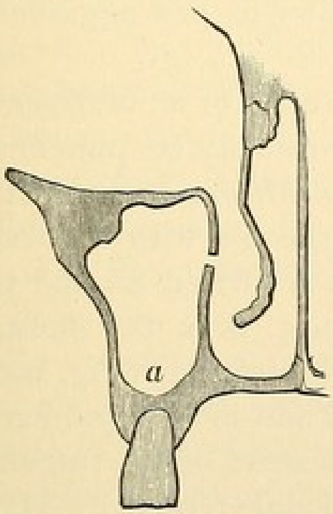


FIG. 904. SCHEMATIC FRONTAL SECTION OF THE RIGHT ANTRUM OF HIGHMORE AND THE NARES

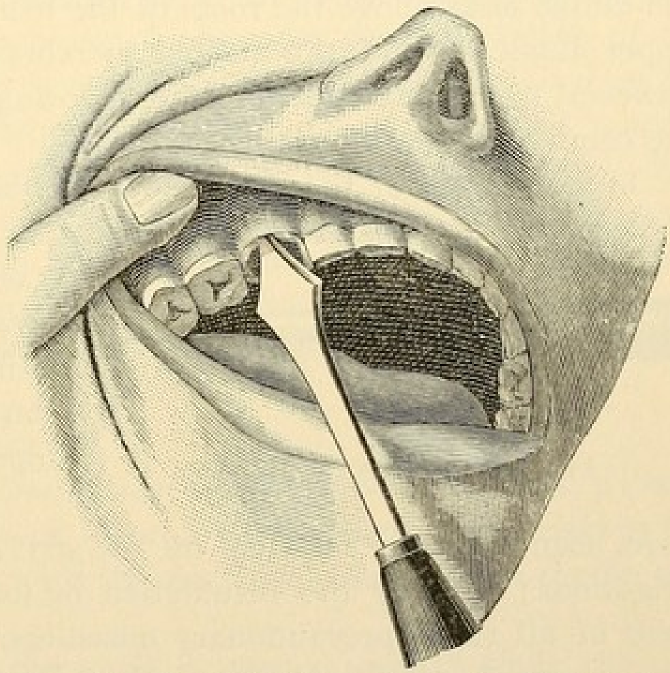


FIG. 905. OPENING THE ANTRUM OF HIGHMORE WITH BORING CHISEL

I. After *the removal of diseased teeth or roots of teeth*, when, as a rule, pus already escapes, an alveolus is perforated, preferably that of the second molar tooth (most dependent point of the antrum, Fig. 904 *a*); the antrum is perforated with a strong bone drill (*boring chisel*, *curette*), and the opening *enlarged* by boring movements with instruments of increasing size, until the little finger can be introduced.

II. After the cavity has been palpated as to its contents, a *strong drainage tube is inserted*, by means of which frequent disinfecting and astringent irrigations can be made. Small *glass or metal tubes* are best adapted to drainage, since the opening must be allowed to remain until the whole rigid-walled (" starrwandig ") cavity begins to close of itself. If, as a result of these irrigations, the pus has become odorless, *a plate with one tooth*, made by a dentist, is employed. *The long root of this tooth* extends into the cavity and keeps the canal open.

Aside from its cosmetic advantage, the artificial tooth assists the patient in mastication; it can be removed after each meal, when the antrum of Highmore has to be irrigated.

For the *removal of sequestra*, the alveoli of several teeth are nipped off with the bone-cutting forceps until the opening appears to be sufficiently large.

In *subperiosteal cysts of the anterior wall of the jaw*, which frequently simulate hydrops of the antrum, the operator may also *bore into and drain* the canine fossa above the roots of the teeth by a small incision through the upper duplicature of the mucous membrane of the mouth. It is difficult, however, to keep the opening from closing, and the flow of pus aggravates the condition.

If the disease of the antrum of Highmore is the result of an *obstruction of its outlet*, the nasal wall of the antrum of Highmore may be punctured (according to *Miculicz*) from the lower nasal passage with a curved stilette, which is carried around the turbinate bone; thus the normal opening may be restored (Fig. 906).

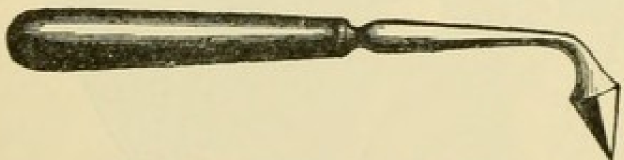


FIG. 906. STILETTE OF MICULICZ

Very good and more rapid cures have been obtained recently by the *dry treatment* instead of by frequent irrigations; viz., by the insufflation of iodoform or iodol (*Krause*). If, in spite of all these precautionary measures, recurrence takes place in obstinate cases, *the whole anterior wall of Highmore's antrum must be removed* (*radical operation*).

A broad opening of the antrum of Highmore made through the thin plate of the *canine fossa* affords most space. The upper lip having been turned upward, the duplicature of the mucous membrane above the first three molars is divided down to the bone; the periosteum is reflected upward as far as the infra-orbital foramen, and the thin wall between the frontal process and the malar bone is opened with a gouge.

For exposing *the antrum of Highmore and the nasal passage*, *Kocher* resects a portion of the upper jaw *osteoplastically*.

1. *External incision* as in resection of the upper jaw (Fig. 894); but the upper lip is not incised.

2. With bone forceps and a fine chisel, the bones are divided above, beginning from the nasal bone obliquely inward through the cribriform plate as far as the inferior orbital fissure, from the lower margin of the pyriform aperture to the infra-orbital canal, next from the horizontal skin incision the orbital plate of the upper jaw along the infra-orbital canal.

3. If the chiselled portion of bone, together with its soft parts, is turned *outward*, a good view of the nasal passage and the antrum of Highmore can be obtained.

RESECTION OF THE LOWER JAW

In the removal of tumors and necroses of the lower jaw, the surgeon is compelled to resect more or less large portions of the jaw.

I. **Resection of the alveolar process,** as in the upper jaw, is made with large *gouge forceps, chisel, or metacarpal saw.* In case retraction of the under lip does not afford sufficient space, then by a *horizontal incision* the operator may divide the skin along the lower duplicature of the mucous membrane of the cheek; the detached piece of lip is turned upwards. The alveolar margin can be removed very safely and rapidly, if the operator uses a chisel, holding it with one hand and controlling it with the other, while an assistant does the hammering (*Roser, three-handed chiselling*).

II. **For resection of one-half of the lower jaw,** the procedure is as follows: —

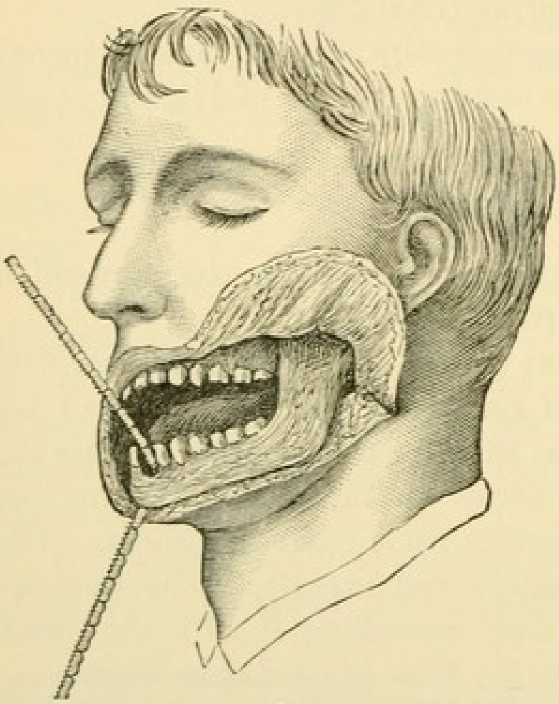
1. *Extraction* of the middle *incisor.*

2. *From the middle of the lower margin of the chin*, a small pointed knife is inserted through the skin of the chin and pushed upward along the *anterior surface of the lower jaw* until its point projects between the lip and the row of teeth.

3. From the same opening, the knife is pushed upward along the *posterior surface* of the lower jaw until the point appears at the frenum linguæ behind the row of teeth.

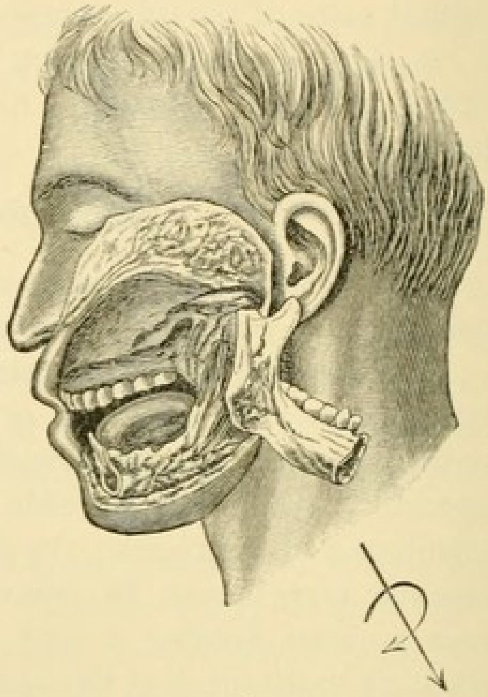
4. **Division of the lower jaw by sawing in the median line,** either with the *chain saw* (Fig. 907) from behind forward, or with the *metacarpal saw* from before backward. The soft parts on the side in the direction of which the saw is advancing must be protected from laceration by a spatula placed underneath or by a strip of tin. If the metacarpal saw is used, the remainder of the bone may be divided with the bone-cutting forceps after half of the jaw has been sawed through.

5. From the point where the incision through the lip was commenced, a free **incision is made along the lower margin of the jaw** as far as the angle, or, if the branches of the facial nerve are to be preserved, the incision is made from the hyoid bone upward and backward and ending the breadth of the thumb behind and below the angle of the jaw (*Kocher*); *the external maxillary artery* thereby severed is doubly ligated.



a

Fig. 907



b

Fig. 908

Resection of One-half of the Lower Jaw. *a*, external incision and division of bone by sawing; *b*, rotating condyle out of the glenoid cavity

6. If it is deemed necessary, the incision is prolonged along the posterior margin of the ascending ramus of the jaw until within a finger's breadth below the lobule of the ear; but *not higher,* else the upper branches of the facial nerve, the transverse facial artery, and the parotid gland might be injured. If, during the subsequent steps of the operation the hemorrhage becomes profuse, Kocher suggests a resort to *ligation of the external carotid* above the superior thyroid or the direct ligation of the lingual artery after the skin incision.

7. *Detachment of the skin,* mucous membrane, and the masseter from the anterior surface of the lower jaw.

8. The lower jaw is pressed *downward and outward* until its sawed surface projects through the median angle of the wound. The *soft parts are separated from the internal surface of the bone* (mylohyoid

muscle, geniohyoid, internal pterygoid, submaxillary gland, and mucous membrane).

9. By a more forcible depression of the lower jaw, the *coronoid process* is made to project; from this the tendon of the *temporal* muscle is *detached*. Since this, however, is rather difficult to do, the operator may cut off the coronoid process with the bone-cutting forceps (*Chassaignac*).

10. After the parotid and the inner surface of the masseter have been retracted from the ascending ramus of the jaw by means of an elevator, the portion of the jaw is firmly grasped with the hand, and by a vigorous pressure from **without downward,** the **condyle is rotated** forcibly out from the glenoid cavity (Fig. 908). By this means, the articular capsule, the ligaments of the joint, and the insertion of the external pterygoid muscle are torn off from the neck of the bone, the periosteum is detached from the neck in form of a ring, and the nerve and the mandibular artery are *torn out* from the canal (torsion). If a clean enucleation with the knife is made, the severing of this artery and the almost unavoidable *injury to the internal maxillary artery* coursing close behind the neck would cause considerable hemorrhage.

11. After the removal of the bone, the hemorrhage, as a rule, is slight; should hemorrhage of the mandibular artery occur from the sawed surface of the other side, a ball of wax is forced into its lumen.

12. The *margins of the mucous membrane of the mouth*, as far as it can be preserved, are *sewed together;* thereby the wound is excluded from the cavity; the external wound is sutured and drained.

In all cases in which *complete exposure and survey of the field of operation* are of special importance, the surgeon must not hesitate *to divide the lower lip and the skin of the chin in the median line*, and thus form an *angular incision.* By detaching the flap of skin, one-half of the lower jaw is laid completely bare (Fig. 897).

In the same manner *the entire lower jaw* can be removed — if possible, in two stages, separated by a somewhat long interval.

III. **Resection of the maxillary arch** is made mostly *for the removal of tumors*, and in a similar manner as resection of one-half of the jaw.

1. After the extraction of *the two teeth* between which the operator desires to remove the lower jaw, the *external incision* is made in accordance with the extent of the disease, *along the lower margin of the chin;* the soft tissues are detached in an upward direction. *The lip, too, may be divided perpendicularly*, if necessary, and the flaps thus obtained can be turned backward in a direction like the wings of a double door.

2. *The bone is divided* as described above. Since, by the removal of the median portion, the arch of the jaw becomes smaller, so that, as the jaws no longer fit one upon the other, mastication is rendered difficult or impossible, and since the contour of the face suffers, it is very advisable to preserve, if possible, *a portion of the bone*, no matter *how small*, either on the lower margin or on the inner surface.

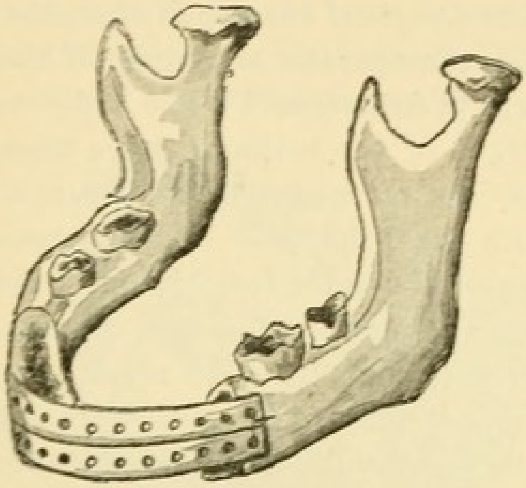


FIG. 909. METAL STRIPS TO BE USED AS PROTHESIS AFTER RESECTION OF THE MAXILLARY ARCH (Bartsch)

If this is not possible, some mechanical support must be constructed to fill in the defect.

According to *A. Martin*, it is advisable directly after the removal of the bone to insert an exactly fitting hard rubber prothesis, which, by means of metal clasps, surrounds the bone, and is fastened to it with screws, after which the external incision is sutured. It is still better to insert, instead of hard rubber, gold or aluminium bronzed wire (*Bönnecken*), or to use small strips of Victoria metal (*Hannsmann, Bartsch*, Fig. 909). *Bardenheuer*, in resecting the angle of the lower jaw, implanted successfully a portion of bone which he had taken from the lower

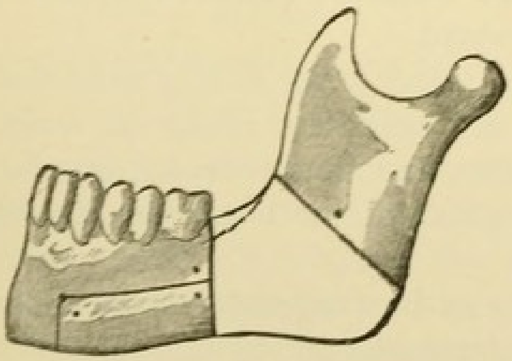


FIG. 910

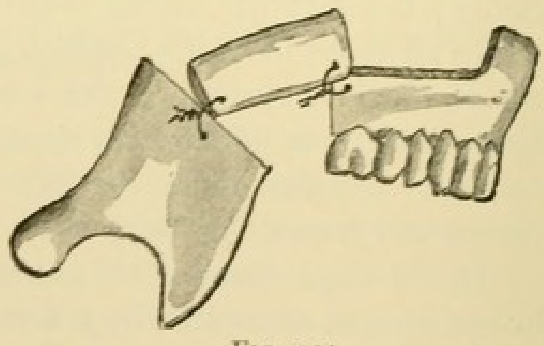


FIG. 911

BARDENHEUER'S OSTEOPLASTY AFTER RESECTION OF LOWER JAW

margin of the maxillary arch, inserted it into the gap, and secured it in place by sutures (Figs. 910, 911).

3. When *the soft parts* along the inner surface of the jaw *are detached*, a great danger threatens the patient from the *detachment of the two genioglossi muscles*, which alone are able to hold the tongue forward. If their function is suspended, *asphyxia* may ensue from closure of the larynx by

the falling back of the base of the tongue, especially when the head is *bent backward.* It is, therefore, advisable to postpone detaching these muscles until near the end of the operation, to place the patient's head in a forward and downward position, and to secure the tongue by a thread loop or by hooked forceps. *Delpech* sutured the base of the tongue to the skin of the neck.

IV. **Resection of the articulation of the lower jaw** is indicated in *purulent and chronic inflammation* and in *ankylosis* of the same.

1. A small *external incision* is made downward about one centimeter in front of the anterior margin of the ear. The *temporal artery*, ascending in front of the ear and easily felt, must not be injured.

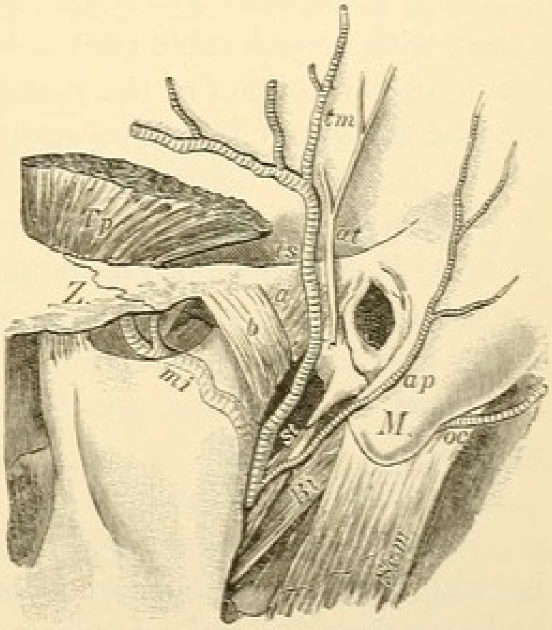


FIG. 912. TOPOGRAPHY OF THE TEMPORO-MAXILLARY ARTICULATION. *Z*, zygomatic process; *M*, mastoid process; *a*, capsular ligament; *b*, accessory lateral ligament; *Tp*, temporal muscle; *Scm*, sternocleidomastoid; *Bi*, biventer; *St*, stylohyoid; *mi*, internal maxillary artery; *ts*, superficial temporal artery; *tm*, middle temporal artery; *ap*, posterior auricular artery; *oc*, occipital artery; *at*, auriculotemporal nerve

2. After the *soft parts* and the periosteum *have been reflected, the neck of the maxilla* is exposed; this is divided transversely *by careful strokes with the chisel* (Fig. 883). The *articular end*, which *has become loose*, is removed with bone forceps. *The internal maxillary artery*, coursing closely behind it, must not be injured. This artery might easily be injured if the resection were made with the metacarpal saw or with the bone-cutting forceps.

During *the after treatment, a movable nearthrosis, to as high a degree as possible*, must be obtained by frequent gymnastics of the jaw.

In *ankylosis*, whether produced by *cicatricial bands*, or possibly by *bony union* of a portion of the inferior with the superior maxilla, *the simple division of the bands and of the shortened muscles* is of little avail, even if it is followed by a gradual stretching of the same by means of oral specula and gags. In cicatricial contraction of the masseter and the pterygoid muscles the operator may try to detach the insertions of these muscles from the bone (*Le Dentu*). Cicatricial bands of the mucous membrane of the cheek are extirpated; the defect thus caused must be covered by major plastic operations, according to the rules of meloplasty (see page 88, *Gussenbauer*). In cases where this is not possible, or where it does not produce the desired effect, the jaw bone must be laid bare in front of the site of the cicatrix, and *a piece about two or three centimeters long* must be sawed out from its thickness (*von Esmarch*); **a false articulation** is thereby produced, consisting of fibrous union, which enables the patient to open the mouth and masticate. *Baum* resected a *wedge-like piece* from the angle of the jaw. The *simple division* of the jaw *by sawing* (*Rizzoli*) tends very rapidly to produce a bony reunion of the fragments. *Resection of the articular end* (see page 491) has been recommended by *Bottini* and *König* as the most successful procedure in osseous ankylosis. *Küster* divided also the coronoid process to relieve the tension of the temporal muscle. In serious cases, with considerable contraction of the muscles and ligaments, even the whole upper portion of the ramus of the lower jaw directly over the lingula may be removed (*Mears*) by adding a transverse incision along the lower margin of the malar bone to the incision mentioned on page 491. To prevent *a reunion* (*by growth*) of the resected jaw with the acetabulum (glenoid cavity), *Helferich interposes* a flap taken from the *temporal muscle*, which at the same time prevents too great a displacement of the lower jaw in an upper and backward direction. By this means, the position of the jaw and the form of the face are better preserved than by a simple extensive resection.

He proceeds as follows: —

1. A *longitudinal incision* four centimeters long is made a finger's breadth in front of the ear, penetrating deep down (protecting the parotid and also the temporal artery) until the bone in the region of the articulation of the jaw is exposed.

2. The articular process of the lower jaw is resected with the chisel to an extent of more than one centimeter above and below, without preservation of the periosteum.

3. After enlarging the external incision in an upward direction, a longer *flap* three centimeters broad with a lower base is excised from the *temporal muscle* and turned over downward, so that it can be placed *around the malar bone* into the defect, where it is fastened by a few lateral sutures. If the turning over causes any difficulty, a corresponding portion is resected from the zygomatic arch.

4. The wound in the temporal muscle is diminished by buried sutures; the external wound is closed completely without drainage.

Subperiosteal resection of the lower jaw for **phosphorus necrosis,** *Dumreicher* makes as follows: —

From an *incision* made along the lower margin of the jaw throughout the whole extent of the swelling of the bone, the gums and the ensheathing periosteum are detached from the bone on the anterior and posterior surfaces. The bone thus exposed is *divided* at both limits of the necrosis with a metacarpal or a chain saw, and the loosened portion is extracted. The bone can also be removed subperiosteally from the mouth after an incision has been made at both limits of the necrotic area about 3 centimeters in length along the lower margin of the jaw; and, after the detachment of the soft parts from the anterior and the posterior wall, the bone is sawed through on both sides.

Concerning the **temporary resection of the lower jaw,** see below (amputation of the tongue).

NERVE STRETCHING AND NERVE RESECTION

In obstinate diseases of the peripheral nerves, which will not yield to any internal remedies, a surgical operation is justifiable and proper.

Least destructive, but at the same time productive of permanent relief only in rare cases, is

Neurotony, nerve stretching.

With a knife, the nerve is laid bare at an easily accessible place, grasped with a blunt hook or with the fingers, separated from the underlying tissues, and *forcibly stretched.* This force, of course, must be adapted to the tensile strength and the thickness of the nerve trunks; for example, while the facial nerve is easily torn, on the other hand the whole leg may be lifted by the sciatic nerve. Whether the stretching has been sufficient may be determined by the *serpentine position* of the nerve after the operation.

Neurotomy, simple division of the nerve, is only *temporarily* useful, because, by the rapid reunion of the severed ends, *conductivity* is too soon *restored.* Its place, therefore, has been taken by

Neurectomy, nerve resection, that is, the excision of as long a portion of the nerve as possible. This procedure is especially suitable for the purely sensory nerves (trigeminus), for which *preliminary operations* of considerable magnitude are required. *Thiersch,* however, has shown that sufficiently large portions of the nerve can be removed without these preliminary measures by

Neurexairesis, nerve extraction, that is, the *tearing out* of the nerve. For this purpose it is necessary to expose the nerve at one place only. Next, with the *Thiersch forceps* (Fig. 913), it is grasped transversely and by slow *turns wrapped around* the forceps. During this traction, the peripheral, as well as the central, parts of the nerve, together with its ramifications, may be stretched considerably before they tear off as a result of too great

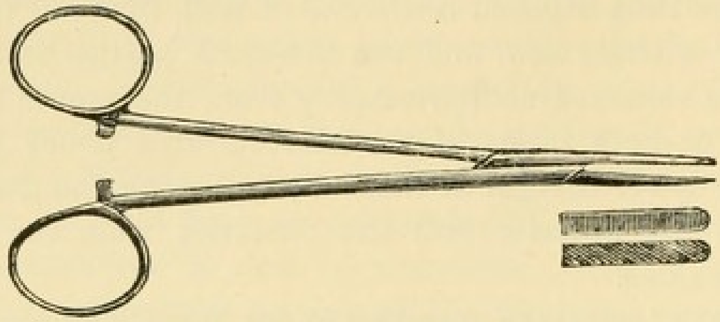


FIG. 913. THIERSCH'S FORCEPS FOR NERVE EXTRACTION

tension. In this manner, portions of nerves from 5 to 7 centimeters long may be torn off from one point, while the parts still remaining are greatly stretched.

Nerve stretching has been made: —

1. In disturbances of *sensibility and motility* (*neuralgias*, tonic and clonic spasms), especially when their cause consists in a peripheral disease, incurable in itself.

2. In *reflex epilepsy*, if it originates from the peripheral nerves.

3. In *traumatic tetanus*.

Resection and extraction of nerves is more especially made for the relief of *obstinate neuralgias of the several branches of the trifacial nerve* (Fig. 914).

THE SITES FOR LOCATING THE SEVERAL NERVES

are as follows: —

SUPRA-ORBITAL NERVE

The *first branch of the trigeminus, the ophthalmic nerve*, enters the orbit through the *superior orbital fissure*, and takes its course as *the supra-orbital nerve*, between the roof of the orbit and the levator of the upper eyelid, and then in a straight anterior direction to *the supra-orbital notch*, where it divides into branches in the skin of the forehead. Not rarely it gives off some branches previously, which, as *frontal and supratrochlear nerves*, extend up to the forehead and over the internal portion of the superior margin of the orbit (Fig. 914, *I*).

1. *External incision in the form of a curve* 3 centimeters long, taking its course closely below the shaved-off eyebrow along the orbital margin.

2. Division of the fibres of the *orbicular muscle* and the *tarso-orbital fascia*.

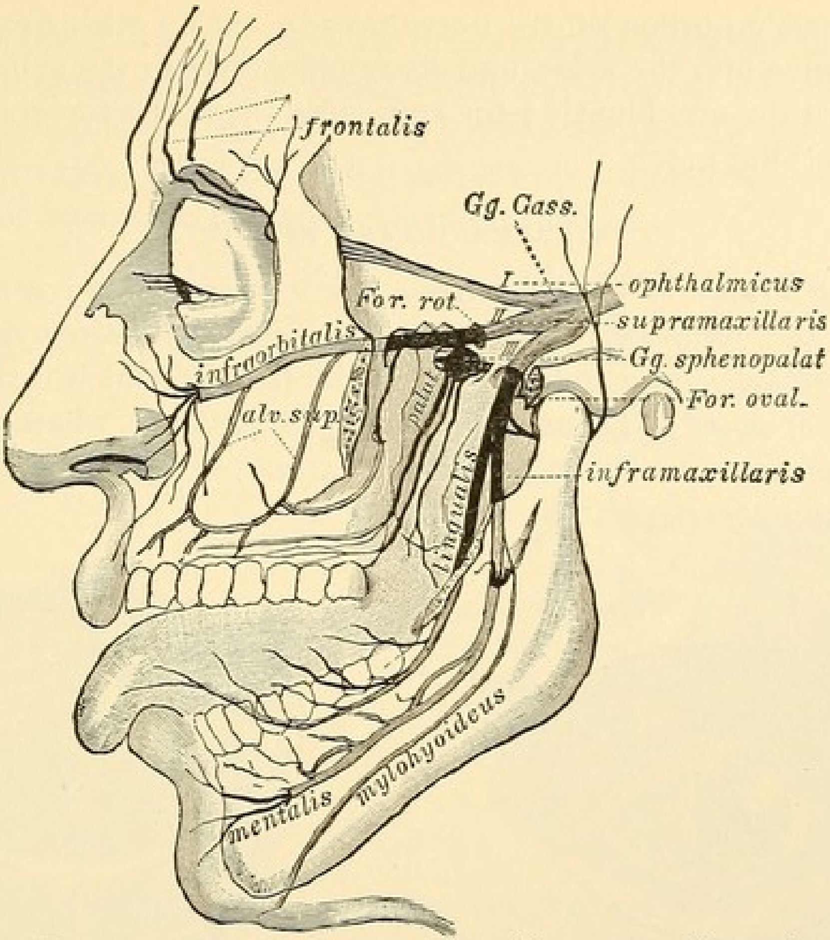


FIG. 914. DIAGRAM OF THE DIVISIONS OF THE TRIGEMINAL NERVE, ZYGOMATIC ARCH, AND MANDIBULAR PLATE, RESECTED ACCORDING TO KRÖNLEIN

3. With a spatula, the *levator palpebræ superioris* muscle is pushed *downward* together with the eyeball; the nerve can then be seen running

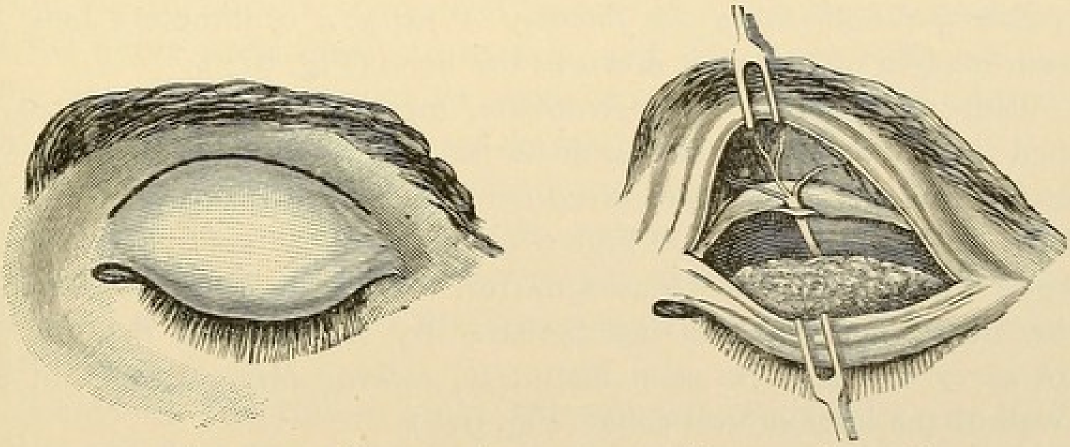


FIG. 915 EXPOSING SUPRA-ORBITAL NERVE FIG. 916

along the roof of the orbit between the fatty orbital layer and the periosteum, and can easily be grasped and drawn forward with a strabismus hook; *the frontal nerve* is found more toward the inner side (Fig. 916).

The accessible portion of the nerve may be cut off with *Cooper's scissors* near its entrance into the orbit, and its ramifications in the skin of the forehead may be torn out bluntly; for *extracting* them, the forceps are applied at the supra-orbital notch.

SUPRAMAXILLARY NERVE

The second branch of the trigeminus, the *supramaxillary nerve*, takes its course from the *foramen rotundum in* the *sphenomaxillary fossa* through the *inferior orbital fissure* to the orbit, in the floor of which it runs along in the *infra-orbital canal* as far as the *infra-orbital foramen*, where it ramifies in a fascicular manner, as the *pes anserinus minor*, in the canine fossa under the *levator labii superioris* (Fig. 914, *II*).

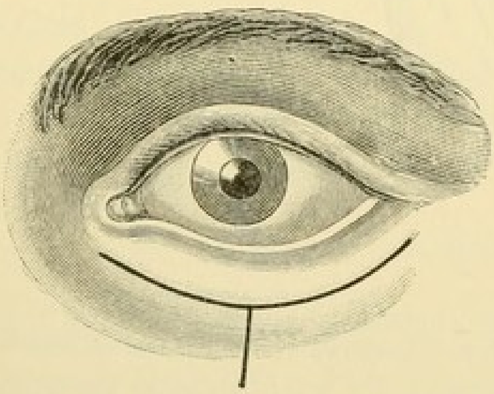
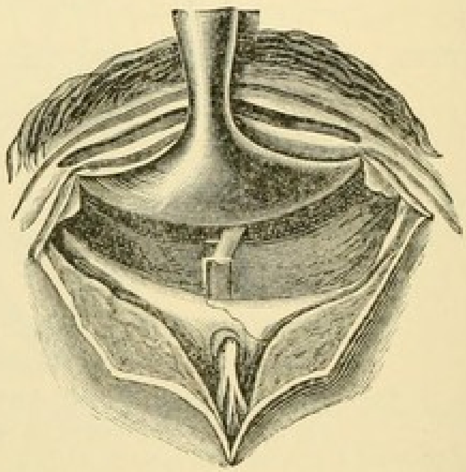



FIG. 917 EXPOSING INFRA-ORBITAL NERVE FIG. 918

1. *External incision in the form of a curve* 4 centimeters long along the lower margin of the orbit down to the bone (Fig. 917).
2. With an elevator, *the periosteum*, together with the soft parts, is detached from the floor of the orbit as far as the *infra-orbital groove*, and all the contents of the orbit are lifted from the bone by means of the *reflecting hollow refractor* (*Wagner*, Fig. 919), a spoonlike spatula, the external surface of which is as smooth as a mirror. If necessary, a silver teaspoon may be substituted for this instrument. By the side of the artery the *whitish nerve* can now be seen distinctly, *shining through* the thin upper bony wall of the infra-orbital canal (Fig. 918).
3. In case a larger portion of the nerve is to be *resected*, the *thin wall of the infra-orbital canal is opened* with a fine chisel; the nerve is drawn forward with a tenaculum, and *cut off* with scissors *at its place of entrance into the orbit*, as far back as possible.

4. At its place of exit in the infra-orbital foramen the *pes anserinus minor* is exposed, if necessary, by a small additional external incision in a downward direction (Fig. 917, *a*). From this place the already severed end of the nerve is drawn from the infra-orbital canal with a tenaculum or with forceps, and cut off or torn from its ramifications in the skin.

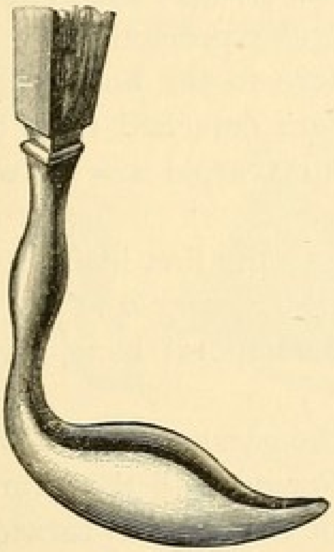


FIG. 919. WAGNER'S REFLECTING HOLLOW REFRACTOR

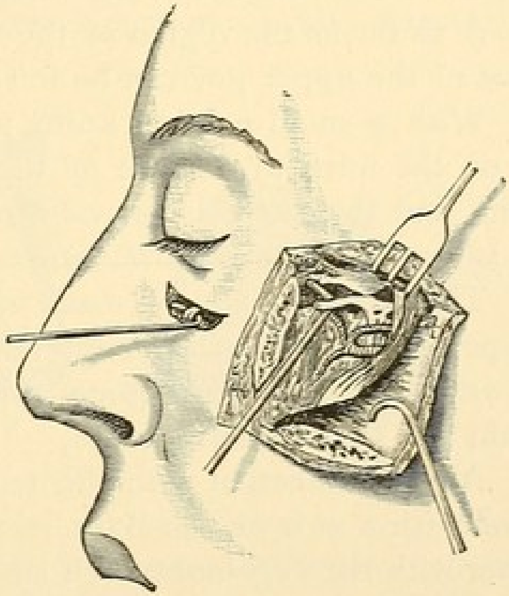


FIG. 920. NEURECTOMY OF THE INFRA-ORBITAL NERVE. *b*, Lücke-Braun-Lossen's resection of the malar bone; *a*, Thiersch's method of exposing infra-orbital nerve for extraction

For *extracting the nerve* on this branch it is sufficient to *expose* its *place of exit* at the infra-orbital foramen (Fig. 920, *a*). The forceps are introduced under the nerve transversely to its axis, and, by slowly rolling it up, twist out the central part (as far as its place of entrance into the orbit) and its peripheral extensions (*alveolar and dental branches*).

For dividing the superior alveolar nerves, *von Langenbeck* detached with raised upper lip the duplicature of the mucous membrane from the bone by a long incision; and with the metacarpal saw or chisel he divided the anterior wall of the antrum of Highmore from the nose as far as the pterygoid process.

If it appears desirable to make the supramaxillary nerve accessible *as far as its exit from the cavity of the skull* (*foramen rotundum*), the surgeon performs :—

NEURECTOMY OF THE SUPRAMAXILLARY NERVE WITH TEMPORARY RESECTION OF THE MALAR BONE (*Lücke-Braun-Lossen*)

1. *The external incision is in the form of an angle. The first incision* begins 1 centimeter above the external angle of the eye, and 2 to 3 millimeters from the external orbital margin; in *an anterior direction it descends obliquely* as far as the region of the third upper molar, where the zygomatic process of the upper jaw can be felt as a sharp angular projection.

2. With a small pointed knife, always kept close to the bone, the soft parts on the internal surface of the malar bone are detached from below upward, and the latter is *sawed through* with a metacarpal saw or with a chain saw *obliquely toward the median line.*

3. The *second incision* is made at a right angle to the first incision from its upper end, in a posterior direction *along the upper margin of the zygomatic arch* as far as the zygomatic process of the temporal bone, dividing the skin and the temporal fascia.

4. At its connection with the temporal bone the *zygomatic arch* is then *divided* with a saw or chisel (or merely nicked, *Braun*), and the skin flap, together with the zygomatic arch and the masseteric insertion, is **turned in a downward direction** (Fig. 920).

5. After the anterior fibres of the temporal muscle, if necessary, have been divided, the masses of fat bulging from the *sphenomaxillary fossa,* together with the *venous plexus and the internal maxillary artery*, are pushed backward with broad retractors; if necessary, the fatty tissue lying below may be cut away.

6. The nerve is now sought for with a strabismus hook introduced into the infra-orbital groove, and an attempt is made to *separate* the nerve *from the infra-orbital artery;* the artery, a branch of the internal maxillary, takes its course *from without backward* and *downward;* the nerve take its course *from behind inward and upward,* obliquely *forward, downward, and outward,* and may be traced *centrally as far as the foramen rotundum.*

7. While the nerve is vigorously drawn forward with a tenaculum, it is divided with pointed curved scissors ("*Hohlscheere*") as near the foramen rotundum as possible; its peripheral branches, together with the severed pieces, are evulsed.

Kocher reaches the foramen rotundum by avoiding the facial branches **by turning the malar bone in an outward direction.**

1. External incision, beginning 1 centimeter towards the median line at the palpable infra-orbital foramen, takes its course forward and in an

external direction, somewhat obliquely downward as far as the zygomatic arch (Fig. 921); ligation of the angular artery, avoiding Steno's duct; division of the orbicular muscle of the eye, which together with the periosteum is raised as far as the orbit. The musculus quadratus of the upper lip is detached subperiosteally, and the infra-orbital nerve thereby exposed is grasped with a strabismus hook at the place of its exit. The insertions of the zygomatic muscles and of the anterior portion of the masseter are detached from the malar bone.

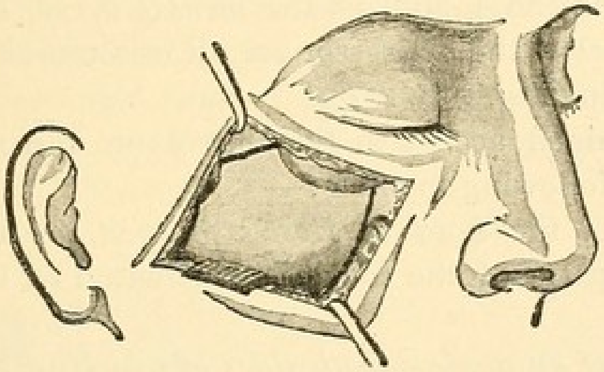


FIG. 921

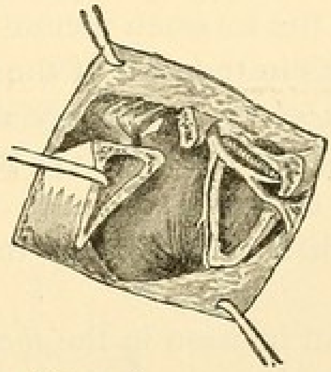


FIG. 922

KOCHER'S METHOD OF EXPOSING THE SUPRAMAXILLARY NERVE AT THE FORAMEN ROTUNDUM

2. The zygomatic arch is freed internally and externally, and chiselled through obliquely; the union with the upper jaw is divided so that the incision from the infra-orbital canal, which is opened lengthwise, extends as far as the anterior insertion of the masseter through the superior wall of the antrum of Highmore. The nasal process is chiselled through obliquely in an inward direction.

3. The malar bone is then turned *upward and outward* by means of a bone hook (Fig. 922), and the fatty orbital layer is raised with a blunt hook. The infra-orbital nerve may then be inspected with ease as far as the foramen rotundum, and may be grasped, divided, or extracted behind the spheno-palatine nerve coursing downward.

4. The turned-up malar bone is then replaced in its former position; bone sutures are usually superfluous. The external wound is sutured throughout its whole extent.

THE INFRAMAXILLARY NERVE

The third branch of the trigeminus, or inframaxillary nerve, makes its exit from the cavity of the skull through the *foramen ovale*, and at once divides into several branches, of which the most important sensory are: *the auriculotemporal nerve*, which ascends around the articular process of the lower jaw in front of the ear; the *lingual nerve and the maxillary nerve*, both of which course downward and forward behind the internal pterygoid muscle and the inner surface of the lower jaw. *The lingual nerve* then takes its course along the floor of the cavity of the mouth and in a lateral direction to the tongue; *the maxillary nerve* enters, together with the accompanying artery, *into the maxillary canal at the lingula* and together with the artery courses along the canal, and, as the *mental nerve*, leaves it through the foramen mentale below the depressor anguli oris muscle where it ramifies in the skin of the chin (Fig. 914, *III*).

Sonnenberg and Lücke obtained access to this nerve on the *internal surface of the lower jaw* in the following manner: —

The operation is made with the *head in Rose's position*, to afford a more satisfactory view of the parts of the lower jaw, situated on its inner surface.

1. An incision in the *form of an angle — both sides of which are equal* — from 5 to 6 centimeters long, through the skin and the periosteum, running closely around *the angle* of the lower jaw (Fig. 923).

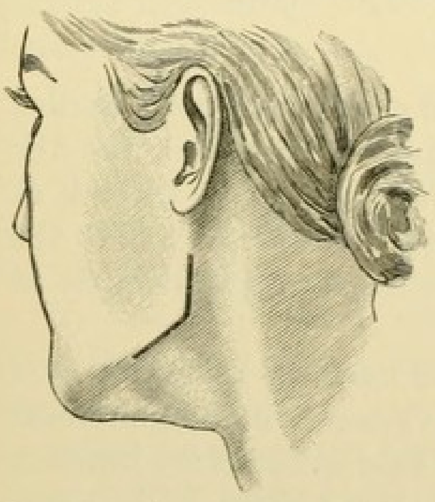


Fig. 923. Sonnenberg - Lücke's Method of exposing Infra-maxillary Nerve

2. The periosteum on the internal surface of the lower jaw, together with the *insertion* of the *internal pterygoid muscle*, is *detached* with an elevator and pushed upward and backward until the projecting bony lamina of the *canal* is felt (Fig. 909).

3. Guided by the finger, a tenaculum is now introduced upward and inward as far as the canal; with a tenaculum, the nerve is separated from the accompanying artery, drawn strongly forward, and held firmly with torsion forceps.

4. Either the nerve can then be *resected* by dividing it first close to the opening of the canal and then as far toward the central portion as possible (centrally), or, according to *Thiersch*, it can be *torn out* with the *Thiersch forceps* instead of with the torsion forceps. Around these forceps, the whole peripheral part, as it issues from the dental canal, and also the central portion of the nerve as far as the base of the skull are twisted and forcibly extracted.

Kühn and Bruns removed portions of *the angle* of the lower jaw in order to expose the dental canal.

Bruns made a *curved external incision* along the posterior margin of the lower jaw from the ear downward as far as the anterior insertion of the masseter. The parotid gland is pushed backward; the detached masseter upward. From the angle of the jaw, now easily accessible, a *rhomboid piece* from 1 to $1\frac{1}{2}$ centimeters wide and from 3 to $3\frac{1}{2}$ centimeters long is *sawed out* from its posterior margin and detached from the *internal pterygoid muscle* (Fig. 924, *a*); the nerve, lying in the open canal, can then be easily drawn forward with a tenaculum.

Velpeau and Linhart chiselled an *opening* in *the anterior surface of the lower jaw*, through which the canal is opened (Fig. 925).

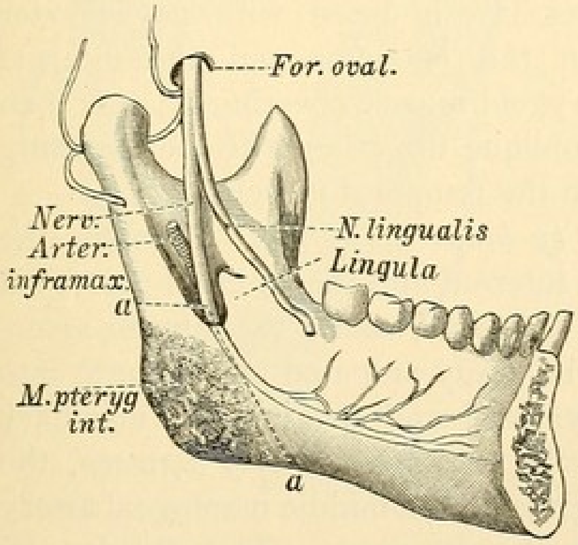


FIG. 924. INTERNAL HALF OF LEFT LOWER JAW. *a, a*, saw incisions according to Bruns

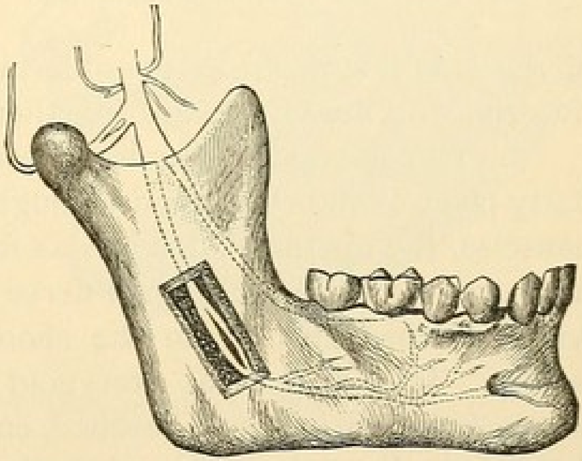


FIG. 925. EXTERNAL HALF OF RIGHT LOWER JAW WITH VELPEAU-LINHART FENESTRA

1. *External incision* from 3 to 4 centimeters long in the *median line* of the ascending ramus of the lower jaw.

2. After the *masseteric fascia* has been split and *Steno's duct* exposed, the latter is drawn upward together with the *transverse facial artery;* the fibres of the *masseter* are *divided lengthwise.*

3. The periosteum is split in the same direction, and pushed back with a raspatory until a sufficient portion of the jaw has been exposed.

4. With chisel and hammer, a *rectangular piece* is chiselled off from the anterior wall, layer by layer (Fig. 925), until the *canal has been opened* and the nerve, together with the artery, can be seen coursing through it; here it may be grasped with facility.

The **foramen ovale** may be reached as follows : —

(*a*) By the **retrobuccal method** of *Krönlein* (Fig. 926).

1. *Transverse incision of the cheek*, beginning 1 centimeter from the angle of the mouth and ending 1 centimeter in front of the lobule of the ear; division of the fatty tissue. The buccinator muscle and the mucous membrane of the cheek remain uninjured. Division of the anterior two-thirds of the masseter with careful avoidance of the parotid gland and Steno's duct.

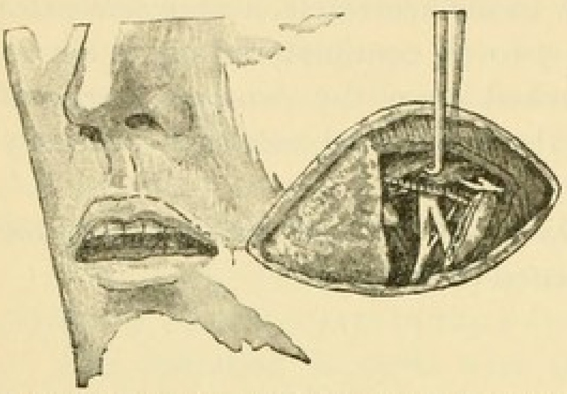


FIG. 926. KRÖNLEIN'S RETROBUCCAL METHOD

2. The coronoid process of the lower jaw is freed with an elevator from the masseter and the internal pterygoid muscle covering it; it is then divided as low down as possible in an oblique direction with bone-cutting forceps, and drawn upward together with the temporal muscle.

3. The nerves are made accessible *by blunt dissection*. Through the fatty layer of the cheek and through the internal and the external pterygoid muscles, the operator advances as far as the *canal*, where the inferior alveolar nerve and also the lingual nerve can be easily palpated and brought into view; farther upward lie the chorda tympani and the internal maxillary artery. If the external pterygoid muscle is drawn *forcibly upward*, the *auriculotemporal* nerve is reached, encompassing the middle meningeal artery behind the lingual nerve and the inferior alveolar nerve. Thus the *base of the skull* is reached, where the nerves can be extensively resected, or where, according to *Thiersch*, they can be removed by extraction.

By this method, also, single twigs of the third branch of the artery can be removed if desired: the buccinator nerve, the inferior alveolar, the lingual, and the auriculotemporal.

(*b*) *Miculicz* makes a **temporary resection of the lower jaw**: —

1. *External incision* along the sternocleidomastoid from the mastoid process as far as the level of the great cornu of the hyoid bone; thence in a short curve upward to the anterior margin of the masseter and $1\frac{1}{2}$ centimeters beyond the margin of the lower jaw (Fig. 927).

2. The bone and the cervical portion of the parotid gland are exposed; the ligament extending from the lower jaw to the fascia of the sternocleidomastoid is divided.

3. The jaw is *sawed through by the step method.* Along the anterior margin of the masseter, the most anterior insertions of which must in most cases be also removed, the periosteum at the external and the internal surface of the lower jaw as far as and behind the last molar is exposed without injuring the mucous membrane of the mouth. With a chain or wire saw, the bone is divided perpendicularly half through from behind the molar; 1 centimeter farther toward the front, the bone, from the outside, is also sawed half through with a metacarpal saw, and the middle portion is chiselled through horizontally (Fig. 927 ⌐——).

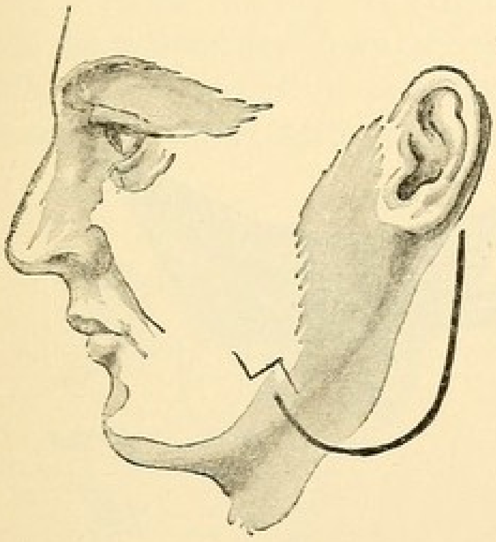


FIG. 927

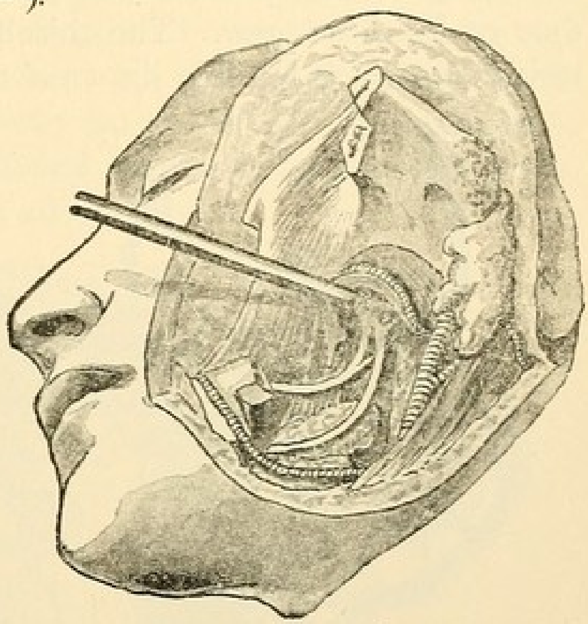


FIG. 928

MICULICZ'S METHOD OF EXPOSING INFRAMAXILLARY NERVE

4. The portions of bone are forcibly drawn apart with hooks, the insertion of the internal pterygoid muscle is detached, the inframaxillary nerve behind the canal is drawn out, and the lingual nerve, running immediately below the mucous membrane of the mouth along the molar teeth, is sought for. By advancing bluntly upward along these trunks of nerves, during which procedure the external pterygoid muscle must be forcibly drawn inward and upward, the *foramen ovale* is reached (Fig. 928).

5. The nerves having been resected, the lower jaw is united by a bone suture of silver wire (the step form of the fracture prevents a displacement of the fragments by muscular traction); a gauze tampon is inserted behind the angle of the jaw, and the external wound as far as the drainage opening is sutured.

6. In the after treatment, care must be taken that the mouth be thoroughly cleansed, in case the mucous membrane has been injured.

(*c*) *Kocher* reaches the foramen ovale after **temporary resection of the zygomatic arch.**

1. External incision from the frontal process of the malar bone obliquely downward as far as below the posterior end of the zygomatic arch, then upward at right angles in front of the ear; ligation of the temporal veins; division of the superficial and the temporal fascia, which are drawn downward (Fig. 929).

2. *Chiselling through the zygomatic arch;* anteriorly directly behind the ascending frontal process and posteriorly immediately in front of the condyle of the lower jaw. The chiselled-out portion, together with the masseteric insertion, is forcibly drawn *downward.*

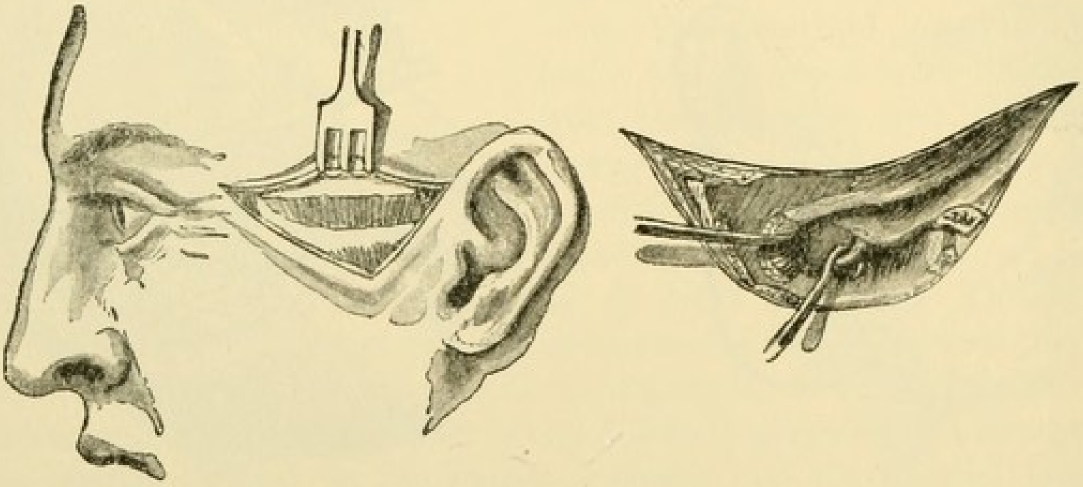


FIG. 929 FIG. 930
KOCHER'S METHOD OF EXPOSING THE SUPRAMAXILLARY NERVE AT THE FORAMEN ROTUNDUM

3. The *temporal muscle* now exposed, covered by fat, is *forcibly* drawn *forward* with a blunt hook from behind; in case of necessity, the coronoid process is divided with the bone-cutting forceps.

4. The periosteum of the infratemporal crest is divided from the root of the zygomatic arch in an anterior direction and together with the soft parts is pushed back *toward the middle line* from the base of the skull as far as the pterygoid process. The *foramen ovale* can be felt immediately behind the crest.

5. After the removal of the nerve at this place, the zygomatic arch, which has been turned down, is again replaced in its natural position and fastened with bone sutures; the external wound is sutured throughout.

Salzer proceeded similarly to *Kocher*, but from a curved incision with the convexity directed upward which penetrates the skin, fascia, and temporal muscle down to the bone a finger's breadth above the zygomatic arch.

For the purpose of following up **conjointly the second and the third branches of the trigeminus** centrally as far as possible and as far as their *exit from the cranial cavity*, *Krönlein* extended the method of *Lücke-Braun-Lossen* by resecting the coronoid process of the lower jaw in addition to the zygomatic arch (Figs. 914 and 931).

1. For this purpose, he forms a *semilunar flap* in the *temporobuccal region* with the base above the superior margin of the zygomatic arch and the apex of which meets a line drawn from the nostril to the lobule of the ear.

2. After the flap of skin has been turned up and the temporal fascia has been detached from the whole superior margin of the *zygomatic arch*, the arch is *resected* in the manner mentioned by *Lücke*, and turned *downward* with the masseteric attachment still adhering to it.

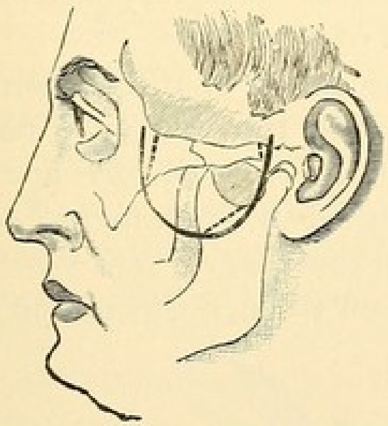


FIG. 931. KRÖNLEIN'S METHOD OF RESECTING THE II AND THE III DIVISION OF THE TRIGEMINUS. —— external incision; - - - - saw incisions

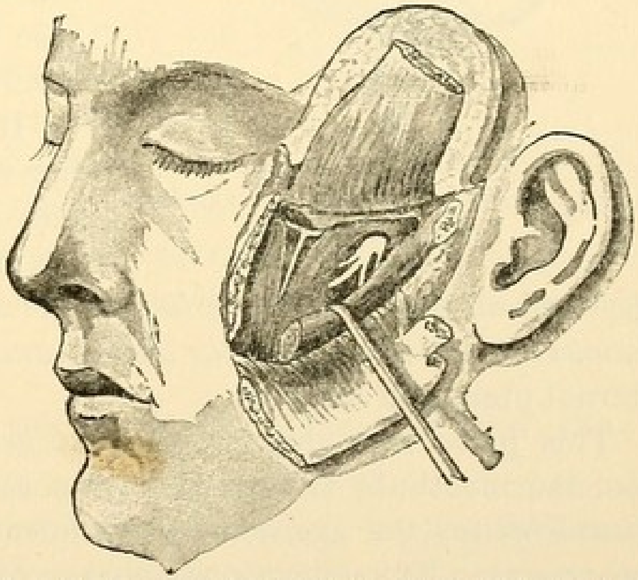


FIG. 932. KRÖNLEIN'S METHOD OF EXPOSING THE II AND THE III DIVISION OF THE TRIGEMINUS

3. The coronoid process of the lower jaw is exposed, chiselled off obliquely downward and forward, and then turned upward together with the insertion of the temporal muscle (Fig. 932).

4. After the *internal maxillary artery* coursing between the margins of the pterygoid muscles *has been ligated*, the superior insertion of the *external pterygoid muscle* is bluntly detached from the infratemporal crest; the *inframaxillary* is then accessible *as far as the foramen ovale*.

5. By penetrating deeper into the sphenomaxillary fossa, as above described, *the supramaxillary nerve* is exposed *as far as the foramen rotundum*. The resection or extraction of both nerves can then be made.

THE LINGUAL NERVE

This nerve can be made accessible from *within the mouth* (*intrabuccally*) at the place where it enters *the tongue laterally* from the side of the jaw. On account of its superficial location, it can be seen shining through the mucous membrane. It can be easily reached by a simple incision through the mucous membrane of the cheek at its point of reflection from the tongue. But in case the widely opened mouth does not offer sufficient access, *the cheek must be divided transversely* from the angle of the mouth to the ascending ramus of the lower jaw (*Roser*), in which case the external maxillary artery is severed (Fig. 933).

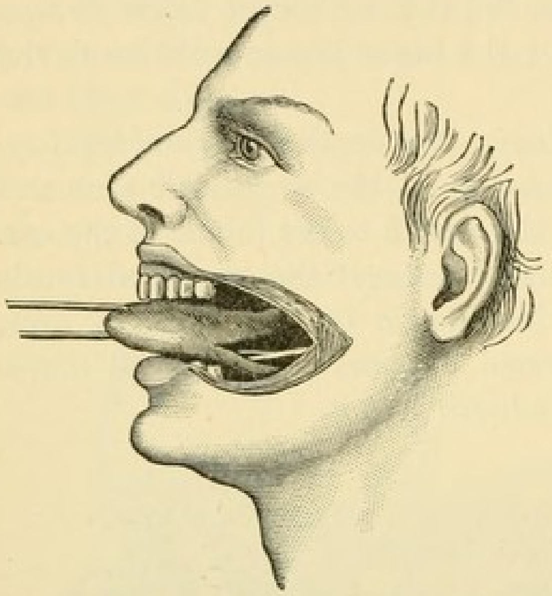


FIG. 933. ROSER'S METHOD OF EXPOSING LINGUAL NERVE

If it is necessary to resect more of the nerve toward the brain, the resection is best made *extrabuccally*, according to the method of *Sonnenburg-Lücke*, described on page 500. The *lingual nerve* is then found *at the side of the inframaxillary nerve, above the dental canal*, between the periosteum and the internal pterygoid muscle.

This place may also be made accessible from the mouth, by the method proposed by *Paravicini* for the excision of the inframaxillary nerve. The mucous membrane of the mouth is divided along the anterior margin of the ascending ramus of the lower jaw as far as the last molar tooth, the periosteum and the internal pterygoid muscle are elevated from the bone, and then the operator, starting from the opening of the canal, endeavors to detach the nerve from its surroundings with blunt instruments (Fig. 934).

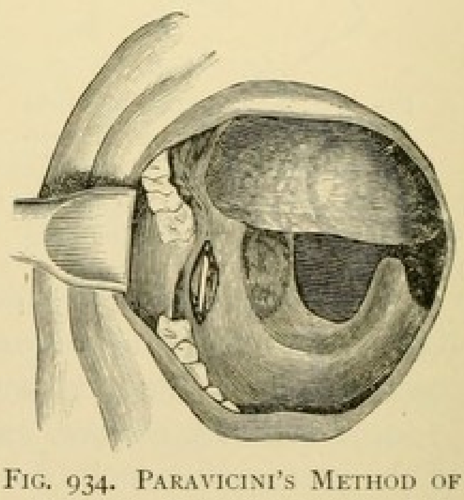


FIG. 934. PARAVICINI'S METHOD OF EXPOSING MANDIBULAR AND LINGUAL NERVES

MENTAL NERVE

In order to lay bare the inframaxillary nerve at its place of exit from the mental foramen, the operator can proceed *intra-orally* or *extra-orally*.

1. After the everted lower lip has been drawn forcibly downward, a *horizontal incision* from 2 to 3 centimeters long is made about 1 centimeter below *the insertion of the gums*, between the *first and second molars.* From this incision, the surgeon penetrates carefully as far as the mental foramen, where the nerve, which makes its exit at that point, can be grasped. The nerve, together with its ramifications, is then either excised or torn out (Fig. 935).

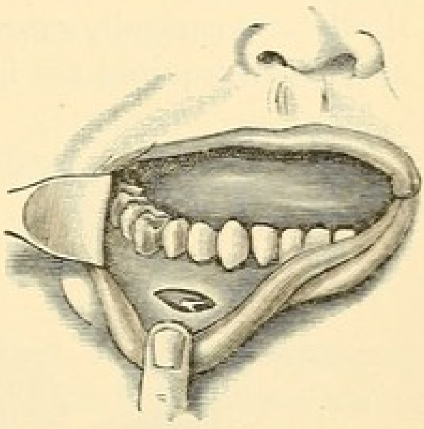


FIG. 935. EXPOSING MENTAL NERVE

2. *If the removal of a larger portion* is desired, it is better to make a horizontal incision through the *skin over the chin*, without injuring the mucous membrane of the mouth; the incision begins at *the canine tooth* and extends close to the *anterior margin of the masseter* (external maxillary artery!) and down to the bone. Next, the divided periosteum is detached in an upward direction, the foramen mentale is searched for, and the inframaxillary canal for some distance from this point is chiselled open in the form of a groove.

If, in a severe form of neuralgia of the trigeminus, *all remedies* have proved *without avail*, finally, as a *last resort*, with a view to permanent success, there is left the

INTRACRANIAL RESECTION OF THE GANGLION GASSERI (*Krause*, 1893)

As early as 1890, *W. Rose*, with a *trephine*, opened the base of the skull in front of the foramen ovale; along the third branch, he bluntly detached the ganglion from the dura and removed it piecemeal with forceps or sharp spoon, after having divided the second and the third branches extradurally.

1. **Opening of the cranial cavity**. The *external incision* is made in the form of a uterus-shaped *flap* in the temporal region above the zygomatic arch in front of and near the external ear. After the hemorrhage has been carefully arrested, the surgeon penetrates through the fascia, muscles, and periosteum down to the bone and opens the latter with the trephine or with the chisel. According to *Wagner*, the skin-muscle-bone flap thus formed is reflected in a downward direction. The serrated lower margin of bone sometimes remaining on the lower margin of the opening is smoothed with *Lüer's* forceps and removed as far as the base of the skull (Fig. 936).

2. **Ligation of the middle meningeal artery**. Extending with the finger and a blunt elevator between the dura mater and the base of the skull into

the median cranial fossa (hemorrhage! is arrested by a temporary tamponade), the operator, after a double ligation, divides first the trunk of the middle meningeal artery near the *foramen spinosum.* He raises the brain *carefully* with a broad spatula bent at right angles.

3. *Exposure* and **removal of the ganglion** (Fig. 937). Advancing deeper slowly and carefully raising with the spatula only so much of the brain as is absolutely required for inspection (brain pressure!), the operator succeeds

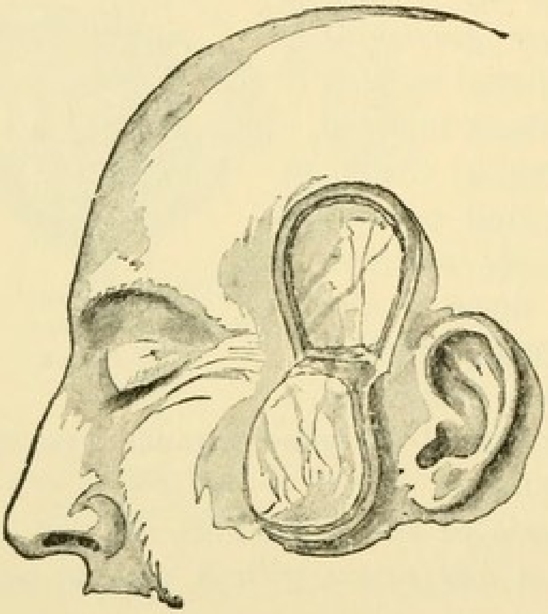


Fig. 936

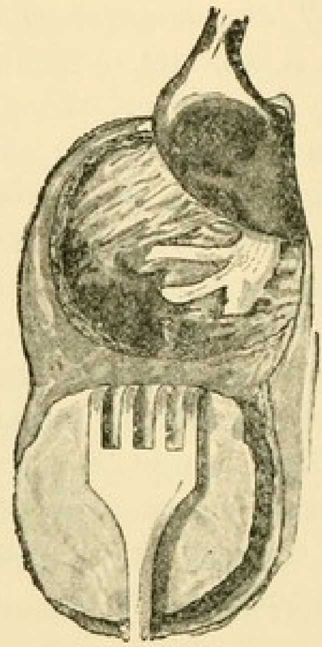


Fig. 937

Krause's Intracranial Resection of the Gasserian Ganglion

in exposing with an elevator first the *third branch*, next the *second branch* occupying the centre, and then the entire ganglion above, from the dura; below, from the bone (the *first* branch coursing in the *sinus cavernosus* must *not* be dissected free).

The ganglion is grasped transversely with *Thiersch's* forceps; next, the second and the third branches at the foramen rotundum and the foramen ovale are divided with a pointed tenotome, and then, by slow windings with the forceps, the *ganglion* with its branches and a more or less large portion of the *trunk of the trifacial* are twisted out (mostly throughout its whole extent as far as the pons Varolii).

4. The brain is then released, and the skin-bone cover is fastened in its natural position by a few sutures. After a small opening has been made by breaking off with the forceps a small piece of bone, it is to be recommended that the operator insert for two or three days a drainage tube into the depth

of the wound between the dura and the base of the skull and at the posterior margin of the opening.

With very weak patients, the duration of the operation may be essentially shortened if the bone is removed with chisel or *Lüer's* forceps after the soft tissues have been detached and reflected. As a matter of course, this operation leaves a permanent depression in the temporal region.

Doyen removes the ganglion in a similar manner (temporosphenoidal) by chiselling open the skull after making *Krönlein's* temporary resection of the malar bone. This procedure, however, is still more radical than the preceding.

THE FACIAL NERVE

This nerve can be exposed either after its exit at the **stylomastoid foramen,** or more anteriorly at the anterior margin of the lower jaw — about midway between the zygomatic arch and the maxillary angle.

1. The *external incision* divides the posterior margin of the lobule of the ear from the auricle and takes its course downward along the posterior margin of the jaw. After division of the parotid-masseteric fascia, the exposed *parotid is drawn forward*, and the auricular posterior artery *backward*. At the anterior margin of the *mastoid process*, the operator advances *deeper* near the insertion of the sternocleidomastoid, and finds the nerve on the side of the *digastric muscle* under which the external carotid takes its course.

The facial nerve may be exposed more easily, according to *Löbker-Hueter*, **in the parotid tissue.**

1. *External incision* 5 centimeters long from the lobule of the ear along the posterior margin of the jaw, extending downward.

2. *After division of the parotid fascia*, the *parotid tissue* is carefully *divided* by means of oblique incisions directed toward the margin of the jaw (*external carotid artery!*) until the *inferior branch of the facial nerve* is brought into view.

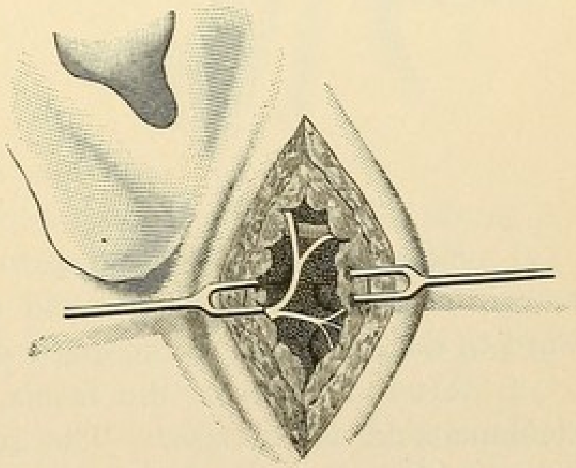


FIG. 938. LÖBKER-HUETER'S METHOD OF EXPOSING FACIAL NERVE

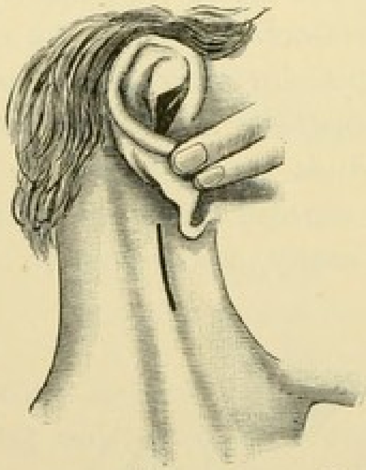
3. By following the latter in a backward direction, the operator reaches the *superior branch* and farther on the union of the two in front of the stylomastoid foramen (Fig. 938).

4. For a better exposure of the latter, another *oblique incision 2 centimeters long* backward and upward may be made from the lower angle of the wound and beyond the mastoid process (*Kaufmann*). The *stretching* of the trunk of the nerve thus found is carried out *very carefully* by means of a strabismus hook or a rubber tube placed under the nerve.

In completing this chapter, mention may be made of other nerve trunks most frequently exposed for the purpose of *stretching*.

NERVUS ACCESSORIUS WILLISII (SPINAL ACCESSORY NERVE)

This nerve leaves the cavity of the skull, together with the vagus nerve, through the jugular foramen, and whilst its *anterior* branch coalesces with the vagus nerve, its *posterior* branch behind the digastric and stylohyoid muscles descends obliquely downward between the internal jugular vein and the occipital artery, and about 5 centimeters below the mastoid process enters the sternocleidomastoid, which it pierces in order to branch off in the trapezius.



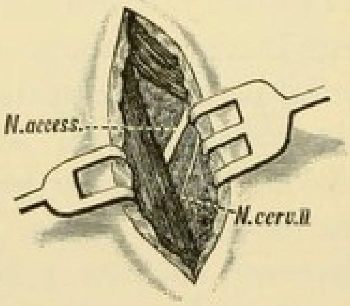


FIG. 939 EXPOSING SPINAL ACCESSORY FIG. 940

1. *External incision* from 5 to 6 centimeters long along the anterior margin of the sternocleidomastoid muscle, from the mastoid process downward to the eminence of the angle of the jaw (Fig. 939).

2. After division of the fascia, the free *anterior margin* of the sternocleidomastoid is *retracted*. The surgeon can then either see or feel the nerve under the deep fascia immediately below the transverse process of the atlas, which can be felt in the upper angle of the wound covered by the digastric muscle.

At the side of the accessory nerve there is also found in most cases a delicate twig of the *second cervical nerve* (Fig. 940).

In exposing the nerve at its *exit from the sternocleidomastoid*, an incision from 4 to 5 centimeters long is made along the posterior margin of the muscle about a finger's breadth below the mastoid process. Here the nerve appears as an oblique loop embracing the posterior margin of the muscle.

BRACHIAL PLEXUS

1. The head is turned toward the opposite side, the arm is drawn downward (as in the ligation of the subclavian artery) from the external margin of the sternocleidomastoid, an incision from 5 to 6 centimeters long is made 1 centimeter *above and parallel to the clavicle* (Fig. 941).

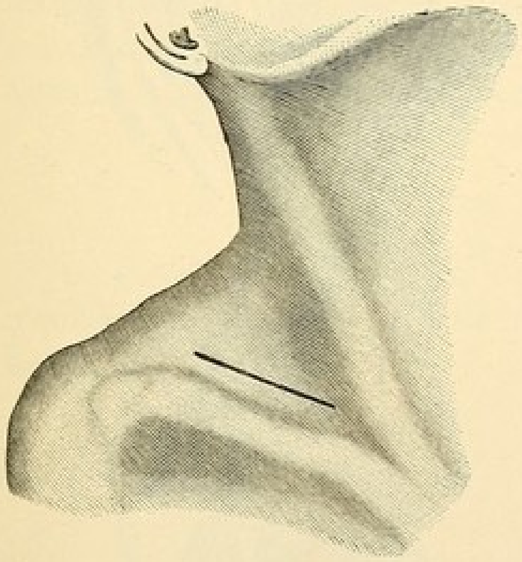


FIG. 941

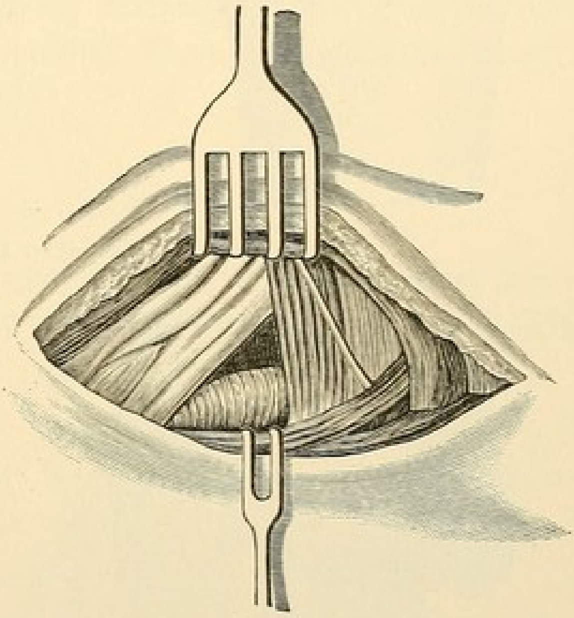


FIG. 942

EXPOSING BRACHIAL PLEXUS

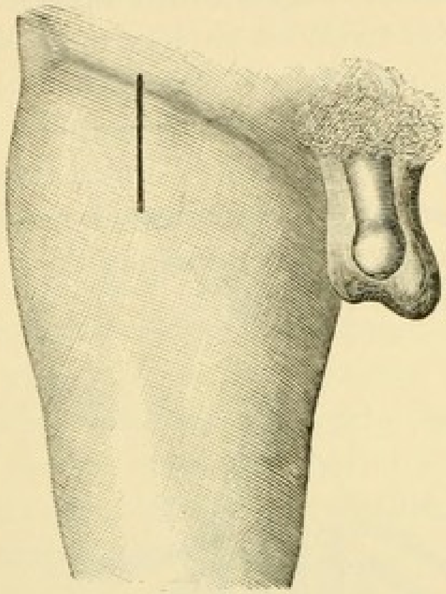
2. After division of the platysma myoides and the superficial fascia of the neck, the operator penetrates bluntly through the fatty tissue until he reaches the *omohyoid muscle*.

3. The latter is drawn *downward*; the brachial plexus *behind* it lies in loose cellular tissue (Fig. 942).

THE CRURAL NERVE

1. A *longitudinal* incision is made 4 centimeters to the inner side of the anterior superior spine of the ilium, taking a downward course from Poupart's ligament to a distance of 6 centimeters (Fig. 943).

2. Division of the *fascia lata*, under which lies the bundle of nerves covered by several lymphatic glands — the femoral artery lies toward the median line (Fig. 944).



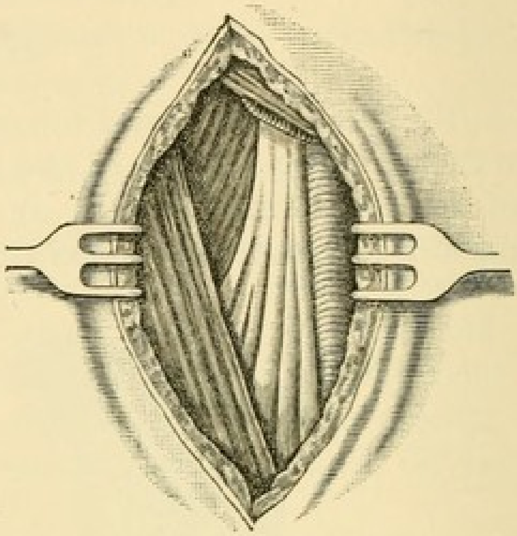
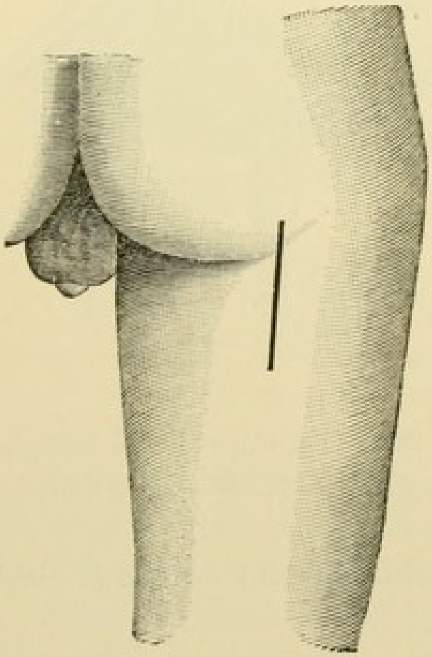


Fig. 943 Exposing Crural Nerve Fig. 944



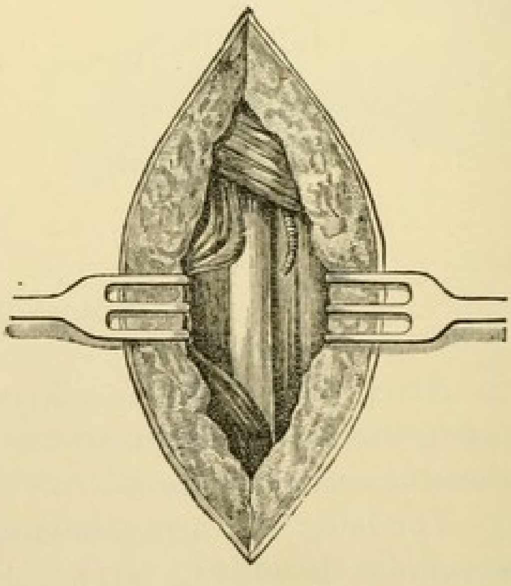


Fig. 945 Exposing Sciatic Nerve Fig. 946

THE SCIATIC NERVE

1. *Perpendicular external incision* 10 centimeters in length midway between the greater trochanter and the tuberosity of the ischium (Fig. 945).

2. Longitudinal division of the fascia *at the side of the posterior cutaneous nerve* until the lower margin of the *gluteus maximus* appears in the upper corner of the wound.

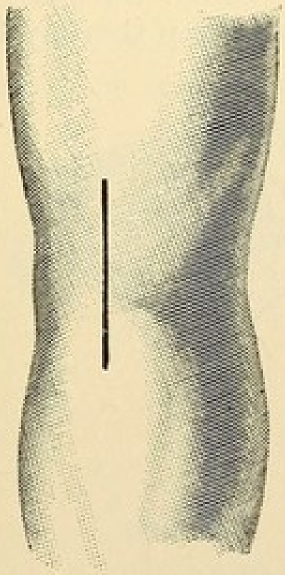
3. By penetrating with blunt instruments between the *biceps* and *the semitendinosus muscle*, the nerve is reached; the latter lies in its sheath upon the *adductor magnus muscle* (Fig. 946).

4. The nerve is isolated with a blunt instrument, drawn from the wound with the finger, and **vigorously stretched.** During this procedure, it is advisable not to injure the *accompanying ischiatic artery* which lies over the posterior surface of the sheath and which at times is very much increased in size.

Under profound anæsthesia, the sciatic nerve may be stretched bloodlessly over the **tuberosity of the ischium** by extending the leg at the knee joint, flexing it at the ankle joint, and bending it slowly over the abdomen of the patient until the toes touch the face.

THE POPLITEAL NERVE

1. *External incision* from 5 to 6 centimeters long, taking its course downward in the median line from the upper angle of the popliteal space (Fig. 947).



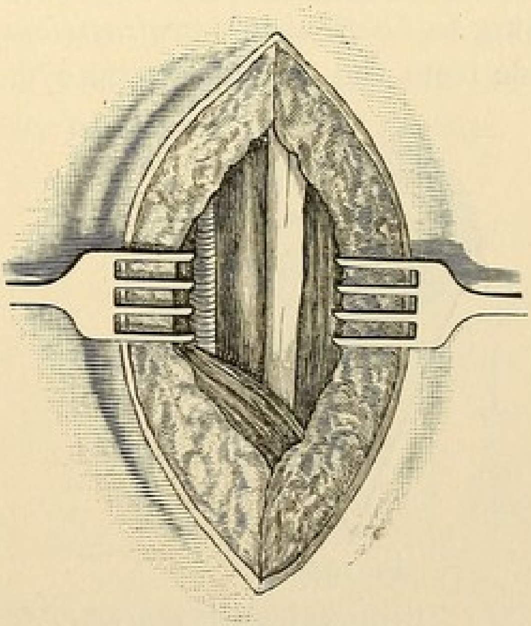


FIG. 947 EXPOSING POPLITEAL NERVE FIG. 948

2. *After division of the fascia*, the common *sheath* of the nerve and the vessels can be felt between the *biceps muscle and the semitendinosus*. After this is opened, the nerve lies very superficially (Fig. 948).

PLASTIC OPERATIONS ON THE FACE

Plastic operations are intended to supply portions of the body that have been destroyed, by grafting other living portions into their place or by closing defects that are congenital or that originate from wounds, ulcerations, etc.

BLEPHAROPLASTY

(PLASTIC SURGERY OF THE EYELIDS)

This operation is intended to restore a lost eyelid:—

1. Caused by *injury*.
2. By the extirpation of tumors.
3. By ulcerations with *cicatricial retraction* and protrusion of the mucous membrane (*ectropium*).

In ectropium (eversion) of the lower lid — which occurs most frequently — according to *Dieffenbach*, *two incisions converging downward to a point* may be made from the corners of the eye. The triangular flap thereby formed

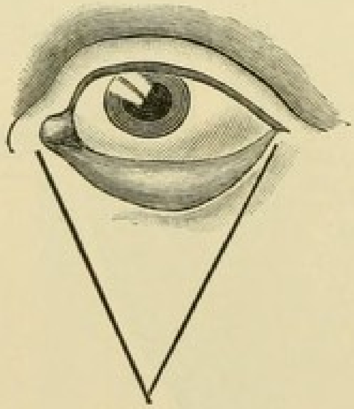


FIG. 949

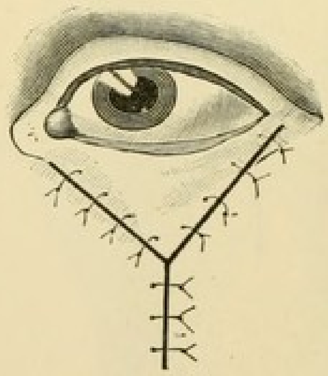
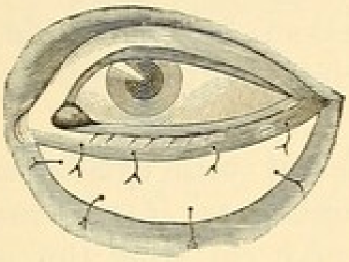


FIG. 950

DIEFFENBACH'S BLEPHAROPLASTY (Plastic Surgery of the Eyelids)

should be pushed so far upward that the tarsal border of the lid is not only replaced into its natural position, but a little above its normal level; in this position the flap is sutured in place, the line of *suturing* assuming the form of a Y (Figs. 949, 950).

Or, according to *Wolfe,* an incision is made parallel to the margin of the lid; this margin is drawn upward and temporarily stitched with two or three sutures to the upper lid. *A portion of skin* from the arm of the patient is grafted into the wound thus formed, corresponding in size and shape to the



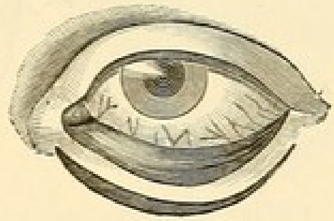


FIG. 951 WOLFE'S BLEPHAROPLASTY FIG. 952

wound, but somewhat larger. The graft must be carefully freed on its inner surface from all fatty tissue until it is *as smooth and thin as glove-leather*, its margins are fastened to the edges of the defect with a few interrupted sutures (Figs. 951, 952).

Even if these grafts unite by primary union, still in most cases they afterward *contract considerably*.

Skin transplantation, according to Thiersch, is said to have met with better success, especially when the skin grafts are placed in the direction of the fissure, and after the hemorrhage has been *completely* arrested. To prevent *contraction* as much as possible a large gaping surface of the wound is obtained by temporary *suturing of the palpebral fissure* (*Plessing*).

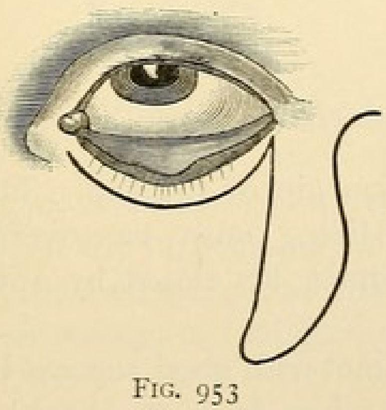


FIG. 953

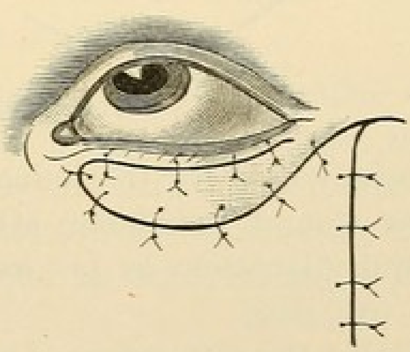


FIG. 954

AMMON AND VON LANGENBECK'S BLEPHAROPLASTY

Still less inclined to contraction are the **pedunculated flaps of skin**, which, according to *Fricke*, are taken from the *temporal region* (Fig. 955), or, according to *Ammon and von Langenbeck*, from the lateral *aspects of the cheek* (Figs. 953, 954). In forming the flap, care must be taken to direct the peduncular incision *externally in the form of a curve*, whereby less distortion ensues in rotating the flap in position, and also to cut the flap sufficiently large, so that the eyelid can be turned inward sufficiently after the flap is brought into position.

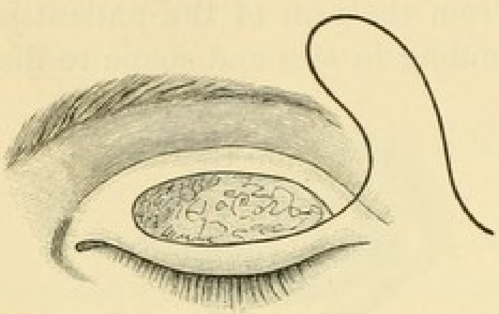


Fig. 955. Fricke's Blepharoplasty

These methods are also applicable in covering defects after extirpation of tumors.

If portions **of both eyelids** are to be *restored*, according to *Hasner von Artha*, the surgeon may cut from the neighboring skin sickle-shaped flaps encircling the whole defect, and by sliding them together, restore the angle of the eye and the palpebral fissure without leaving a gaping wound (Figs. 956, 957).

Dieffenbach's method of **lateral sliding of rhomboid flaps** can also be used in restoring defective eyelids. Every remnant of the conjunctiva ought to

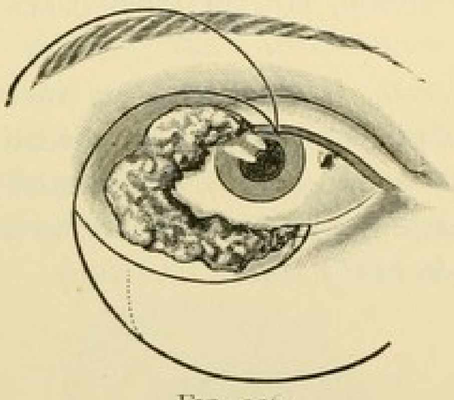


Fig. 956

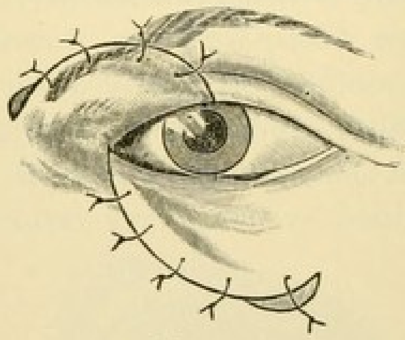


Fig. 957

Hasner von Artha's Blepharoplasty

be carefully used for the lining of the upper margin of the flap. The triangular wound remaining after the lateral sliding must be covered by skin transplantation as far as the wound cannot be closed by suturing (Figs. 958, 959).

Finally, the restoration of an entire lid has met with good success by the process of *sliding* a **double pedunculated** *flap* taken from the healthy lid, according to *Tripier*. For instance, after excising the lower eyelid in its entire extent, he forms from the upper eyelid a double pedunculated flap, by two parallel incisions about 1 centimeter from each other, the lower of which takes its course exactly on the upper margin of the tarsal cartilage (Fig. 960).

At the same time, he penetrates bluntly from these incisions into the fibres of the orbicular muscle, detaches them from the tarsal cartilage together with the bridge of skin liberated entirely by an incision, and turns

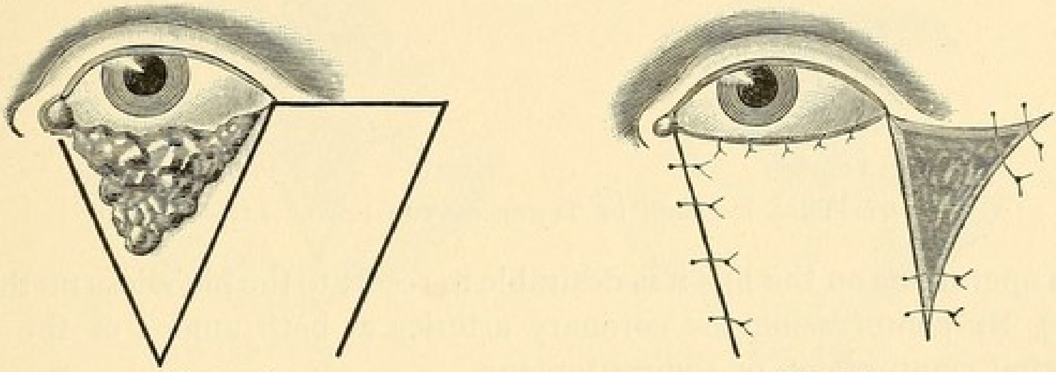


FIG. 958 FIG. 959

VON DIEFFENBACH'S BLEPHAROPLASTY

the *musculocutaneous flap* thereby formed into the defect over the upper lid, where it is fastened with fine silk sutures (Fig. 961). The secondary defect on the upper lid may likewise be *sutured throughout* (Fig. 962). By the transplantation of the muscular fibres the patient is enabled to open and close the lids in an almost natural manner.

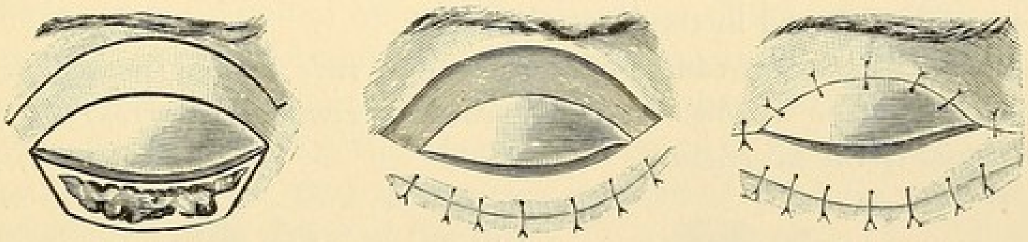


FIG. 960 FIG. 961 FIG. 962

TRIPIER'S BLEPHAROPLASTY

With all these methods, *permanent success* of the operation can be expected only if so much of the conjunctiva has been saved that the new flap can be *lined* with it throughout. If too much of the conjunctiva has been lost the surgeon may overcome the difficulty either by *doubling* (turning over) the free margin of the flap, or still better by *transplanting a piece of mucous membrane* (*Wölfler*).

CHEILOPLASTY

(FORMATION OF THE LIPS)

Restoration of the lower lip becomes especially necessary after the *extirpation of malignant tumors* (carcinoma) or for the correction of disfiguring *cicatrices* after tubercular or syphilitic ulcerations; the **restoration of the upper lip** in most cases becomes necessary from the latter cause.

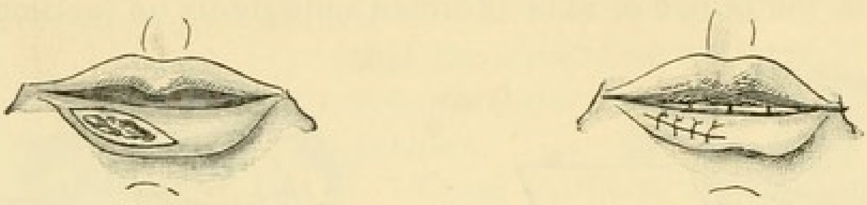


FIG. 963 FIG. 964
SUPERFICIAL EXCISION OF TUMOR OF THE LOWER LIP — SUTURE

In operations on the lips it is desirable to resort to the bloodless method:—

(*a*) By compressing the coronary arteries at both angles of the mouth by digital compression or sliding forceps.

(*b*) Or by clamping off the field of operation with parallel forceps of special construction (Fig. 965).

(*c*) By applying the *indirect ligature* (*Langenbuch*) at the portion to be removed — especially if an assistant cannot be present.

With strong silk threads knotted as firmly as possible over the skin, the portion involved is encircled in the form of either a triangle or a square, so that each loop forms a crossing with the other. Aside from anæmia, anæsthesia is also produced in the ligated portion.

In the **extirpation of cancer of the lips,** the *rule* should prevail to make the incisions in the *healthy tissue at least* $1\frac{1}{2}$ *centimeters from the demonstrable limits of the neoplasm.*

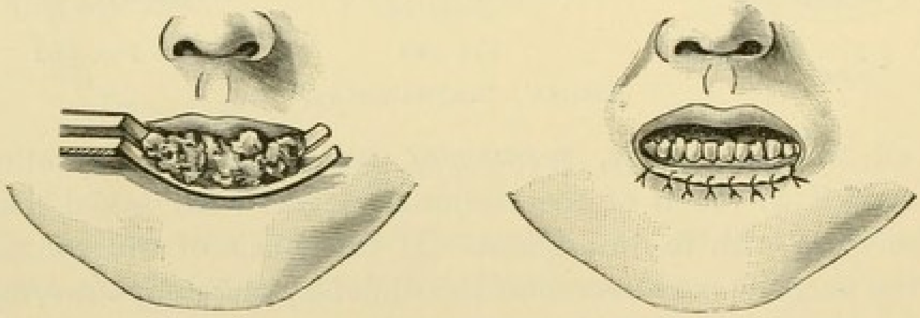


FIG. 965 FIG. 966
EXTIRPATION OF THE ENTIRE VERMILION BORDER OF THE LOWER LIP
(Using the bloodless method by means of parallel clamp forceps)

1. *Smaller tumors of the margin of the lips* may be grasped with the sliding forceps or with the transverse forceps, and then lifted up and excised with the curved scissors (Hohlscheere) or the knife. The wound is then united by a horizontal row of longitudinal sutures (**superficial excision**, Figs. 963, 964).

In this manner, extirpation of the *whole vermilion border of the lips* can be made, when the tumor is superficial and the wound may be lined with the mucous membrane of the lips (Figs. 965, 966).

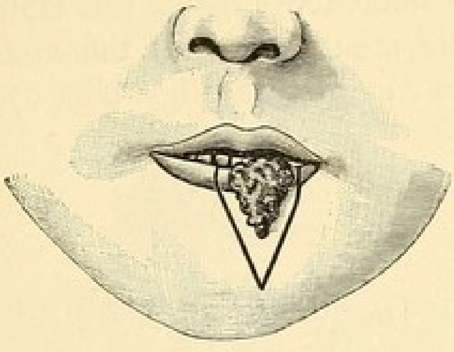
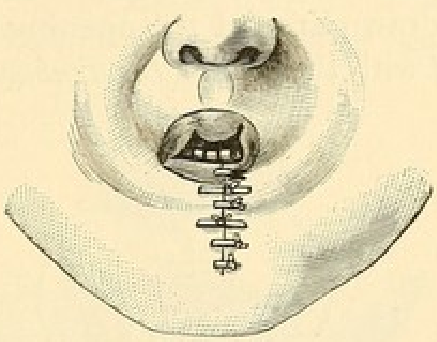



FIG. 967 FIG. 968

CUNEIFORM EXCISION OF TUMOR OF THE LOWER LIP—SUTURE

2. *Larger tumors* occupying only a portion of the lips but *extending considerably beyond their margin* are removed by *two lateral incisions meeting below* (*wedge excision*).

The *wedge-shaped defect* is closed by a perpendicular suture; first, a few deep sutures are applied through the whole thickness of the lip, whereby the hemorrhage is arrested at the same time. Then the margins of the wound are carefully united by superficial sutures (Figs. 967, 968).

If more than half the under lip has to be removed, the opening of the mouth becomes very narrow; and, owing to the great retraction of the remainder of the under lip, the upper lip projects in the form of a snoutlike disfiguration; however, that disappears in a short time on account of the great elasticity of the tissue of the lips.

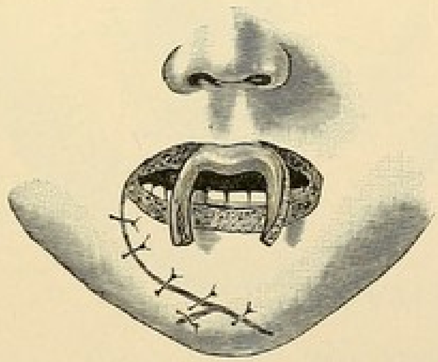
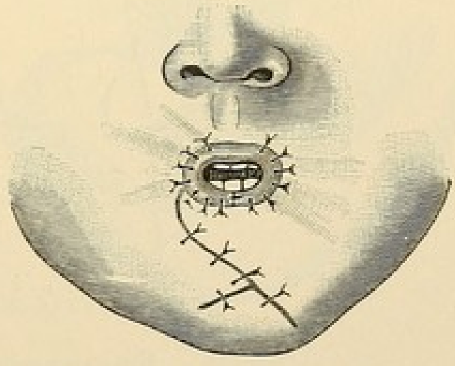



FIG. 969 FIG. 970

GRAFTING LOWER LIP, RESTORED BY PLASTY, WITH THE VERMILION BORDER OF THE UPPER LIP—SUTURE

3. If the *border of the lip* is diseased *throughout its whole extent*, and if the proliferation extends *so deep* into the tissues of the lip that, after surface

excision, the lip would become *too short,* the removed margin can be replaced by *utilizing a portion of the labial border of the upper lip.* For this purpose, the whole upper lip is divided closely above the vermilion border in such a manner and to such an extent that the detached strip of the labial margin can be drawn around the opening of the mouth and that the *under lip can be lined* with the same (*Dieffenbach, von Langenbeck,* Figs. 969, 970).

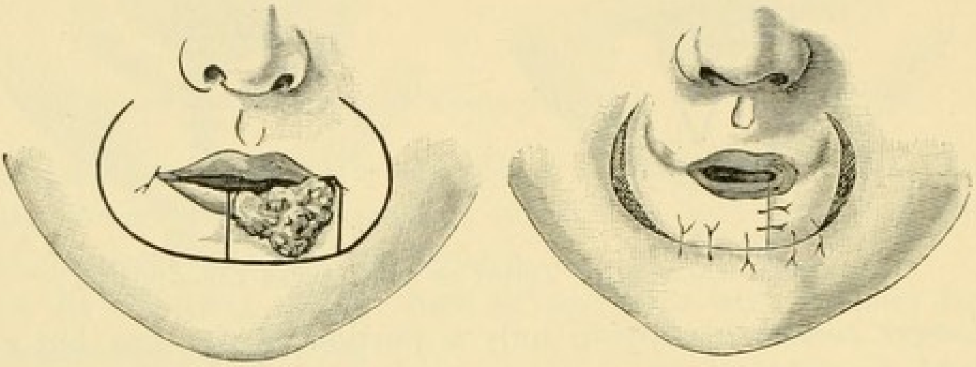


FIG. 971 FIG. 972
BRUNS'S CHEILOPLASTY (Formation of lips)

In a similar manner, *Bruns* restored a large portion of the lower lip. He encircled the buccal orifice by *two curved incisions* and united again the edges of the wound thereby made movable (Figs. 971, 972).

In like manner, *Estlander uses the upper lip for forming the lower lip.* He cuts from the upper lip a triangular flap, the vascular bridge of which lies on the margin of the lip, and, by rotation, places the flap into the defect of the lower lip (Figs. 973, 974).

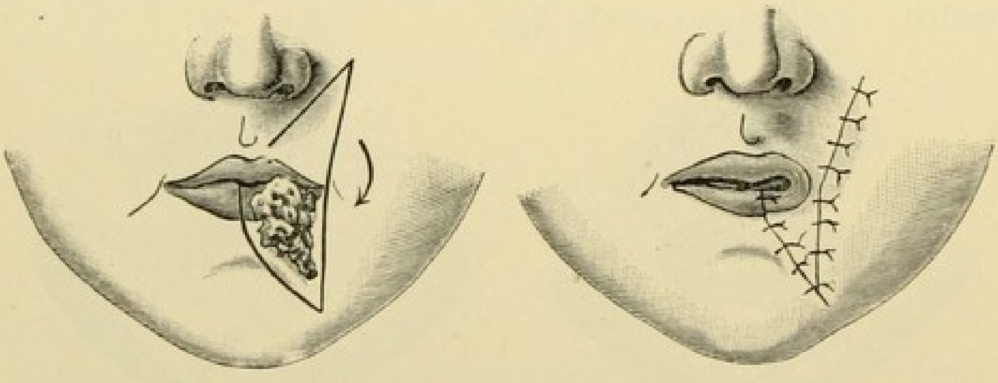


FIG. 973 FIG. 974
ESTLANDER'S CHEILOPLASTY

For the restoration of the whole lower lip, many methods have been devised.

1. *Dieffenbach,* after a *cuneiform* excision of the diseased lower lip, made horizontal incisions from both angles of the mouth through the whole thick-

ness of the cheek; from the ends of these, he made oblique incisions downward and parallel to the margins of the wound. He united in the middle the *rhomboid flaps* thus obtained, and on the free margin of the new lip sutured the mucous membrane to the skin (Figs. 975, 976). After this procedure, gaping wounds are left at both sides of the lip; these must heal

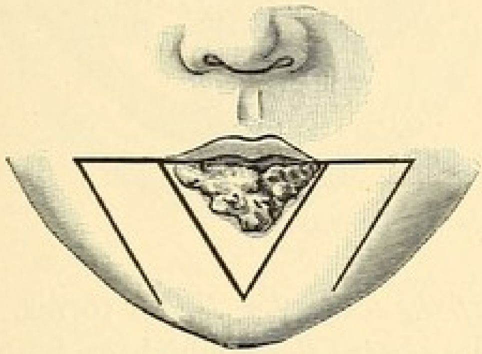


FIG. 975

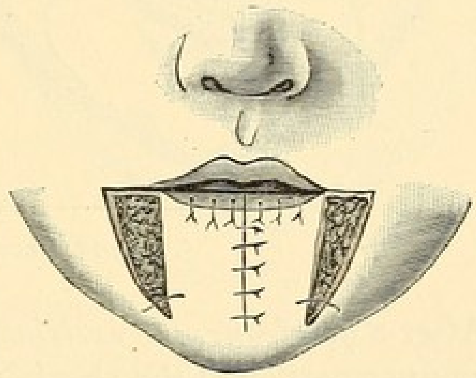


FIG. 976

DIEFFENBACH'S CHEILOPLASTY

by granulation. It is better, according to *Jäsche*, to make the incisions of the cheek *in a curve outward* and then downward (Fig. 977). The margins of the wound which have been brought into approximation can be closed throughout by suturing after the formation of the lip (Fig. 978). *Trendelenburg* modified the form of the incision, so that, by a greater curve of the

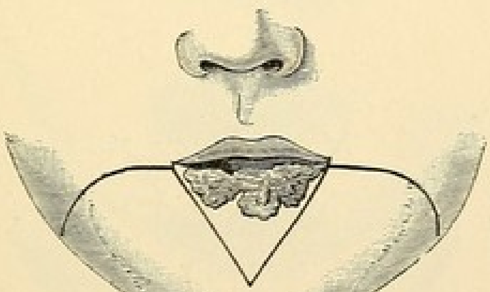


FIG. 977

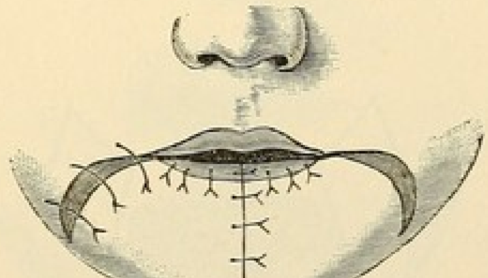
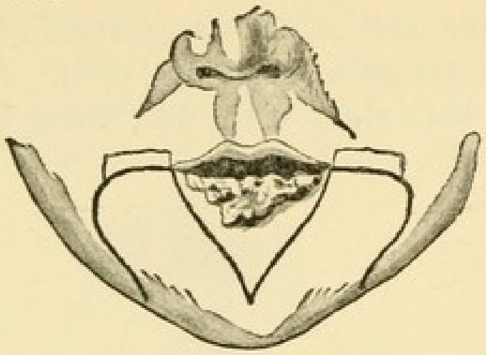


FIG. 978

JÄSCHE'S CHEILOPLASTY

arch, its external point came to lie *in front* of the facial artery (Fig. 979). For the purpose of obtaining sufficient mucous membrane to cover the margin of the lip, he made the incision of the cheek only down to the mucous membrane, dissected the latter somewhat from the upper part of the cheek, and divided it *about* $\frac{1}{2}$ *a centimeter above* the external incision; the flap of mucous membrane still adhering to the cheek was used for lining the surface of the wound.



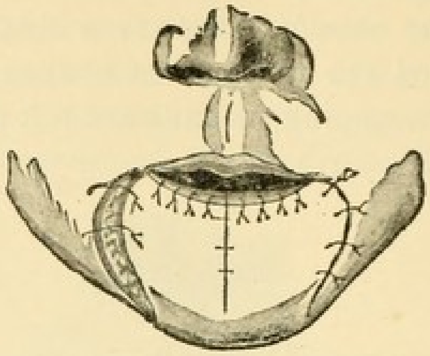


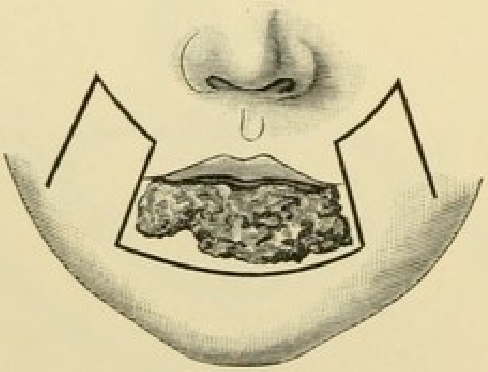
FIG. 979 FIG. 980

TRENDELENBURG'S CHEILOPLASTY

2. After a *quadrangular excision of the lower lip*, *Bruns* forms, from the anterior upper portion of the cheek, *two square flaps*, which on both sides of the upper lip ascend to the alæ of the nose.

Having first circumscribed the tumor along its margin by a transverse incision through healthy tissue, he adds at the angles of the mouth two lateral incisions ascending from the angles; from these two flaps are formed outside of the angles of the mouth.

He turns these in the direction of the wound, and having united them by sutures, he lines the border of the lip with the freely movable mucous membrane of the cheeks adhering to them (Figs. 981, 982). But if the mucous



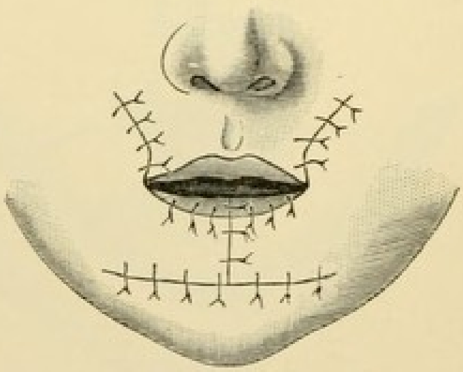


FIG. 981 FIG. 982

BRUNS'S CHEILOPLASTY

membrane covering the flaps becomes too much stretched longitudinally, it is nicked at its base by transverse incisions.

3. *Burow*, with his method of *lateral triangles*, obtained very good results, although *two healthy portions of skin* are unnecessarily *sacrificed* thereby.

The mucous membrane of the triangles to be excised may, however, be saved and used very advantageously for lining the surface of the wound (Figs. 983, 984).

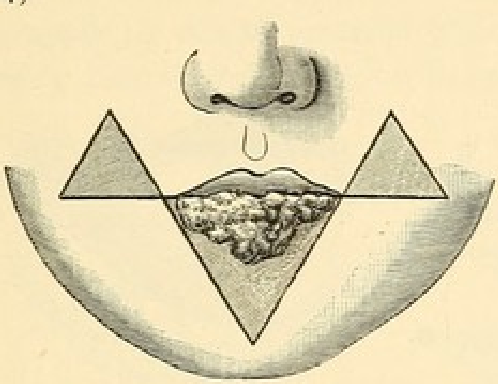


FIG. 983

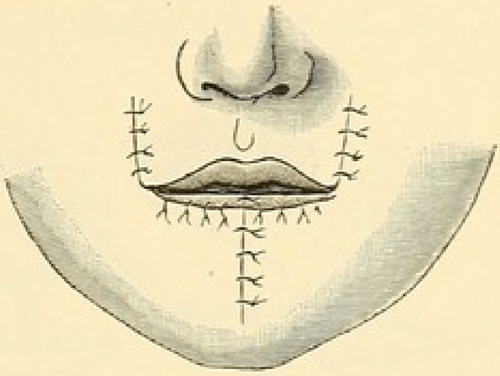


FIG. 984

BUROW'S CHEILOPLASTY

The *skin of the chin* may also be used for restoration of the lower lip; this is best done according to the procedure of *Blasius, Morgan*, and *von Langenbeck*.

From the middle of the lip, which has been excised in a semilunar form, *Blasius makes two semilunar incisions into the sides of the chin.* The flaps thus formed are transferred upward on the "*spur*" *of the skin of the chin* remaining between them and are thus reunited (Figs. 985, 986).

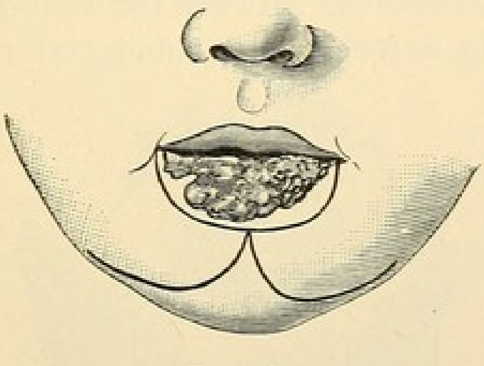


FIG. 985

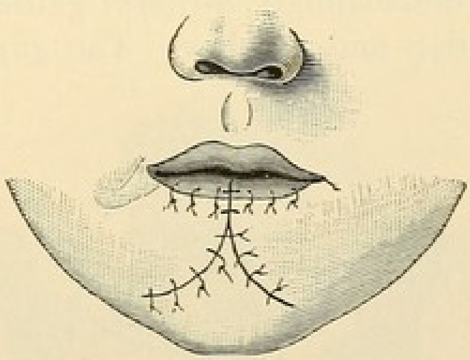


FIG. 986

BLASIUS'S CHEILOPLASTY

Von Langenbeck forms from the middle of the chin a flap with a lateral peduncle. He lifts it over the "spur" of skin which has remained on the opposite side and sutures it in this position. The "spur" itself is also detached and again united with the lower margin of the flap wound (Figs. 987, 988).

The lip formed according to these methods has a tendency to swell and to draw in, *since it is not sufficiently covered with mucous membrane.* It is, therefore, advisable to line the free margin with mucous membrane drawn over from the upper lip or from the mucous membrane of the cheeks (*e.g.* Figs. 969, 970).

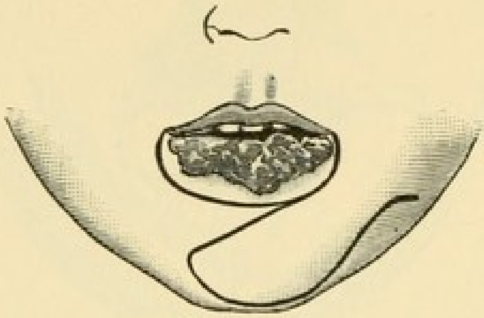


Fig. 987

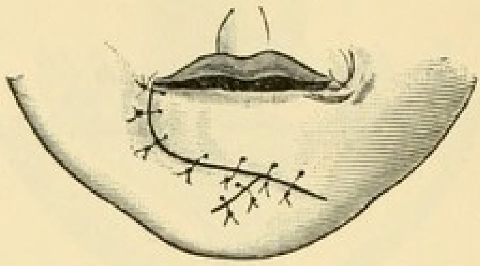


Fig. 988

Von Langenbeck's Cheiloplasty

Morgan (1829), *in very extensive defects*, restored the upper lip by utilizing the skin of the chin or the submental region. Along the lower jaw he made a curved incision about 12 centimeters long and distant from the margin of the defect about 1 centimeter above the level of the extirpated lower lip (removing any diseased glands). The *cutaneous bridge* formed by the incision is liberated by horizontal incisions from its basement membrane, turned up like the visor of a helmet and held in position by a few sutures. At its lower margin, it is stitched to the lower jaw to prevent it from descending. Strips of gauze are inserted between the wound surface of the flap and the jaw. The gaping defect of the submental region is

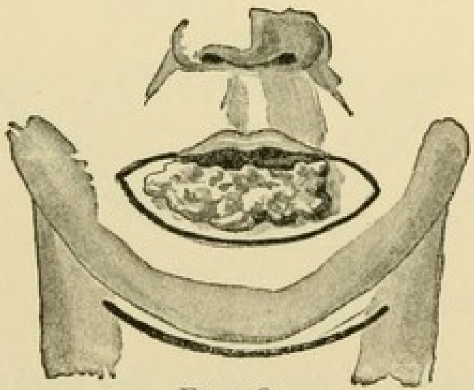


Fig. 989

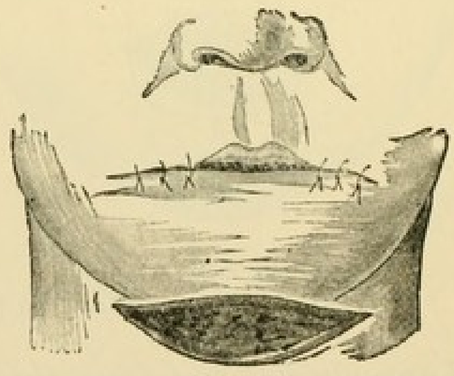


Fig. 990

Morgan's Cheiloplasty

diminished by suturing, the rest of the wound is left to heal by granulation or is paved by skin grafts according to the method of *Thiersch* (*Wölfler*, *Regnier*). The result of this operation is good beyond expectation. Although the new lip does not become easily movable, there appears less inclination to contraction and drawing in than in lips restored without any mucous membrane according to other methods.

The **upper lip can be restored** either by sliding the surrounding parts or by forming lateral pedunculated flaps.

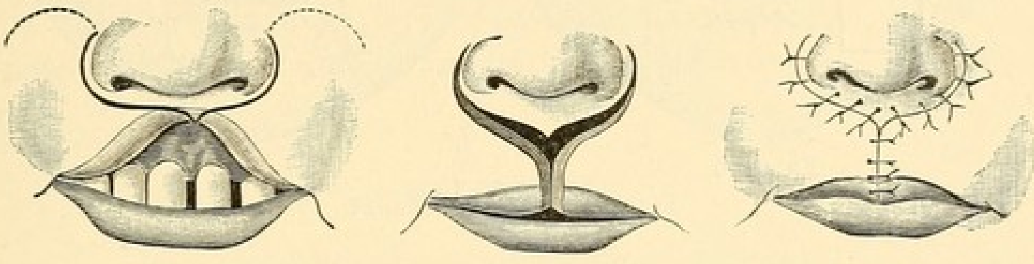


FIG. 991 FIG. 992 FIG. 993

DIEFFENBACH'S SINUOUS INCISION

Dieffenbach makes incisions on both sides, which encircle the alæ of the nose and ascend to one-half their height. Next, he detaches the soft parts sufficiently from the upper jaw, draws them down and over the margin of the teeth, and unites them in the median line under the nose (*sinuous incision*, Figs. 991–993).

If, by this means, the flaps do not become sufficiently movable, a curved incision may be added on each side in an outward direction (Fig. 991).

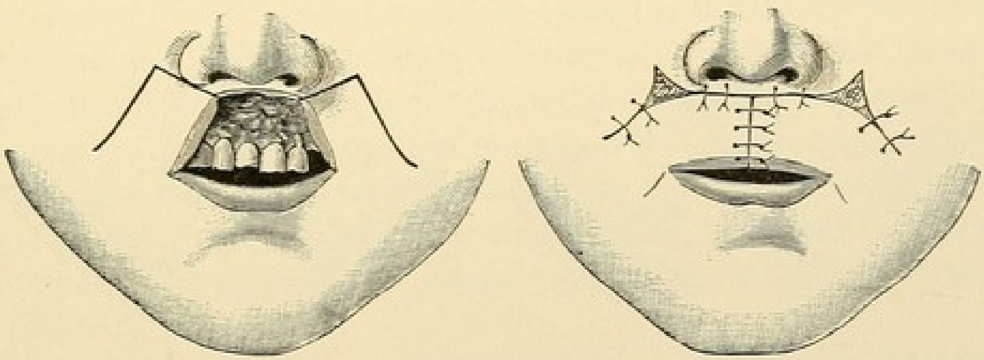


FIG. 994 FIG. 995

BRUNS'S CHEILOPLASTY

It is better, however, to form *two lateral flaps from the cheek*, which, having been detached from the bone, may be united in the median line (*Bruns*, Figs. 994, 995).

The method of *Sédillot* is also applicable in certain cases. He cuts out from the lower region of the cheek *two lateral square flaps* with upper bases, and turns them up over the under lip (Figs. 996, 997).

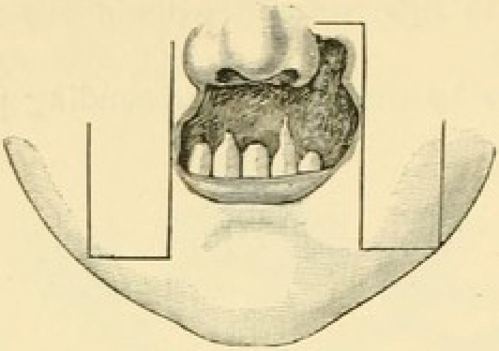


Fig. 996

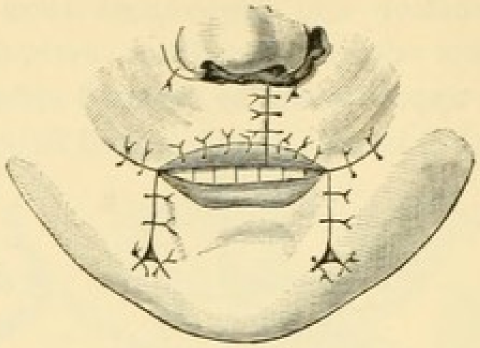


Fig. 997

Sédillot's Cheiloplasty

STOMATOPLASTY

(STOMATOPOESIS OR PLASTIC SURGERY OF THE MOUTH)

This is made in cases of *contraction of the oral orifice*, which most frequently ensues from *cicatricial contraction* after ulcerations, but which also occurs congenitally.

The procedure of *Dieffenbach* is as follows: From the oral orifice, *two lateral incisions are made through the whole thickness of the cheek* to answer the dimensions of the new mouth (Fig. 998). Next, *the mucous membrane is sewed to the skin;* if this does not succeed easily, on account of the

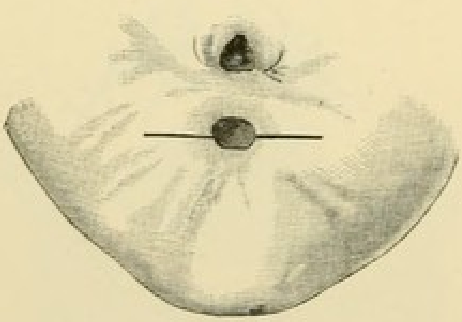


Fig. 998

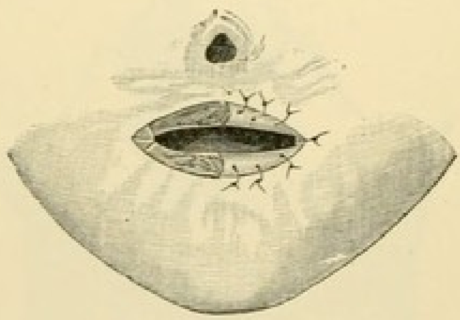


Fig. 999

Dieffenbach's Stomatoplasty (Plastic surgery of the mouth)

cicatricial condition of the skin and the mucous membrane, the latter for some distance is dissected off from the underlying tissues and thereby made more movable. A complete lining of mucous membrane should be carefully obtained especially *at the new angles of the mouth.* Since a new contraction of the rima oris can be prevented only when the mucous membrane unites with the angles of the mouth by first intention, it is advisable to sew the mucous membrane into the angle in the form of a small triangular flap (*Roser*, Fig. 999).

To prevent recurrence of the contracture, the wearing of an artificial mouth (*Hueter*) for some time after the operation is advisable. The artificial mouth consists of a hard rubber tube, the size of which corresponds to the new mouth; it is similar in shape, as illustrated in Fig. 1000.

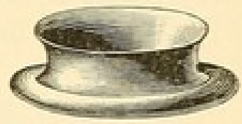


FIG. 1000. ARTIFICIAL MOUTH (according to Hueter)

MELOPLASTY

(PLASTIC SURGERY OF THE CHEEKS)

In extirpating tumors of the cheek, the cheek may be incised from the angle of the mouth as far as the margin of the masseter down to the adipose tissue; this is partly removed and partly pushed aside. The tumor, in order that its limits may be more easily determined, is pushed outward with the finger introduced into the mouth, and with curved scissors is excised completely by cutting through healthy tissue. The wound is sutured throughout; the defect of the mucous membrane is tamponed, and, after four or five days, is *covered* with *Thiersch's* grafts. These skin grafts in the course of time resemble the mucous membrane, and no contraction results (*Ewald-Albert*).

Smaller defects of the cheeks may be closed by *detaching* the *surrounding* soft parts sufficiently from mucous membrane, so that the latter can be united by suture in any direction. Especial care must be taken, however, that the traction of the sutures does not cause other deformities (ectropium, distortion of the rima oris and the alæ of the nose). If sufficient mucous membrane is still at hand, a smaller defect may be closed successfully by two pedunculated *flaps from the mucous membrane of the cheek* and that of the lips (*Oberst*).

In *larger defects*, flaps must be formed from the surrounding parts; by *stretching and sliding* the defect is covered; Figs. 1001–1004 may serve as examples.

If the *mucous membrane* in these places is *deficient*, and the mouth cannot be opened, as is the case in most instances, this condition would be increased by a contraction of the flaps. To prevent this a portion of the lower jaw may be sawed out, so that a *false joint* is formed (*Esmarch*, see page 492); or a flap of skin with the epidermis as *a cover* may be turned into the defect, and over this another flap of skin; or, finally, the attempt may be made by skin transplantation to cover with skin a pedunculated flap already formed at its wound surface before its transplantation into the defect (*Thiersch*). *Bayer* forms a large-sized flap from the mucous membrane of

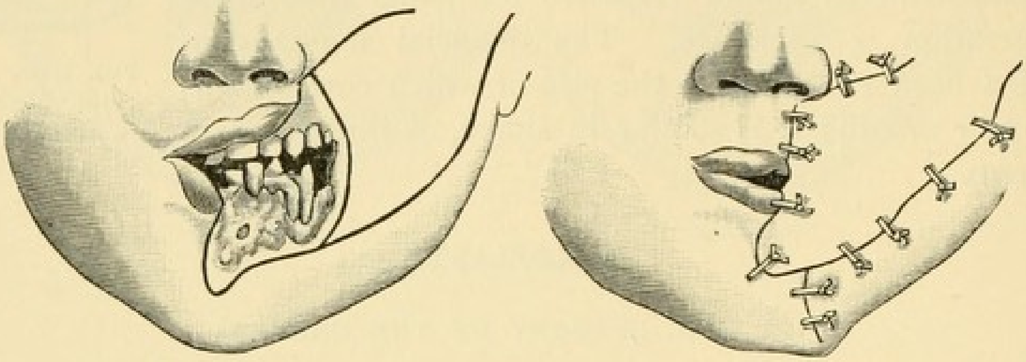


Fig. 1001 Fig. 1002

Meloplasty (Plastic surgery of the cheeks) by stretching a Pedunculated Flap

the palate. The flap of skin to be applied over this surface is taken from the submaxillary region.

From the *immediate surroundings* of the defect *Kraske* forms a flap which is turned into the defect; this flap may heal in, though its pedicle *consists only of subcutaneous tissue* (*Gersuny*). Having been sewed into the defect, its epidermal surface forms the *inner side* of the new cheek, while its wound surface, as well as the place from which it has been taken, is covered by *Thiersch's* skin grafts (Figs. 1005, 1006). This procedure may

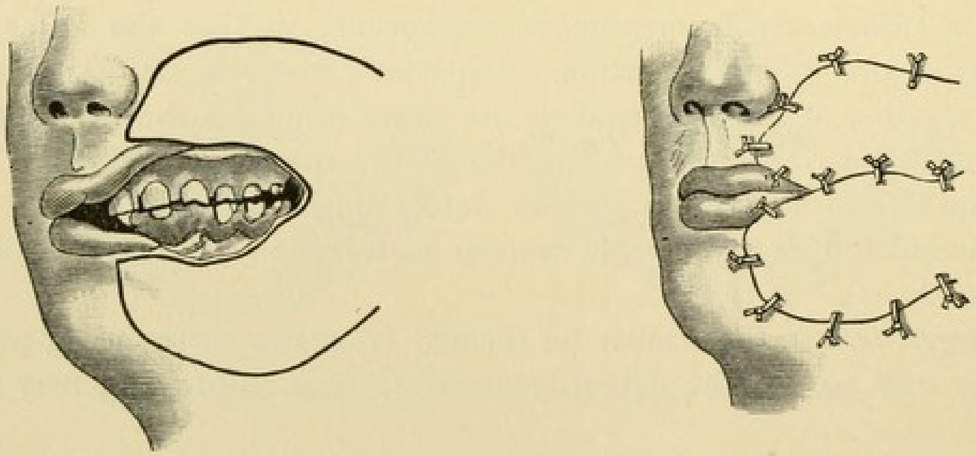


Fig. 1003 Fig. 1004

Meloplasty by sliding Two Pedunculated Flaps

result satisfactorily if performed in one sitting; still, in the male, the hair of the beard growing into the buccal cavity causes great inconvenience. Although it has been observed several times that the inverted skin became similar in structure to the mucous membrane, and that the follicles of hair were destroyed, still *Israel* and *Hahn* have devised procedures which, they

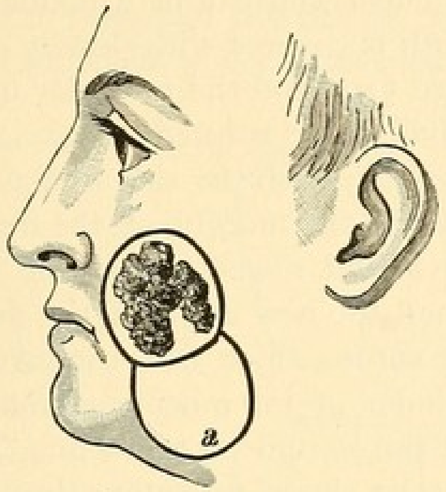


Fig. 1005

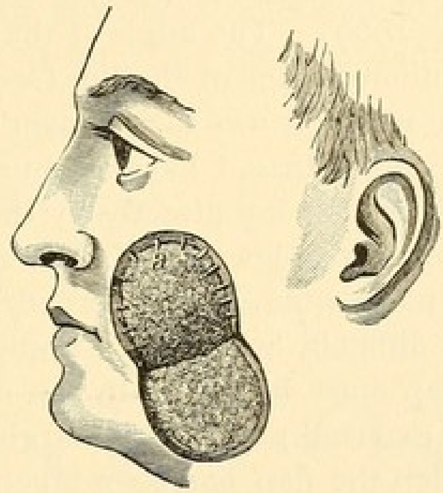


Fig. 1006

Kraske's Meloplasty

claim, avoid this unpleasant condition by supplying large flaps of skin without hair, taken from *more remote* parts of the body (neck, breast).

Israel cuts a *long flap out of the skin on the side of the neck*, which remains attached at the base. He turns this flap over and sews it with its anterior half to the margin of the mucous membrane of the defect, so that the epidermal surface lies inward toward the buccal cavity (Fig. 1008).

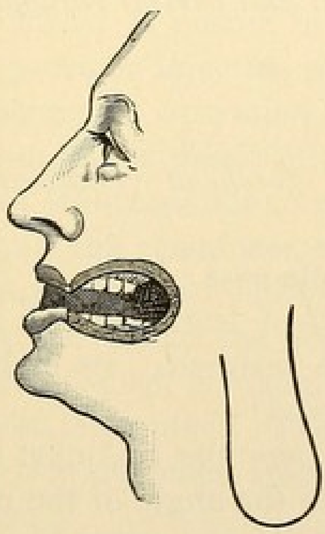


Fig. 1007

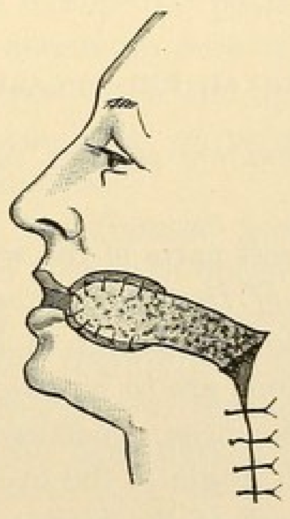


Fig. 1008

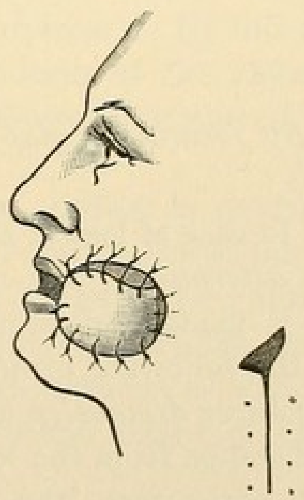


Fig. 1009

Israel's Meloplasty

After this piece has healed in — from fourteen to seventeen days — the pedicle is severed, and the posterior portion, which has now become free, is likewise turned over, and, after all granulations have been scraped off, is sewed to the former (wound surface being in apposition to wound surface) so that the new-formed portion of the cheek consists of a double layer of skin (Fig. 1009). The angle of the mouth is covered with skin by displacing the vermilion border of the lips (see page 519), and the posterior opening at the place where it was turned over is vivified and sutured.

In a similar case, I have taken a long flap from the skin of the neck, the pedicle of which lay directly by the side of the margin of the defect. By turning over the lower half, I doubled it and sewed it into the defect, so that the place where it was turned formed the new angle of the mouth. It is rather difficult, however, to apply the suture, since first the inverted end of the flap must be sewed to the remainder of the mucous membrane, and next the external part to the margins of the wound of the skin. The place from which the flap has been taken may be closed by suture throughout its whole extent.

RHINOPLASTY

(PLASTIC SURGERY OF THE NOSE)

Restoration of the nose may be attempted *if it has been destroyed by trauma, tuberculosis, syphilis, and neoplasms.*

According to the procedure by which either the whole nose or only portions of it are to be restored, we distinguish *total and partial rhinoplasty.*

TOTAL RHINOPLASTY

I. *By forming a flap from the skin of the forehead* (*so-called* **Hindoo method**).

(*a*) **In case of loss of the soft parts of the whole nose**: —

For determining the size of the flap, a model of leather or of adhesive plaster is made and fitted to the defect to be restored. In making the model, the following proportions are to be observed: —

The *lower dimension* of the nose, measured over the tip, must be equal to the distance from the lower angle of the eye to the angle of the mouth — about 7 centimeters; the *length of the bridge of the nose* must be equal to the distance from the limit of the hairy scalp to the glabella; the longer the septum is made, the higher the nose becomes. In order to obtain a curved (Roman) nose, the lateral margins of the flap are somewhat curved; straight lateral margins produce a form more like the Grecian.

The flap of skin has been made in very different ways by various surgeons; compare Fig. 1010.

After the form and the size of the flap have been determined upon and cut out in adhesive plaster, the model is fastened on the forehead over the

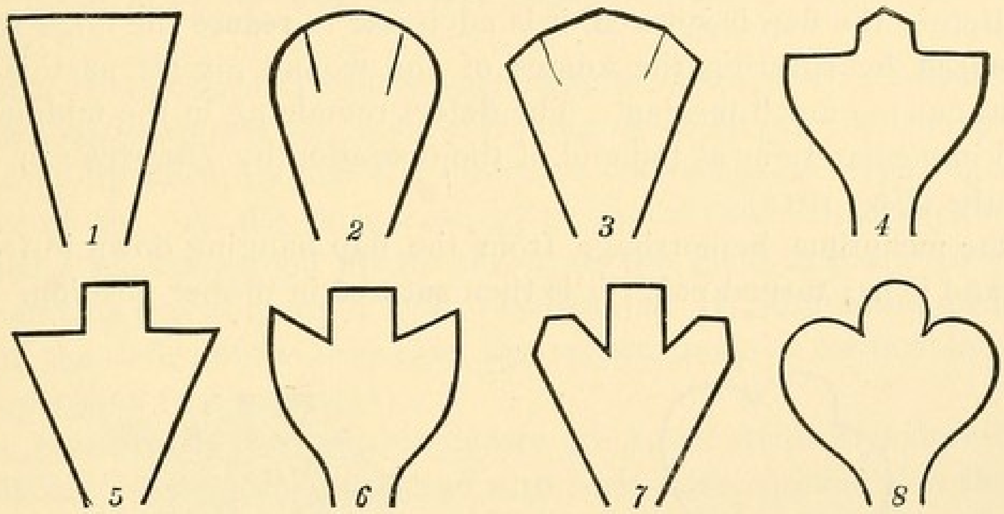


FIG. 1010. MODELS FOR RHINOPLASTY (Plastic surgery of the nose). 1, original Hindoo model; 2, 5, Dieffenbach's models; 4, von Ammon-Zeis's model; 3, 6, 7, 8, von Langenbeck's models

nose, *the pedicle of the flap* being directed *obliquely* toward the margin of one of the orbits, so that the angular artery is included in the vascular bridge (Fig. 1011). The operation is then performed as follows: —

The patient is placed in a half-sitting position under mixed chloroform narcosis (previous injection of maximum dose of morphine). By this means, during the entire operation, even when the application of the chloroform mask is no longer possible, a condition of painlessness is produced, whilst the patient still responds to requests.

1. First, **the remainder of the diseased nose is vivified** in equiangular form by making deep incisions along the margin of the defect as far as the site where the alæ of the nose are to be implanted. Above the philtrum, a small triangular slit is made with the knife on the place where the new septum is to be implanted. The margins of the lateral incisions as well as the upper lip are detached from the bone outwardly to the extent of about $\frac{1}{2}$ centimeter.

2. With a sharp knife, the **model** fastened to the forehead is **circumscribed** accurately everywhere down to the bone. The internal or lower margin of the pedicle in the neighborhood of the angle of the eye is made to terminate in the upper angle of the wound of the vivified remainder of the nose; the external or upper margin is deflected *outwardly* above the

eyebrow *in the shape of a hook.* By this means, traction and tearing in turning the pedicle are avoided as much as possible. The flap of skin thus circumscribed by the knife is *detached* from the bone *together with the periosteum*, and the adhesive plaster is removed; the flap is then *turned downward* so that it hangs in front of the nasal cavity.

3. Before the flap is sutured, it is advisable to **reduce** the *large* **wound of the forehead** by suturing the angles of the wound, as far as this is possible without too much tension. The defect remaining in the middle can be covered immediately or at the end of the operation by *Thiersch's* or *Wolfe's* skin grafts (Fig. 1012).

In the meantime, hemorrhage from the flap hanging down in front has ceased and it has turned pale; it is then **sutured** in proper position.

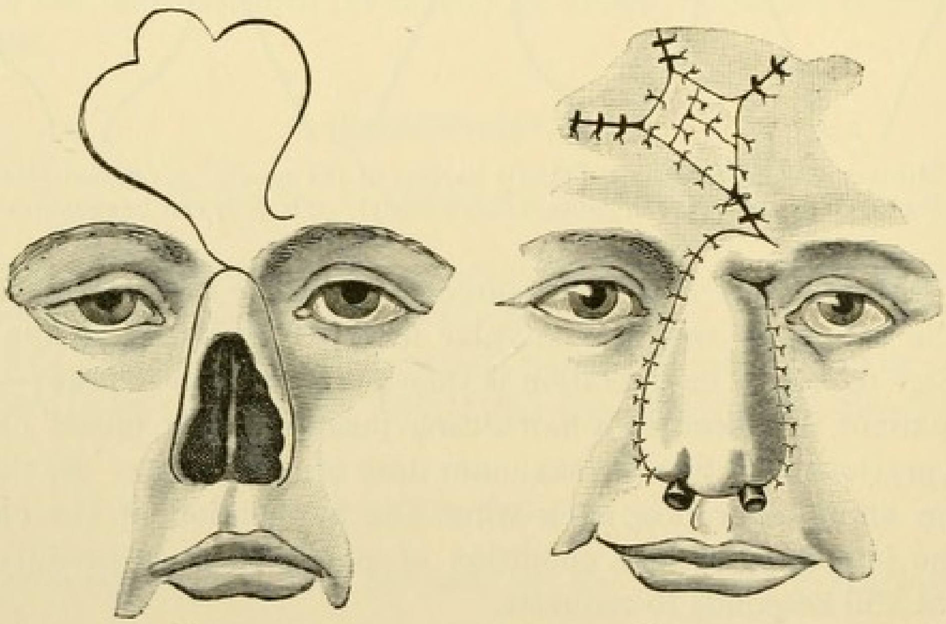


Fig. 1011 Fig. 1012

Total Rhinoplasty (Hindoo method) by a Flap from the Skin of the Forehead

4. First, the piece of flap designed for the *septum* is vivified superficially with a sharp knife at its lower angles and *is lightly folded lengthwise;* it is then sewed with interrupted sutures into the triangular incision above the philtrum; next, the *alæ of the nose* are formed *by turning over in an inward direction the two lateral angles.* They are fixed in this folded condition by a loose quilt suture applied *throughout the whole thickness* of the new ala of the nose, and the posterior sides are stitched to the freshened lower angle of the wound of the defect by button sutures. Then, the *lateral margins* are carefully sewed into the fold of the wound with numerous button sutures.

Near the twisted pedicle, the sutures must *not be applied too closely;* it is best to insert them alternately.

Two rubber tubes, wrapped with iodoform gauze, are inserted into the newly formed nostrils to counteract the great tendency to form adhesions and also to press gently together the upturned margins of the skin (Fig. 1012). Even after the wounds have healed, the tubes must be worn for a long time.

In order to remedy this troublesome inconvenience, *von Volkmann advised not to suture the septum* but to leave it hanging down; in the course of healing, it rolls up inwardly into the nose and leaves sufficient passage for the entrance of air. At the same time, by means of this round swelling, there is formed a passably good tip for the nose, the good appearance of which in all methods leaves more or less to be desired. If, afterward, an improvement of the deformity is desirable, the septum may be formed by a subsequent operation (see page 541).

The best *dressings* after rhinoplasty are small strips of iodoform gauze or small compresses of linen covered with boric salve, applied over the sutures so that the surgeon can always observe the condition and the color of the new nose. The sutured and grafted large wound in the forehead may be protected by a light antiseptic dressing.

A *pale color* exhibited by the nose on the following day is rather a favorable sign; during the next few days it turns pale-pink, and finally assumes the normal color. If, however, it is discolored, *bluish red* or dark brown, then, in most cases, a partial failure of the operation, on account of partial gangrene, is to be feared; sometimes the application of leeches renders good service.

The deformity from *twisting of the pedicle*, at first very disfiguring, is removed afterward by a simple excision of the prominence; likewise, several smaller operations may become necessary to improve the cosmetic result. All these operations, however, must not be made too early; at any rate, not before the fourth to the sixth week, since the new nose changes more and more by subsequent contraction (in most cases disadvantageously), especially if the hoped-for ossification of the pericranium is limited or does not set in at all.

(*b*) **In cases of the loss of the whole nose together with its bony structure,** the new nose, formed in the manner described above, contracts from want of support, and becomes more and more flattened.

To prevent this condition, surgeons have endeavored, by suitable *lining* with bone-producing tissue, to give greater support to the soft parts of the nose.

Von Langenbeck thought that greater solidity or strength might be given to the nose *by including the periosteum* in the soft tissues taken from the forehead. He conceived also the plan of forming a flap with a bony framework ("knochenspange") corresponding to the new bridge of the nose; this has been successfully done by *von Hacker* in recent times.

Hueter formed from the skin of the remaining portions of the nose a flap, which he turned downward so that its wound surface appeared externally. Upon this the flap of skin taken from the forehead is applied. Owing to the tendency of the twisted flap to assume its former position, the bridge of the nose may remain somewhat raised (*elastic support flap*—"federnder stützlappen") (see also Fig. 1014).

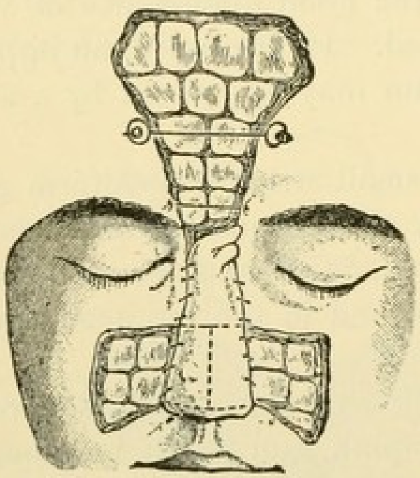


FIG. 1013. THIERSCH'S RHINOPLASTY

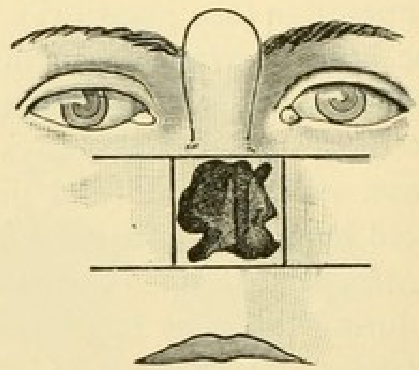


FIG. 1014. VERNEUIL'S RHINOPLASTY

Thiersch used two lateral *quadrangular flaps from the skin of the cheeks* for lining the nostrils; these flaps he sewed together in the median line with the wound surface outwardly, and over them applied the flap from the forehead; the large defects thus caused are covered by skin grafts (Fig. 1013).

Verneuil and Bouisson proceeded in a similar but reversed manner; they used *the flap of the forehead for lining* and covered it by two lateral flaps from the cheeks (Fig. 1014).

Von Langenbeck attempted to restore the *bony framework of the nose by an osteoplastic procedure;* he raised the bony support of the nose, which in most cases was sunken in, but which still existed in fragments, together with the callous masses produced by the chronic course of former ulcerations. After the pyriform aperture has been laid free by a median incision running from the nasal process of the frontal bone downward, and the skin has been somewhat dissected backward toward both sides, the operator, with the metacarpal saw, saws off from the margin of the pyriform aperture on both sides a *small strip of bone* which, at its lower end, remains in connection with the superior maxillary bone (Fig. 1015). The trabeculæ thus formed are raised perpendicularly with the elevator, and the flaps of skin previously detached are fastened to them; next, the *depressed nasal bones* are sawed off on both sides from the nasal process of the superior maxillary bone and slowly raised with the elevator; the connective suture between the nasal and the frontal bones forms the hinge joint (ginglymus). Over *this supporting framework, arranged like the rafters of a roof*, the new nose formed from the skin of the forehead is now applied in the above-mentioned manner (Fig. 1016).

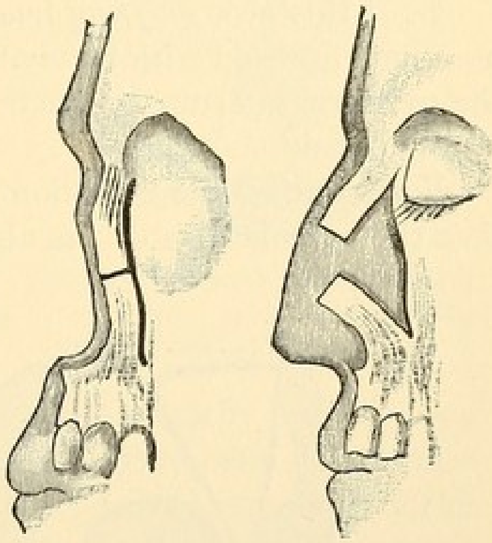


Fig. 1015 Fig. 1016
Von Langenbeck's Osteoplastic Framework of the Nose

In cases where the operator succeeds, in consequence of the great flexibility of the bone, in so raising these supports that their vascular bridge does not break off or does not become infracted, the result of this skilful operation is very beautiful; but in most cases necrosis sets in.

König took from the forehead a *skin-bone flap* by cutting from the glabella a small square strip; he then chiselled out with a sharp chisel a thin lamella of bone from the cortical layer of the frontal bone which remained in close connection with the flap of the skin and represented its inner surface. This flap was turned downward over the nasal defect, and the flap consisting of the soft parts of the forehead was fastened to the new bridge of the nose thus formed (see page 542).

In the following manner *Schimmelbusch* obtained a *perfectly bony nose* with very good permanent results: —

1. After division of the skin, the operator, with a broad chisel as sharp as a knife, chisels out from the most superficial layer of the frontal bone a *skin-bone flap*, the base of which is from 7 to 9 centimeters wide, with the upper border corresponding with the limit of the hairy scalp; great care should be taken that the thin lamella of bone does not break. This flap is elevated and wrapped with iodoform gauze. The defect of the forehead caused thereby is at once united by sliding the margins of the skin (*Jäsche*). The incisions for the flap run in the form of a curve from the angles of the

defect along the limit of the hairy scalp, which has been shaved as far as the temporal region (Fig. 1017).

2. After 4–6–8 weeks, when some portions have become detached by necrosis and the whole surface is covered with granulations, these granulations are removed with the knife, and the inner surface of the bone flap is covered with small skin grafts (*Thiersch*).

3. If this *skin grafting* has succeeded, the flap is raised in the form of a nose and inserted with its vivified margins into the freshened remainders of the pyriform aperture, in such a manner that the laminæ of the bone are in exact apposition.

For securing the elevation of the profile and for indicating at the same time the indentations of the alæ of the nose, a metal wire is passed through

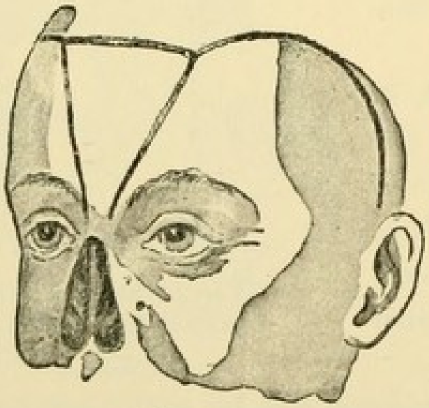


Fig. 1017

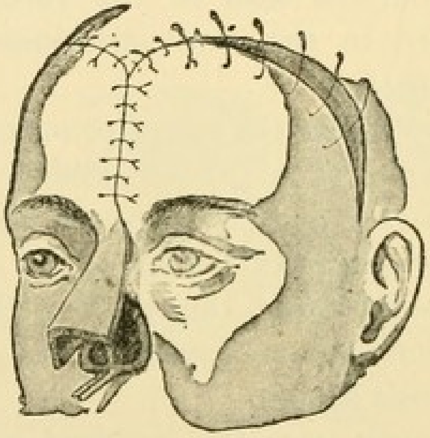


Fig. 1018

Schimmelbusch's Rhinoplasty

the lower portion of the new nose and is fastened on the outside by two buttons or plates. If a *septum* is also to be made, it is taken from the cutaneous covering of the pyriform aperture. Two thin lateral flaps are detached from the lower margin of the aperture toward the median line as far as the normal point of insertion of the septum. These are sewed together and to the tip of the nose (Fig. 1018).

For saddle noses the procedure is the same, only the flap is not transplanted but grafted outwardly with the scraped granulation surface and inwardly with the surface of the skin. The skin of the former depressed nose, having been divided lengthwise in the median line, is drawn directly over the wound surface and detached widely on both sides.

II. If, on account of cicatricial conditions, the skin of the forehead is not well adapted to plastic purposes, *other parts of the face* must be utilized in furnishing the material for the defect. *Nélaton* restored the soft parts of the nose by *two quadrangular lateral* **flaps from the cheek**, which had their base at the bridge of the nose and the inner angle of the eye; for the formation of the septum, one of the flaps must have a square appendage (so-called **French method**, Fig. 1019).

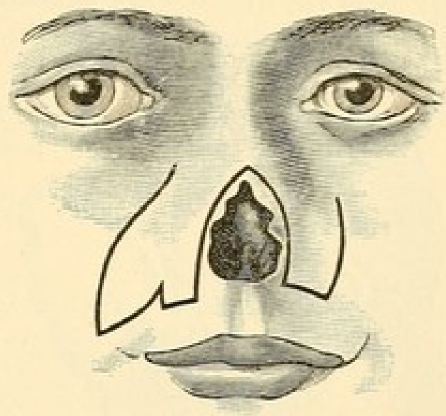


FIG. 1019. NÉLATON'S RHINOPLASTY BY FLAPS FROM THE CHEEK (French method)

III. If the entire face presents no available skin for transplantation, no choice is left but to form the new nose *from the skin of the arm*, according to the method of *Tagliacozza* (professor at Bologna, 1597, " De curtorum chirurgia per insitionem ") and *Gräfe* (1816) (**Italian method**).

For this purpose, *a flap with a double pedicle* is formed from the middle of the arm by two incisions; a little gauze placed beneath the flap prevents it from uniting with the underlying parts. When the cicatricial contraction commences in the flap, one bridge is divided, and the wound surface is sewed to the vivified nasal defect. If the healing proves successful, the other bridge on the arm is also divided (Fig. 1020).

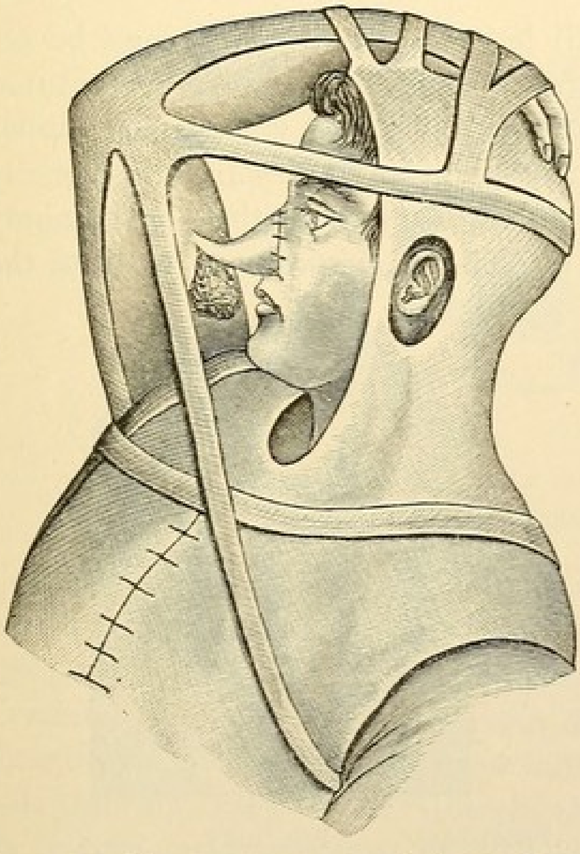


FIG. 1020. TAGLIACOZZA AND GRÄFE'S RHINOPLASTY BY A FLAP FROM THE ARM

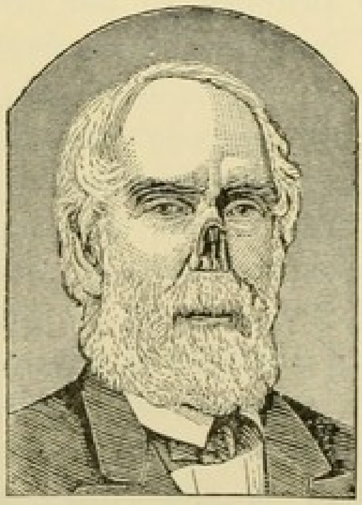
When the Italian method is employed, the arm must remain securely fastened to the head in a fixed position (by bandages or plaster of paris dressing); the patient inhales constantly the secretions of the granulating surfaces of the wound, and the new nose, on account of the inferior value of the skin of the arm as compared with that of the face, is more heterotopic and possessed of less vitality, and progressive contraction is the rule. These disadvantages have prevented the method from being adopted to any considerable extent. At best, it may, in case of necessity, serve as a substitute for the Hindoo method.

In recent times, however, it has been occasionally used with success. For example, *Israel* restored the nose in order to avoid the disfiguring frontal cicatrization by transplanting a *skin-bone flap* taken from the ulnar side of the *forearm*, the bony part of which consists of the border of the ulna lying directly under the skin (Fig. 1021). In the case of a saddle nose, he corrected the deformity by transplanting a fragment of bone sawed off from the tibia.

FIG. 1021. ISRAEL'S RHINOPLASTY

With all these methods, nevertheless, the new-formed nose often leaves much to be desired. Moreover, it has still a tendency to slough, and, in many cases, to contract more and more in the course of time. Hence, a surgeon who desires to obtain *permanent success* is wise in making the nose from the start large enough to make due allowance for contraction.

A much better *cosmetic result* may be obtained by the **nasal protheses** now manufactured in excellent form from vulcanized rubber (*Sauer*) or celluloid (*Kleinmann*), especially since, in fitting, the most suitable form may be found for the physiognomy of the patient by using noses cut out of masks (*Kleinmann*) or from the



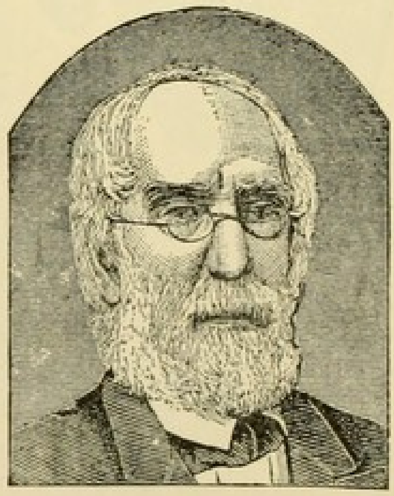


FIG. 1022 TIEMANN'S NASAL PROTHESES FIG. 1023

models of sculptors (*Gronwald*). These protheses are held in place by a spectacle frame (as in masks) or by two wires extending in the form of pincers with a support on the margins of the pyriform aperture, or the remains of the turbinated bones. The line of application is made invisible as much as possible by colored collodium or zinc paste ("zinkleim"), etc. Simple pasting on without a supporting apparatus does not furnish the necessary support.

PARTIAL RHINOPLASTY

serves to **supply separate portions of the nose;** for instance, one-half a nose, one ala, the tip, or the septum.

If one side of the nose is lost by injury or disease, it can be supplied by the Hindoo method of turning down from the skin of the forehead a flap in the form of a divided nose model, and by sewing it into the defect. In the same manner, larger or smaller defects of the *bridge of the nose* can be covered by narrow flaps from the forehead formed in accordance with the defect.

If the loss involves the **ala of the nose** and the skin overlying the same, the flap is taken *from the other half of the nose* (*von Langenbeck*).

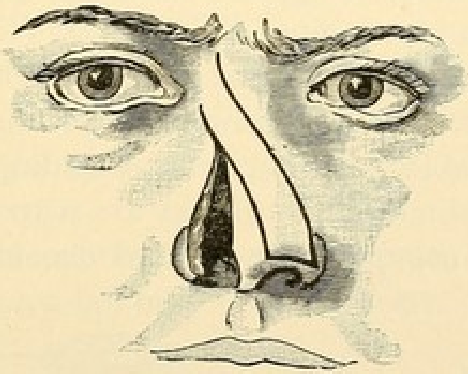


Fig. 1024

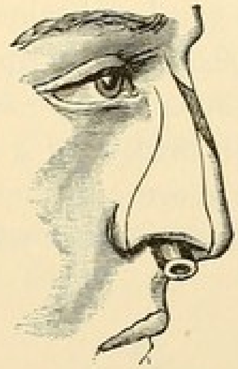


Fig. 1025

Von Langenbeck's Method of restoring an Ala of the Nose from the Other Half of the Nose

A small rectangular flap is cut out from the healthy side, whose base is at the inner angle of the eye of the diseased side, whose sides extend obliquely over the bridge of the nose, and whose lower transverse incision terminates closely over the margin of the healthy ala of the nose; the flap, detached from its base, and a few millimeters longer than the defect, is turned over the remaining "spur" toward the diseased side and sewed in position. By (cicatricial) contraction of its lower free margin, the new nostril assumes the same form as the healthy one, whilst the secondary defect heals by granulation or is grafted at once with skin (*Thiersch*). The success of this operation is excellent (Figs. 1024, 1025).

Smaller defects of the alæ of the nose are covered either by drawing over pedunculated flaps from the neighboring skin of the cheek (Figs. 1026, 1027, 1028), or by sliding down a **V**-shaped flap, and by applying a **Y**-shaped suture

FIG. 1026

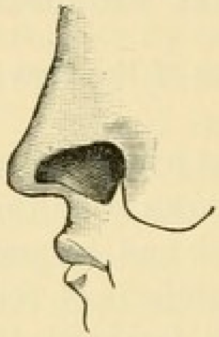


FIG. 1027

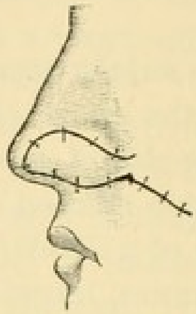


FIG. 1028

RESTORING AN ALA OF THE NOSE BY PEDUNCULATED FLAPS FROM THE CHEEKS

according to *Dieffenbach* (Figs. 1029, 1030). From the upper lip also a restorative flap can be obtained as represented in Fig. 1027 (*O. Weber*).

Smaller defects **of the tip of the nose** may be restored in many different ways by the tissues of the nose itself; for example, by forming small flaps with a vascular bridge in a suitable position, and by sliding. Secondary defects become more and more obliterated, until they are scarcely noticeable. *W. Busch* covered a defect which occupied the tip and one ala of the nose

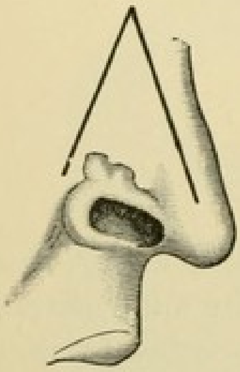


FIG. 1029

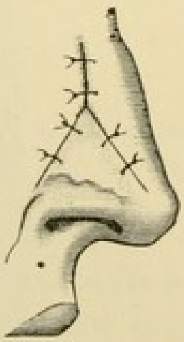


FIG. 1030

FORMING NOSTRIL BY SLIDING A SMALL FLAP

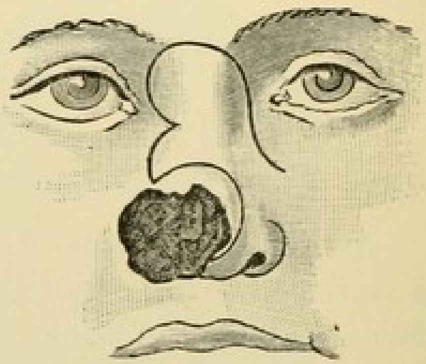


FIG. 1031

W. BUSCH'S METHOD OF RESTORING THE TIP OF THE NOSE AND THE ALA

by a lateral pedunculated flap from the skin of the bridge of the nose and the glabella (Fig. 1031). The procedure of *Hueter* is original; he transplanted as a substitute for the tip of the nose the plantar eminence of the little toe, excised by a cuneiform incision.

may be used : —

1. The *skin of the* **philtrum of the upper lip** (*Dieffenbach*). By means of two perpendicular incisions throughout *the whole thickness* of the lip, its middle portion is excised and turned up so that the mucous membrane lies

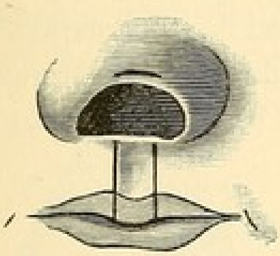


FIG. 1032

FIG. 1033

DIEFFENBACH'S METHOD OF RESTORING THE SEPTUM

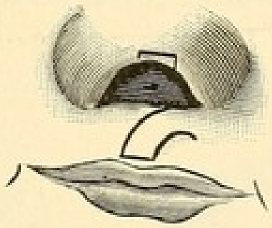


FIG. 1034

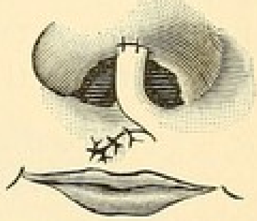


FIG. 1035

VON LANGENBECK'S METHOD OF RESTORING THE SEPTUM

externally. The flap is then sewed to the portion of the nostril, previously vivified, and the wound of the lip is closed completely by suture (Figs. 1032, 1033).

2. The **skin of the upper lip**, from which an *oblique* flap is formed with an upper base. By lateral sliding, it is sewed into the nares; the pedicle must be cut off subsequently and placed in the middle (*von Langenbeck*, Figs. 1034, 1035).

3. The **skin of the bridge of the nose**, from which a small flap is formed and turned down laterally (*Hueter*, Figs. 1036, 1037).

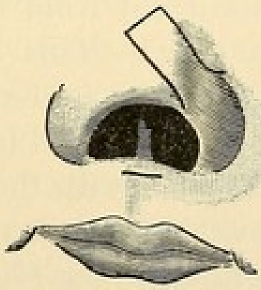


FIG. 1036

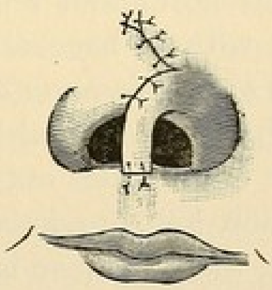


FIG. 1037

HUETER'S METHOD OF RESTORING THE SEPTUM

The correction of saddle noses or of collapsed noses, the bones and cartilages of which have been destroyed by ulcers or injuries (**saddle noses**), in most cases is not permanently successful, if only flaps of skin are employed without any solid support, because, owing to the contraction of the new skin structure, the deformity soon recurs.

In cases in which the *cartilaginous framework is still partly preserved*, but the tip of the nose is deeply depressed and *retracted* (*retroussé*), *von Langenbeck* proceeded as follows : —

By a convex transverse incision in an upper direction, he divided the tip of the nose one wing from the other, and with a sharp hook drawn downward and forward, he brought it out of its recess. In the defect thus produced, of a semilunar form, he implanted a pedunculated flap corresponding in shape, taken from the skin of the forehead, turned down and fastened by sutures to the lateral margins and the nasal eminence (Figs. 1038–1041).

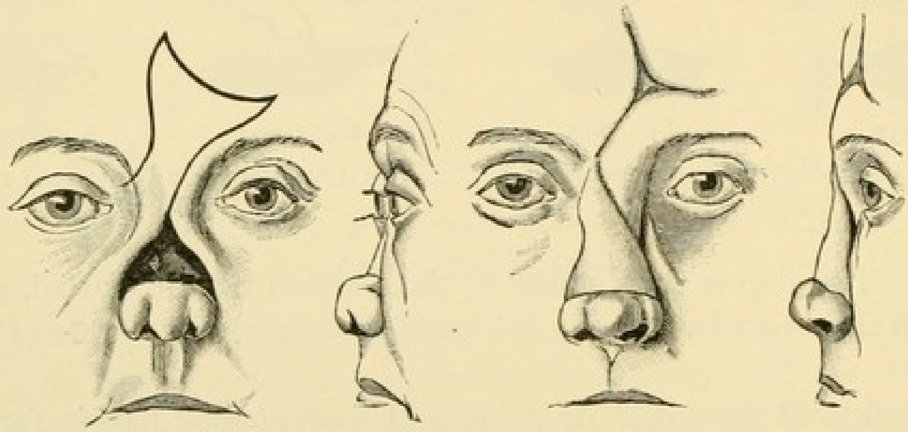


FIG. 1038 FIG. 1039 FIG. 1040 FIG. 1041
VON LANGENBECK'S METHOD OF CORRECTING COLLAPSED NOSES

König formed *a bony bridge of the nose* **by a flap from the bone and the soft parts** of the forehead.

After a transverse division of the soft parts of the nose at its deepest point, a flap of skin about 1 centimeter wide is cut out from the middle of the forehead with its base at the glabella (Fig. 1042). This strip of skin, *together with the periosteum and a thin lamella of bone*, is detached with a small chisel from the frontal bone, turned straight downward in such a way that the bone surface lies outward, and sewed together with the eminence of the nose, which has previously been made movable (Fig. 1043); over this bony support, the new nose is then formed according to the Hindoo method. But in order to obtain the normal depression between forehead and nose and a narrower dorsum, he divided the connecting bridge of the frontal flap and implanted it more deeply.

Israel allowed the skin-bone flap first to become covered with epidermis, then he divided the underlying skin of the nose lengthwise in the form of two door-shaped flaps, which he fastened laterally to the vivified bony support, thus forming the lateral surfaces of the nose. The frontal flap consists of a lamella of bone only 4 millimeters wide, around which the portion of skin at least 2 centimeters wide is united. Upon this newly formed nose, covered with epidermis, the skin of the saddle nose is implanted subsequently.

Ollier made two incisions around the nose, which, beginning at the alæ, converged at the glabella at an acute angle, included at this place the periosteum in the flap, and transplanted its point about 4 centimeters downward, fastening it in this position. Analogous to the blepharoplasty of *Dieffenbach*, the skin of the bridge of the nose thereby becomes more abundant anteriorly, and the tip is forced downward.

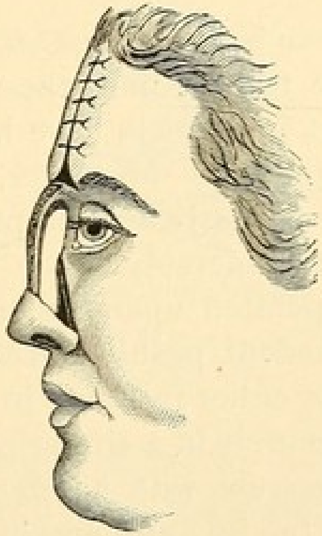
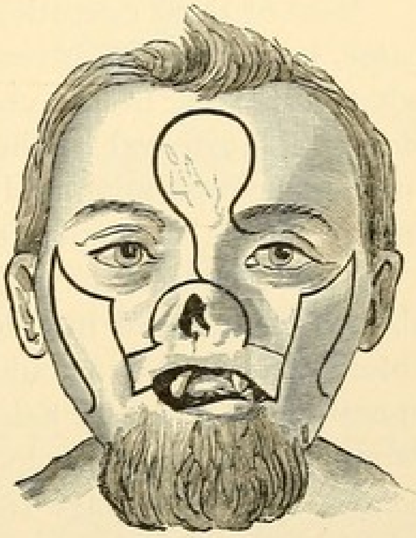




FIG. 1042 KÖNIG'S RHINOPLASTY FIG. 1043 FIG. 1044

Miculicz formed a septum from the existing depressed soft parts. He detached them on the margin of the pyriform aperture by two lateral incisions, turned them toward the median line, and sewed their vivified surfaces together. Over this newly formed septum, which is in connection only with the membranous septum, a new nose was constructed. The procedures of *Schimmelbusch* (page 535) and of *Israel* (page 538), described above, have also been used for the correction of saddle noses.

If all these attempts result unsatisfactorily, the surgeon must content himself with *artificial protheses*, which are made of gold, caoutchouc, amber, etc. *Æyräpää* raised many saddle noses with permanent good success by wire, hard rubber, and soft caoutchouc protheses, which form a kind of artificial septum, and which are inserted from the inside through an opening in the hard palate.

In a simultaneous destruction of the nose and the upper lip, which not seldom occurs in consequence of *syphilis* and *lupus*, the restoration of these parts can be made in *one* sitting (Fig. 1044). For this purpose *as much as possible* of the existing useful portions of skin *is saved*, some of which are used for covering, others for lining, the nasal passage.

PLASTIC OPERATIONS FOR CONGENITAL FISSURE FORMATIONS OF THE ORAL REGION

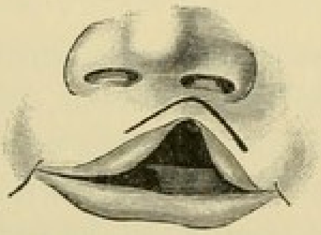
I. HARELIP AND MAXILLARY FISSURES

Most of these operations can be made *immediately after birth.* In serious cases, however, it is advisable to wait until the children have grown somewhat older (one to two years), in order to have better-developed portions of skin at the disposal of the operator. Moreover, in maxillary fissures, by a preliminary operation and by properly applied pressure, the margins of the fissure can be approximated considerably.

Older children may be operated upon under anæsthesia, and, if preferable, with the head in a dependent position (*Rose*); infants ought not to be chloroformed; they should be either fastened in an upright position to the operating table or else held securely in a sitting position by an assistant. At each side, an assistant, by pressure with his fingers and with sponges, can control the hemorrhage from the lip; and any blood flowing into the mouth is removed with sponges provided with a holder.

A. SINGLE CLEFT OF THE LIP (HARELIP)

The *simple vivifying* of the margins of the cleft with subsequent suturing in most cases leaves a disfiguring *depression* from the ensuing contraction of the cicatrix. The following procedures, therefore, endeavor to avoid this depression and to procure an *adequate length for the lip.*



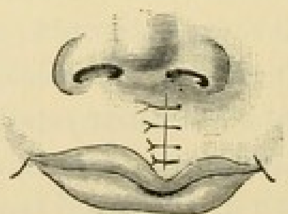


FIG. 1045. Vivifying   FIG. 1046. Wound   FIG. 1047. Suture

NÉLATON'S OPERATION FOR HARELIP

In incomplete clefts of less degree not extending to the nostril, the surgeon may proceed in various ways according to their depth.

1. *Nélaton* divides the lip above the angle of the cleft parallel to its margins. Next, he draws down the angle of the cleft and unites the rhomboidal wound lengthwise, in such a manner that a prominence is produced, which subsequently, by cicatricial contraction, disappears.

2. *J. Wolff*, according to *von Langenbeck's* method, cuts off the entire border of the lip as far as and close to the angles of the mouth, draws it down, and unites the margins of the wound lengthwise. By a horizontal

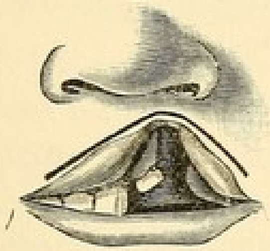
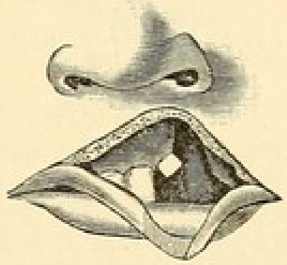
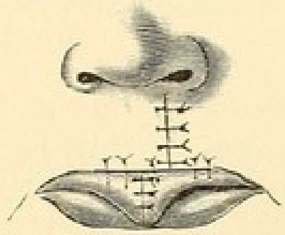




FIG. 1048. Vivifying FIG. 1049. Wound FIG. 1050. Suture

VON LANGENBECK'S AND WOLFF'S METHOD OF DISTORTION OF THE MARGINS OF THE LIPS

suture he attaches the margin of the lip to the newly formed upper lip, after he has cut off as much from the vermilion border of the lips as to leave only a moderate projection. This is again united by a longitudinal line of sutures (*distortion of the margins of the lips*).

3. *Malgaigne* makes a semicircular incision around the angle of the cleft. At both ends of this incision, he makes two smaller incisions on the

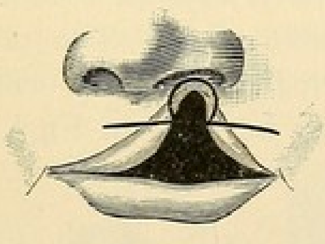
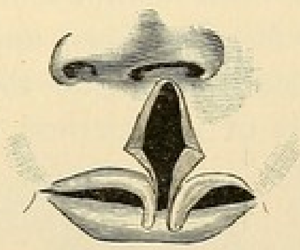
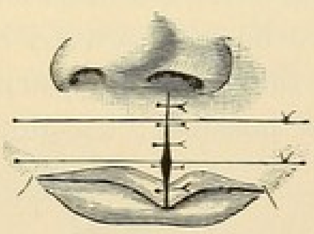




FIG. 1051. Vivifying FIG. 1052. Wound FIG. 1053. Suture

MALGAINE'S METHOD

lip obliquely outward and downward, turns the *segments thus formed* downward, and sews together in the median line the margins of the cleft thereby extended.

4. *Mirault* excises only *one* little flap from one margin of the cleft (best, the lateral). He vivifies the other margin correspondingly in the form of an

angle, and forms the margin of the lip by sewing the flap to the oblique margin of the wound of the other side.

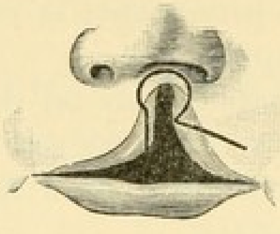
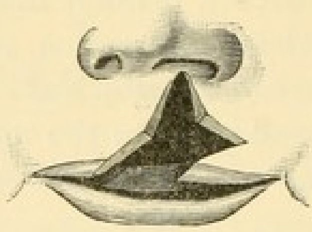
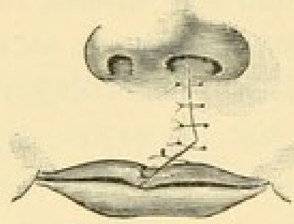




FIG. 1054. Vivifying FIG. 1055. Wound FIG. 1056. SUTURE
MIRAULT'S (VON LANGENBECK'S) METHOD

5. *Giraldés* forms at the lateral margin a small flap *with a lower base;* from the apex of this, he makes an incision outwardly and beneath the ala of the nose. From the inner margin of the cleft, a small flap is cut *with an upper base*, which, on being drawn upward, forms the lower margin of the nostril, whilst the little flap of the other side is drawn down and used as a border for the lip.

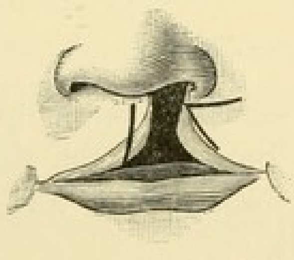
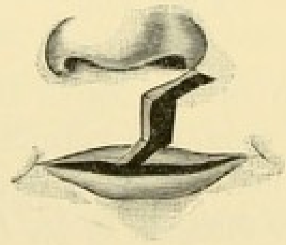
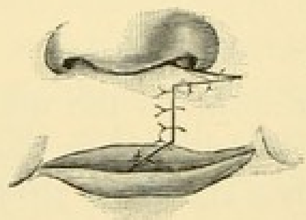




FIG. 1057. Vivifying FIG. 1058. Wound FIG. 1059. Suture
GIRALDÉS' METHOD

These older methods have been modified in many ways in recent times, and have been improved by *König*, *Maas*, and *Hagedorn*. The mode of making the incisions purposes to elongate the margins of the wound as much as possible; the details of the method may be seen in Figs. 1060–1068.

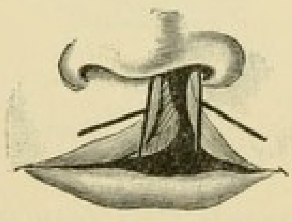
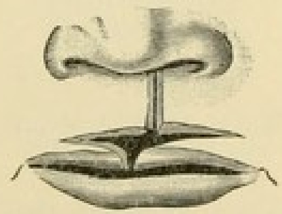
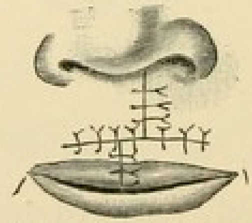




FIG. 1060. Vivifying FIG. 1061. Wound FIG. 1062. Suture
KÖNIG'S METHOD

I, myself, since 1854, in all these formations of clefts (especially in somewhat older children, where sufficient soft parts are at the disposal of the surgeon) have proceeded according to "*the principle of economy*," established by myself. That is, along all the margins of the cleft, I cut around

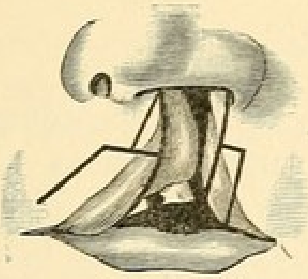
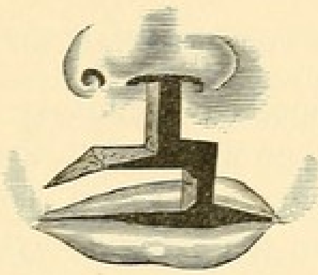
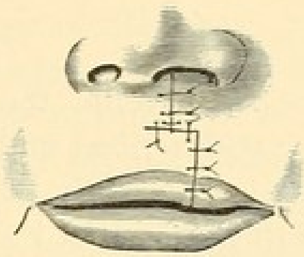




FIG. 1063. Vivifying FIG. 1064. Wound FIG. 1065. Suture

MAAS'S METHOD

the flaps exactly at the limit of the vermilion border of the lips, retrovert the mucous membrane, and sew together with the finest sutures the flaps of the mucous membrane, so that they form a basement membrane with the

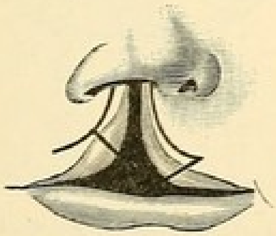
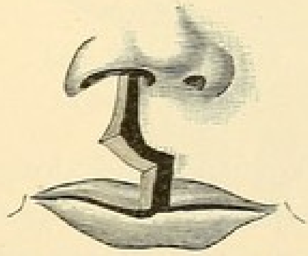
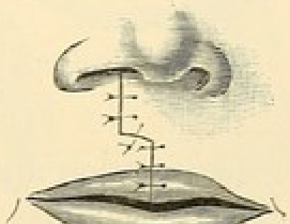




FIG. 1066. Vivifying FIG. 1067. Wound FIG. 1068. Suture

HAGEDORN'S METHOD

surface of the wound turned in an anterior direction; upon this, I slide the margins of the skin together and unite them by sutures (Figs. 1069, 1070).

This procedure is more laborious and requires more time than any of the others, and on that account it is applicable only in the case of older

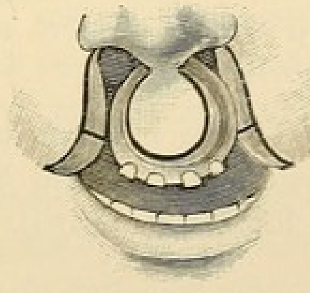
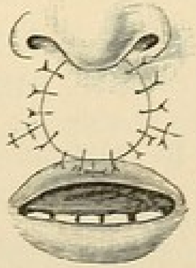



FIG. 1069. Vivifying FIG. 1070. Suture

VON ESMARCH'S METHOD

children; but it produces by far the most satisfactory cosmetic results, especially when the lip is sufficiently detached from the jaw by deep incisions beginning at the duplicature of the mucous membrane, thereby rendering the lip more movable. The liberation of the lip is of the greatest importance in all these operations.

B. DOUBLE HARELIP

In double harelip, the median peninsula is vivified according to the methods just described and then united with the lateral portions. For this purpose, it is especially important to be as *economical* as possible with the existing soft parts; that is, not to cut away anything that might be used.

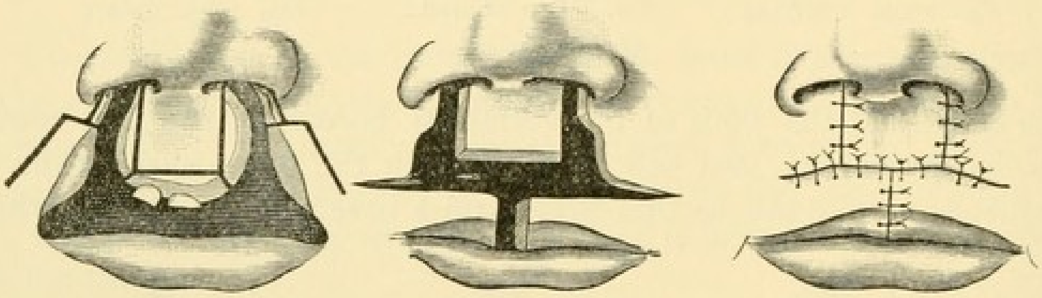


FIG. 1071. Vivifying FIG. 1072. Wound FIG. 1073. Suture
MAAS'S METHOD

The median portion must be cut around along the margins of the mucous membrane, so that either a square margin (*von Langenbeck*) or a round margin (*von Esmarch*) of the wound is secured; to this the fresh lateral

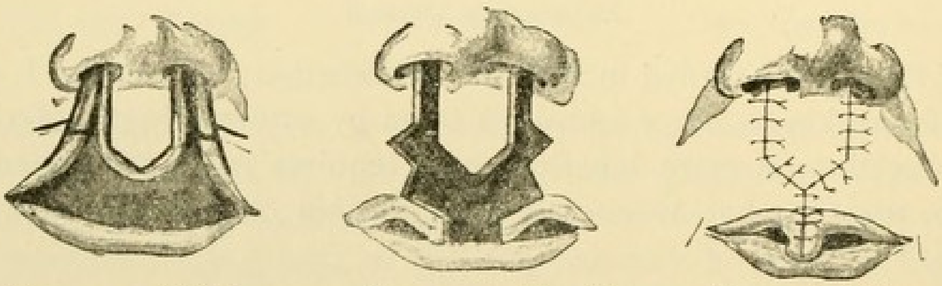


FIG. 1074. Vivifying FIG. 1075. Wound FIG. 1076. Suture
HAGEDORN'S METHOD

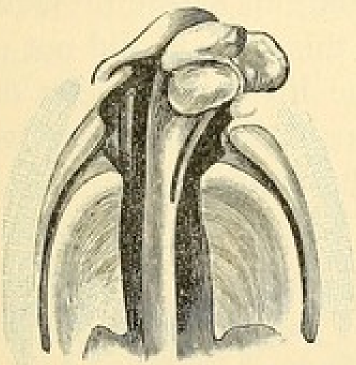
margins are sewed in various ways. If the margins are not sufficiently wide, they may be extended by *lateral incisions* and by sliding together without any tension (*Maas*, *Hagedorn*, Figs. 1071–1076).

C. DOUBLE HARELIP AND MAXILLARY FISSURE

The *protuberance* (Bürzel), or **premaxillary bone,** which is present in these cases, as a rule projects considerably; it is, therefore, necessary to force it back before the union of the clefts of the lip is made.

The *procedure of Bardeleben* is most suitable for this purpose. He divides the vomer *subperiosteally immediately behind the intermaxillary bone.*

For this purpose, he makes on the lower margin of the vomer and exactly in the median line an incision about 1 centimeter in length down to the bone, in order not to injure the *nasopalatine arteries*, which lie on each side (Fig. 1077). Next, with a fine spatula, he detaches on both sides the mucoperiosteal covering, pushes the points of bone-cutting forceps perpendicularly upward under the periosteum on both sides of the vomer, and *divides it throughout its whole extent.* By pressure upon the protuberance (Bürzel) anteriorly, the two bone plates are now made to overlap each other, pressing the projecting premaxillary bone back into the maxillary fissure (Fig. 1078).



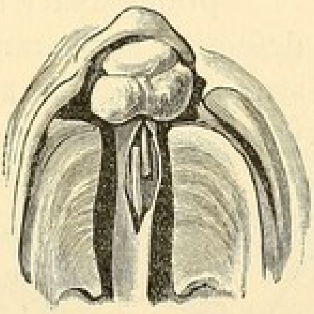


FIG. 1077 FIG. 1078
BARDELEBEN'S METHOD OF FORCING BACK THE PREMAXILLARY BONE

FIG. 1079. FORCING BACK PREMAXILLARY BONE BY ELASTIC TRACTION

In order to retain the intermaxillary bone in its new position, the child is supplied with a *little cap*, to which a rubber band is fastened in such a manner that it comes to lie directly across the upper lip under the nose, keeping back the protuberance without preventing the child from taking nourishment (Fig. 1079). This arrangement is better than the "*Thiersch butterfly*," in which the rubber band is kept in position by strips of adhesive plaster, fastened to the cheek, since the adhesive plaster is very apt to produce eczema.

When the *protuberance is broader* than the intermaxillary space, enough of the lateral margins of the premaxillary bone must be cut off with bone-cutting forceps to fit into the cleft; it is then fastened in position in the cleft with silver wire. If tooth germs are found when incisions are made, they may be scooped out with a small curette. The union of the clefts of the lips may be made at once; it is better, however, to do this later, when the soft parts are more developed.

The simple excision of a cuneiform portion from the vomer together with its coverings, according to *Blandin*, is less practical because the premaxillary portion remains movable and *hemorrhage* from the severed *nasopalatine arteries* may prove very troublesome. The artery, however, may escape injury in the detached periosteum if the cuneiform excision is made *subperiosteally* according to *Czerny*.

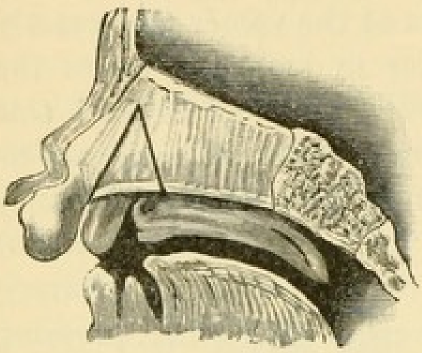


Fig. 1080. Blandin's Method of Resecting Cuneiform Portion from the Vomer

The procedure of *Simon* does not produce good results. He liberated the lateral flaps by curved incisions around the alæ of the nose and by lateral incisions so far that the flaps were sufficiently movable and could be sewed to the vivified lateral margins of the projecting premaxillary bone; in this case, he did not pay attention at first to the defective appearance of the lip thus formed; only afterward, when by the stretching of the lateral flaps the premaxillary bone had been replaced backward sufficiently, was the lip restored.

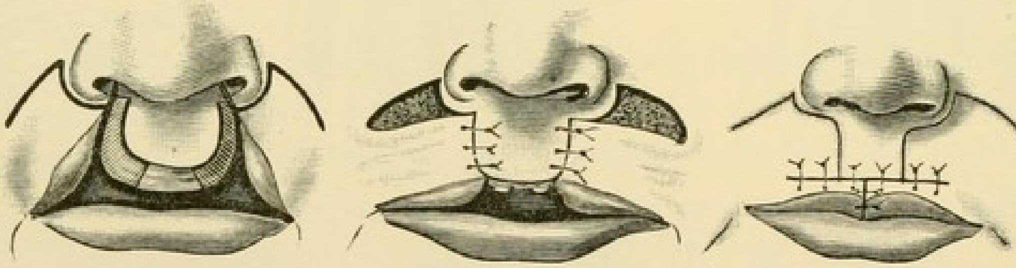


Fig. 1081. Vivifying — Fig. 1082. Temporary stitching of lateral flaps — Fig. 1083. Suture

Simon's Method

The simple excision of the whole premaxillary bone is under no circumstances justifiable, because permanent deformity of the oral region remains as an inevitable consequence.

D. Single Harelip and Cleft Palate

In this case, *the premaxillary bone* projects very *obliquely* toward the other side and thus forms a great obstacle to the union of the soft parts. In order to make it movable and to displace it backward, *a spoon-shaped gouge chisel*, with some force, is pushed upward from below, at the place where the intermaxillary bone unites with the alveolar process, through the margin of the jaw, until the intermaxillary portion can be turned around its axis and pressed into the cleft of the jaw, where it is then held in position by the elastic band attached to the cap; the union of the soft parts can be made immediately or at a subsequent time.

For the removal of the projecting premaxillary bone and the lateral deviation of the tip of the nose toward the healthy side, *Samter* advises section of the cartilaginous septum of the nose with scissors by an incision ascending almost perpendicularly between the upper lip and the premaxillary bone, whereby the tip of the nose is made movable. On the other hand, *J. Wolff* does not employ any of the methods of reposition, because in his opinion the upper lip subsequently recedes too much.

II. CLEFT PALATE

This congenital defect very often presents itself in connection with harelip.

Formerly surgeons postponed operative procedures until the children were sufficiently advanced in age so that they were intelligent enough to be subjected to the operation. In most cases, however, they desired the operation of their own accord. In modern times *very early closure* has produced even better results (*Wolff*), because children learn to speak with greater facility. At any rate, it seems to be safer not to operate on children during the first year, but somewhat later, — at the age of five to seven years. (Dr. *Brophy*, of Chicago, operates during early infancy, and his method of operating has yielded admirable results.) In order that the operation may be *successful*, it is of the greatest importance to make the child practise *articulation* methodically for some time.

The operation is best performed with the head in a dependent position under partial anæsthesia. Adults may be operated upon in a sitting position, without chloroform, in which case they can spit out the blood from time to time, and cleanse the mouth with ice-water. Severe hemorrhages are arrested by temporary tamponade.

STAPHYLORRHAPHY

(CLOSURE OF CLEFTS OF THE SOFT PALATE BY SUTURE)

The operation is performed in the following manner (*von Gräfe*, 1816):

The patient sits on a chair opposite the light, whilst an assistant fixes the head of the patient steadily; the operator sits in front of the patient.

The mouth is kept patent either by the oral speculum of *Whitehead* or by a *wedge of india rubber* forced between the molar teeth, whilst the oral opening, as far as possible, is kept widely distended on both sides by *von Langenbeck's* oral retractors (Fig. 1084, *h*).

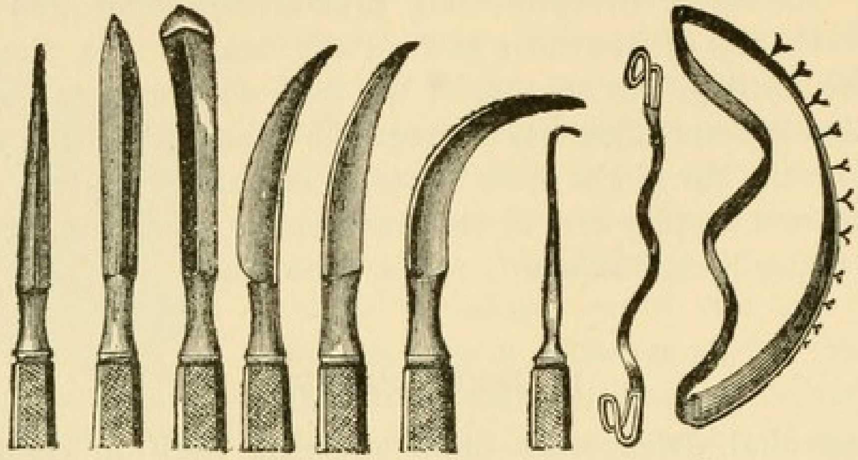


FIG. 1084. VON LANGENBECK'S INSTRUMENTS FOR STAPHYLORRHAPHY. *a*, two-edged pointed knife for vivifying margins in staphylorrhaphy; *b*, *c*, pointed and probe-pointed knife for separating the soft palate from the mucous membrane of the nose and the palate bone; *d*, curved knife for making lateral incisions; *e*, *f*, sickle-shaped knives for dividing palatal muscles; *g*, sharp hook; *h*, oral retractor; *i*, " diadem "

The mucous membrane of the whole palate and of the base of the tongue is rendered insensible by brushing it with a ten per cent solution of cocaine.

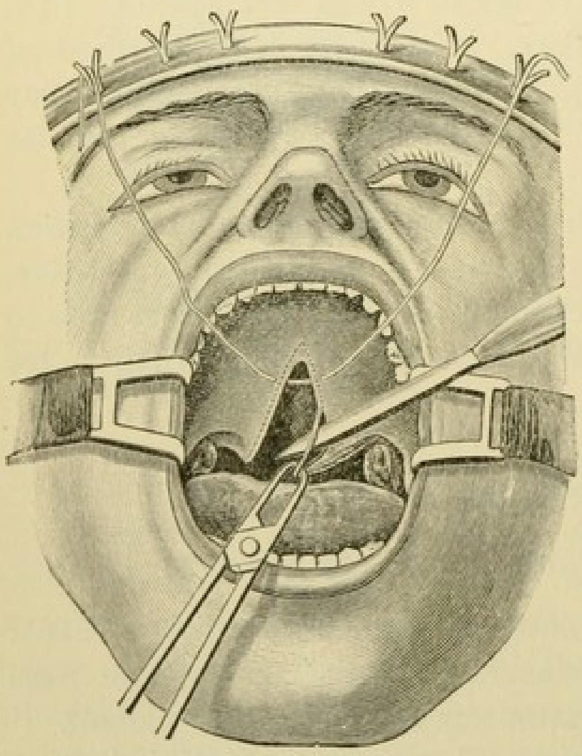
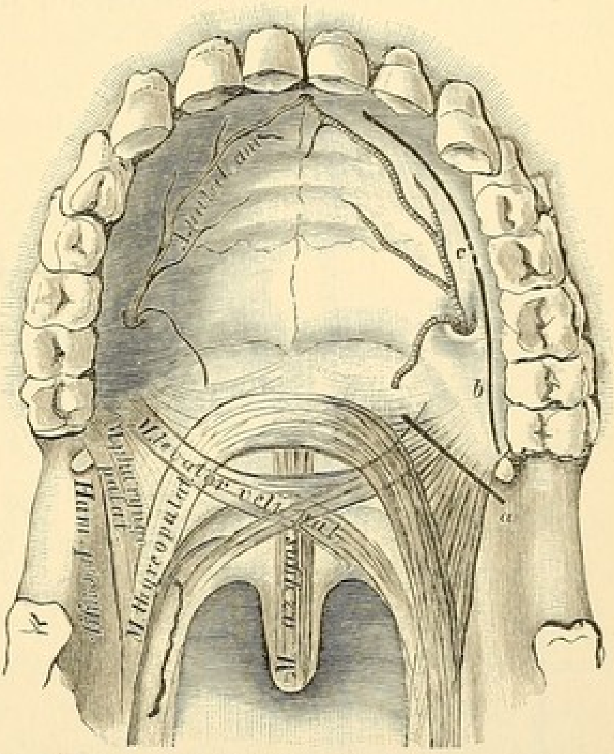


FIG. 1085. STAPHYLORRHAPHY (Closure of clefts of the soft palate by suture)

1. **Vivifying margins of the cleft.** With *Fröhlich's* (Fig. 1085, *a*) long hooked forceps, or a little sharp hook (Fig. 1084, *g*), the *left apex* of the bifid uvula is grasped first, *drawn downward, and made tense;* next, near the place where the uvula has been grasped, and a few millimeters distant from its margin, a small pointed knife (Fig. 1084, *a*), with the edge turned upward, is pushed through the whole thickness of the uvula, and, *with sawing movements, carried upward* as far as and a little above the angle of the cleft (Fig. 1085). That portion of the margin of the cleft of the uvula first grasped is cut off in a downward direction closely along the jaw of the forceps, and the upper end of the margin

thus detached is severed from the angle of the cleft of the hard palate. In the same manner the *right margin of the cleft* of the soft palate is vivified.

2. In order **to relieve the tension of the margins of the wound**, there may be made according to *Dieffenbach* some incisions throughout the whole thickness of the soft palate. These incisions are made on both sides of the margins, and at some distance from them. It is better, according to *Fergusson and von Langenbeck, to divide the palatal muscles* which elevate the soft palate and move the palatopharyngeal pillars of the fauces (namely, *levator veli palatini et musculus pharyngo-palatinus*) (Fig. 1086). A pointed knife, curved like a sickle (Fig. 1084, *f*), is pushed, with its edge directed upward, closely below and a little to the outer side of the hamular process of the sphenoid (*hamulus pterygoideus*), from without inward and from before backward through the soft palate and as far as the posterior pharyngeal wall. Next, with sawing movements, the soft palate is divided throughout its whole thickness as far as the posterior margin of the palate bone (Fig. 1086, *a*).



M. Levator veli palatini | M. Pharyngo-palatinus
M. Thyreo-palatinus | M. Azygos uvulæ

FIG. 1086. MUSCLES OF THE SOFT PALATE

a, incision for dividing muscles, taking their origin from the hamular process of the sphenoid; *b*, incision for separating muco-periosteal flaps in uranoplasty

The trunks of the *pterygopalatine artery*, which take their course more anteriorly through the pterygopalatine canals, are not injured thereby. Moreover, if the tension of the margins of the wound is not too great, these incisions are superfluous.

3. **The suture is best applied** with *von Langenbeck's needle holder*, — a curved needle bent at an obtuse angle and provided with a handle (Fig. 1088). Closely behind the point of this needle, a very fine watchspring, bent at its end in the form of a hook, can be projected by making pressure upon a little disk on the handle. The needle is inserted from before backward, close to the vivified margin of the cleft, and when its point becomes visible in the cleft, the disk is pushed forward. By this means, the hook projects from the

needle and enters the oral cavity *from behind forward,* through the cleft of the palate. By means of a thread carrier, an instrument which carries the suture (a guiding staff terminating in two angles — Fig. 1087), an assistant carries the loop of the suture to the little hook, and as soon as the suture is behind it, the operator allows the watchspring to recede. The hook thus

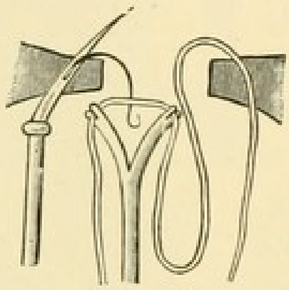


Fig. 1089
Applying the Suture

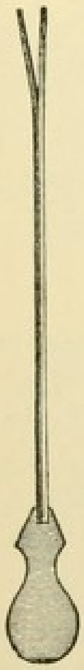


Fig. 1087 Fig. 1088
Von Langenbeck's Needle Holder and Guiding Staff for Suture

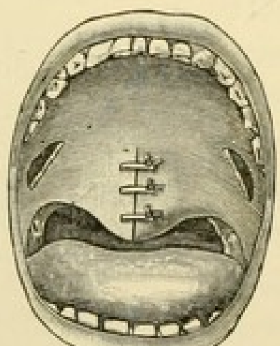


Fig. 1090
Suture completed

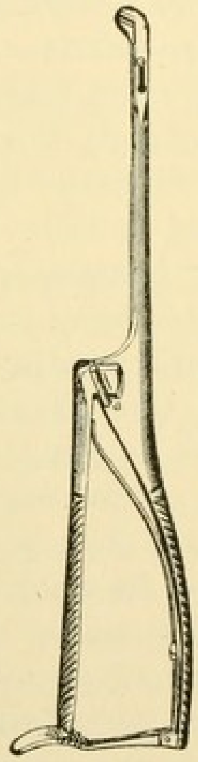


Fig. 1091
Hagedorn's Needle Holder

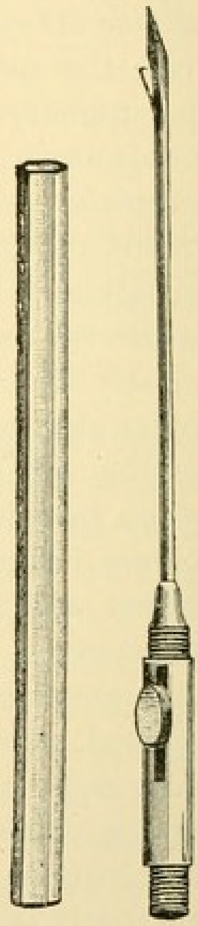


Fig. 1092
Bruns's Needle, provided with a Handle

grasps the suture and draws it forward. The instrument, by a combined posterior and anterior movement, is now drawn, together with the suture, from the margin of the cleft; and, after the watchspring is pushed forward, the suture is liberated from the hook. The corresponding site on the other margin of the cleft is then perforated with the needle; and the opposite end of the ligature stretched over the suture carrier is grasped with the little hook, and, on withdrawing the needle, the suture is drawn out of the mouth (Fig. 1089).

The suturing is done with silk, commencing from the angle of the cleft and proceeding toward the apex of the uvula. As soon as *all the sutures* have been inserted in the manner described above, they are tied with a surgeon's knot and a simple knot over it, in the same order in which they were introduced, and are then cut off close to the knot. In order that the numerous threads hanging out of the mouth may not become entangled, it is advisable to fasten them to a piece of pasteboard in notches arranged correspondingly. (Clamping the corresponding ends of the sutures with hemostatic forceps is an excellent way of disposing of them until they are tied. The traction made by the weight of the forceps adds materially to the facility in adjusting the wound margins.) Still more convenient is *von Langenbeck's* suture holder, — a semicircular ring of tin with clamps riveted to them; this ring, by means of an elastic band, is fastened *like a diadem* in front of the patient's forehead (Figs. 1084, *i*, and 1085).

For staphylorrhaphy, rarely more than three to six sutures are required.

Moreover, the sutures may be applied just as well with other instruments than *von Langenbeck's* instrumentarium; the simpler these instruments are, the better. Instead of the suturing apparatus, *Roser and Stromeyer* used plain needle holders and straight needles. The needle holder devised by *Roux* is also very practical. If the operation is performed under anæsthesia with the head in a dependent position, the sutures may be inserted very conveniently with *Hagedorn's* needles and needle holder for deep sutures — the so-called "schiefmaul" (Fig. 1091). A number of complicated suturing devices have been invented; the best known of all is, perhaps, *Passavant's*, which works like the needle of a sewing-machine. *Bruns's* needle, provided with a handle, is essentially similar to *von Langenbeck's* (Fig. 1092).

URANOPLASTY

(CLOSING CLEFTS OF THE HARD PALATE BY BLOODY SUTURE)

(*Von Langenbeck*, 1860)

This operation is made almost in the same manner as in closing clefts of the soft palate.

1. After similar preparations, the margins of the cleft of the hard palate **are vivified** with a convex scalpel (Fig. 1084, *d*).

2. To relieve tension of the *margins of the wound*, **two lateral incisions** (*Warren*) are made through the coverings of the palate (mucous membrane and periosteum) down to the bone, *running closely along the alveolar arch*, beginning posteriorly at the hamular process of the sphenoid and ending anteriorly between the external and the middle incisors, so that anteriorly they form a bridge 1 centimeter wide adhering to the alveolar process, while posteriorly an uninterrupted connection with the soft palate remains (care should be taken of the palatine artery) (Fig. 1086, *b*).

3. Starting from these incisions, the operator detaches from the bone the whole covering of the palate and *thus forms two* **mucoperiosteal double pedunculated flaps**. For this purpose, he inserts a curved raspatory in the lateral incision, presses it firmly against the bone, and then forces or pushes the periosteum with the mucous membrane from the bone toward the median line. If the detachment has been successful for about 1 centimeter along the alveolar margin, where the attachments are *firmest*, the median portions may be more easily separated from the bone by means of curved elevators. The flaps thus formed are approximated in the median line. Next follows:—

4. **The insertion of the sutures** exactly in the same manner as described on page 119.

In *single clefts of the palate*—that is, when the other half of the palate has united with the vomer—often only *one* lateral incision is required on the corresponding side; or the mucoperiosteal flap is formed from the side of the *vomer* facing the margin of the cleft and is united with the vivified margin of the fissure of the hard palate (*Lannelongue*).

If, in a very wide cleft and deep palate, the material for the flaps is comparatively scanty, the proposition of *Brandt* is noteworthy; namely, to extract all the molar teeth of the upper jaw a few months before the operation, thereby obtaining a flat palate and more material. But if abundant material is present, so that the flaps can be easily united, *von Langenbeck* advises to make the lateral incisions in such a manner that a small vascular bridge remains standing in their middle portion (at about *c* of Fig. 1086); thus the flaps are retained in closer apposition with the palate and gravitate less toward the tongue.

If, as in most congenital defects, **the hard palate, as well as the soft palate, is defective**, then, in the above described manner, staphylorrhaphy is combined with uranoplasty.

The lateral incisions, which begin at the hamular process of the sphenoid, meet with the tension-relieving incision through the velum. In detaching the mucoperiosteal flaps, after the posterior margin of the palate bone has been reached and after the velum of the palate has been lifted from it, the posterior mucous covering of the soft palate, facing the nasopharyngeal cavity, is divided throughout its whole breadth and detached from the palate bone. *Von Langenbeck* has recommended for this purpose a special curved probe-pointed knife (Fig. 1084, *b*, *c*). The tension-relieving incisions in the soft palate, however, are usually superfluous, provided the mucous membrane of the nose is sufficiently divided along the posterior margin of the hard

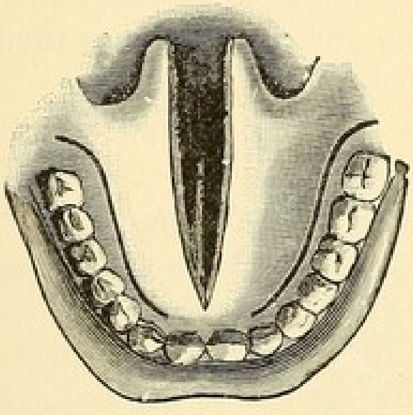


Fig. 1093

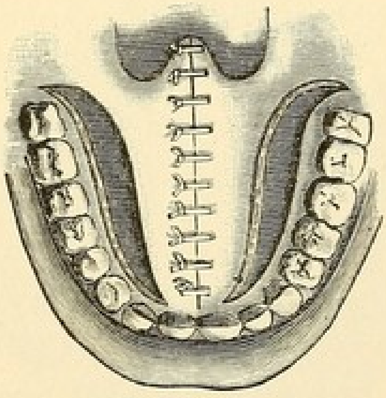


Fig. 1094

Staphylorrhaphy and Uranoplasty in Congenital Cleft of the Palate by sliding Two Pedunculated Mucoperiosteal Flaps

palate (*Küster*). The detached large flaps, which are freely movable, hang down loosely into the cavity of the mouth (like "hammocks") and almost touch each other in the median line, so that no tension is produced in applying the suture.

No dressing is required. The gaping lateral incisions are usually tamponed with iodoform gauze; but the apposition of the flaps and the healing take place more rapidly *without* tamponade (*Küster*).

In the **after treatment**, during the first few days, the patient has to observe *absolute silence* and can take only *fluid nourishment*. Cleansing and irrigation of the cavity of the mouth with weak antiseptic solutions should be made especially after each meal.

The sutures may be removed gradually from the fifth day on. Any small remaining fistulas heal by applying tincture of cantharides; larger ones are sutured with silver wire.

In spite of a successful operation and subsequent methodical articulation exercises, the voice remains more or less nasal, a defect brought about especially by the fact that the *velum of the palate, having become too short*, cannot apply itself completely against the posterior pharyngeal wall in order to close the nares.

To remedy this evil, *Passavant*, as a substitute for staphylorraphy, devised the **palatopharyngeal suture**, by which he sewed the two severed halves of the soft palate to the posterior pharyngeal wall. *Schönborn* performed **staphyloplasty** devised by *Trendelenburg;* he filled the angular cleft of the soft palate with a similarly shaped pedunculated flap from the pharyngeal wall.

By this procedure, of course, a closure of the nares is produced; but, at the same time, its function is completely abolished; the patient can breathe only through the mouth, cannot blow his nose, and the olfactory function is destroyed.

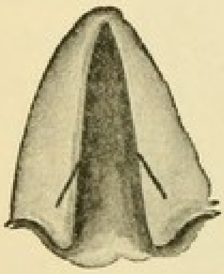


FIG. 1095

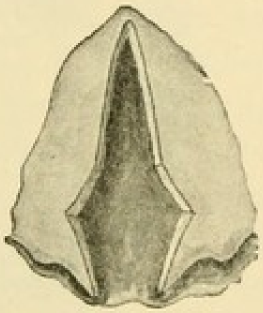


FIG. 1096

KÜSTER'S STAPHYLOPLASTY

Von Mosetig-Moorhof tried to remove these troubles caused by the complete closure of the nares, *by making an opening in the hard palate* in front closely behind the incisors, in order to remove the nasal twang (**fistulous formation on the foramen incisivum**). By chiselling out a piece as large as a lentil, and by inserting a short metal tube, he succeeded in restoring nasal breathing and partly also the function of the olfactory organ. *Küster* proceeds more simply and more successfully by *elongating* the uvula — which is too short — by lateral incisions as in *Malgaigne's* operation for harelip (Figs. 1095, 1096).

The operative closure of palatal fissures, however carefully it may be made, cannot, in many cases, dispense with

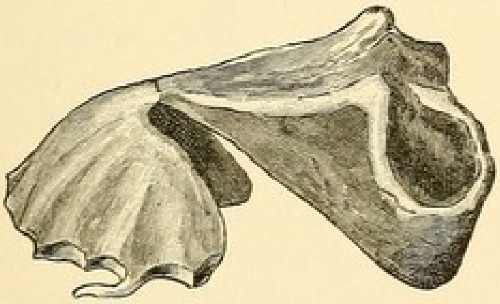
PALATAL PROTHESES, OBTURATORS,

through the practical construction of which an *almost normal articulation* is effected; they can even *take the place* of the operation entirely, provided methodical practice in articulation is continued for a sufficient length of time.

The prothetical closure of *clefts of the hard palate* can be effected with comparative ease by a *plate* supported by the teeth and covering the hard palate. The older idea of closing such defects by packing with wax, cotton, leather, etc., or by pieces of wood in the form of collar buttons, is not at all practical, since the margins of the opening are more and more forced apart by the foreign body. The principal difficulty arises when it becomes a matter of closing *clefts of the soft palate* and, at the same time, of obtaining a closure of the nasopharyngeal cavity to improve speech.

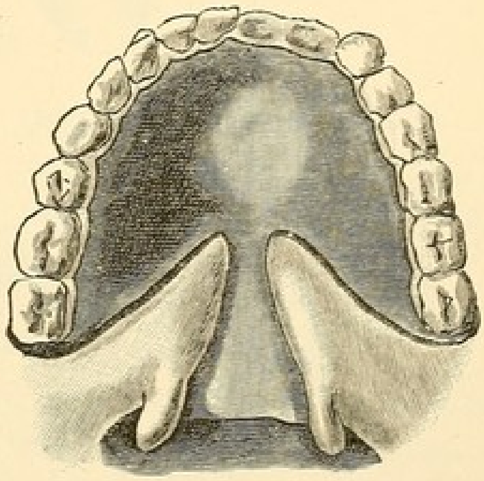
Especially good results have been obtained in modern times by the systems based upon physiological principles.

The construction of the obturator of Süersen, 1867, is based on the principle of *using the superior constrictor muscle of the pharynx* as the motive power for closing and opening the passage between the mouth and the nasal cavities. It consists of a ball of vulcanized rubber, the form of which is



a

Fig. 1097



b

Fig. 1098

Süersen's Obturator (Applied). *a*, side view; *b*, from below

determined by a soft model upon which the patient has *impressed* his contracted pharyngeal muscles by speaking aloud. If these muscles are not active, they are retracted; and sufficient space is made for the passage of air through the nose. But if they are active, they apply themselves against the depression on the ball and close the nares. By means of a small bridge, filling the fissure of the palate itself, the ball is connected with a dental plate, by which it is held in position (Figs. 1097, 1098).

The obturator of Kingsley acts by *using the levator palati muscle of the soft palate.* It consists of an obturator with a movable soft palate, made of rubber resting upon the margins of the fissure. It is lifted toward the pharynx by their action (Fig. 1099).

The obturator of Wolff-Schiltsky closes the nasopharyngeal cavity by means of an *elastic* rubber ball, which in speaking easily adapts itself to the various changes of form of the pharynx. It is kept in position by a rubber plate, is very convenient, and not heavy. At night it is removed, also in the daytime, if the patient does not have to speak. This apparatus can be used as well before as after the operation, since through it the nasal tone is obliterated (Fig. 1100).

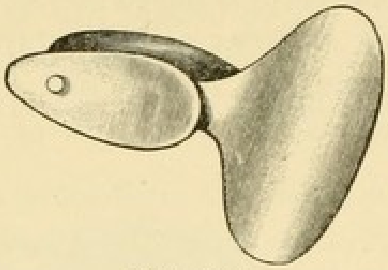


FIG. 1099
KINGSLEY'S OBTURATOR

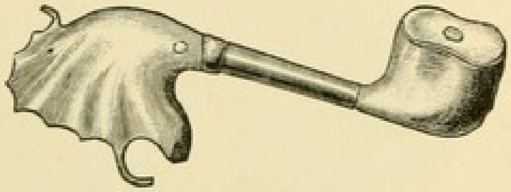


FIG. 1100. WOLFF-SCHILTSKY'S OBTURATOR

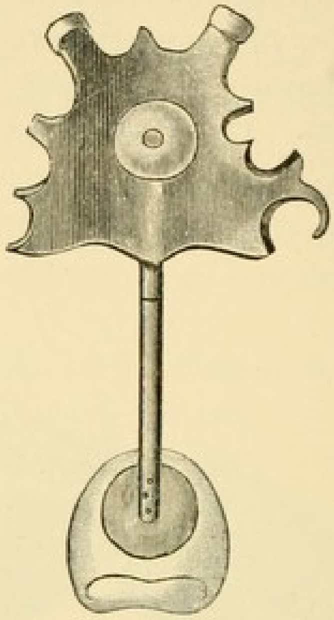


FIG. 1101. BRANDT'S OBTURATOR

Of similar construction is the **obturator of Brandt**, consisting of an elastic *ball of isinglass* or of soft rubber. After the air is exhausted from the obturator, it is introduced into the mouth of the patient, and he himself fills it with air by means of a rubber ball. The thin walls of the rubber ball easily adapt themselves to the changes of form of the pharynx caused by muscular action, and allow the air to be pressed to the place where it is needed to effect closure. The prothesis is durable, can easily be replaced, and is adapted to all palate defects (Fig. 1101).

Concerning the plastic closure of *acquired palate defects*, see page 589.

OPERATIONS INVOLVING THE FACIAL CAVITIES

A. IN THE ORBIT

The clearing out of the orbit must be made (**evacuatio orbitæ**): —

(*a*) In very extensive malignant *neoplasms of the skin* and the *conjunctiva of the eyelids and the lachrymal organs*, if the tumor cannot be completely removed without sacrificing the bulb, which is sometimes still healthy.

(*b*) In intra-ocular *tumors of the bulb*, when they have already *perforated* Tenon's capsule.

1. After the palpebral fissure has been somewhat enlarged by an *incision in an outward direction* and after the eyelids have been widely retracted, a long, straight knife is inserted at the conjunctival fold, and, in sawing movements, carried *closely along the margin of the bone*, as much as possible along the fold *around the bulb*.

2. With a pair of curved scissors, the operator proceeds along the side of the bulb as far as the *optic nerve*, and divides it with one stroke *as near its exit from the skull as possible*.

3. The mass of tissue thereby loosened is drawn forward and completely detached with the scissors.

4. For minimizing *the hemorrhage*, a compression of the cavity for a short time is sufficient. Next, the *ophthalmic artery* is ligated in the depth; finally, the remaining fragments of tissue are thoroughly cleared out.

If the surgeon intends from the beginning to remove the periosteum, he can facilitate the operation considerably by penetrating at once with the elevator from the orbital margin between the bone and the periosteum, and enucleating almost bloodlessly the entire orbital contents in the form of a cone of tissue surrounded by the periosteum.

The large cavity thus produced is *tamponed;* the large wound heals with a very disfiguring, deeply contracted cicatrix unless the cavity is covered by a plastic operation.

If the eyelids can be saved, they are used for covering the cavity. The vivified margins of the wound are sutured after a careful removal of the conjunctiva and the ciliary margins.

But if one lid or even both lids have to be removed, the exposed orbital margin is covered by turning or sliding a *flap from the temporal or frontal region* (*Küster*).

In the

EXTIRPATION OF THE EYEBALL,

that is, *the removal of the eye from its orbit*, the eyeball, together with its surrounding tissue and muscles, are excised from the orbit. This operation, however, has been superseded by the more conservative

ENUCLEATION OF THE EYEBALL,

that is, *the removal of the eyeball from Tenon's capsule.*

This operation is to be made:—

(*a*) In cases of *intra-ocular tumors* that have not yet perforated.

(*b*) In progressive disease of the bulb contents (*sympathetic ophthalmia*).

1. The conjunctiva is removed after raising a fold of the *palpebral ligament* about 3 millimeters from the right or the left corneal margin. *An incision* is then made *into it* with a pair of curved scissors, and it is detached toward the equator.

2. Now, with a strabismus hook, the *tendinous insertion* of the corresponding rectus muscle is searched for and *severed from the sclera*. By extending the incisions into the conjunctiva upward or downward and always concentrically to the corneal margin, and by grasping and dividing the insertions of the corresponding muscles, *a circular conjunctival wound* parallel to the corneal margin is produced, *in which the insertions of the four recti muscles are divided.*

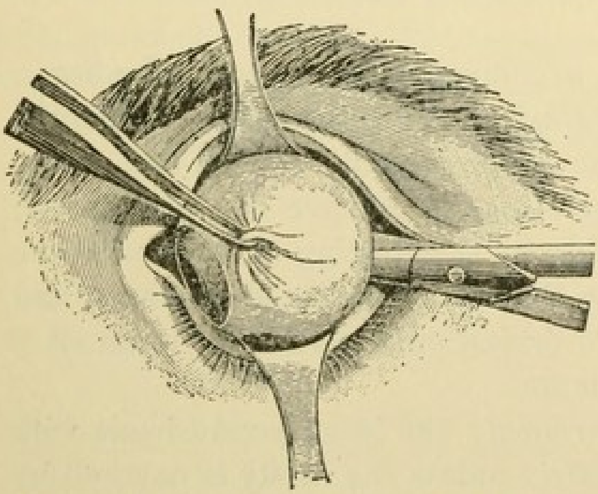


FIG. 1102. ENUCLEATION OF THE EYEBALL (Dividing optic nerve)

3. With strong tenaculum forceps, the tendinous stump of one of the lateral recti muscles is grasped; the eyeball is forcibly drawn out and rotated round its axis. Next, with a pair of *Cooper's* scissors, the operator penetrates downward beside the sclera he has grasped, and *severs the optic nerve* (Fig. 1102).

4. While the bulb is drawn out still more forcibly, the tendons of the *oblique muscles* are also *divided*, and then the enucleated eyeball is removed.

5. The *hemorrhage* is not very considerable, and is easily arrested by tamponing the cavity; the margins of the conjunctiva can be united by a few sutures.

Healing takes place in a few days. For removing the disfiguration, the patient is supplied with an *artificial eye* of glass or celluloid, which, by means of the preserved stumps of the muscles, can be moved in a satisfactory manner.

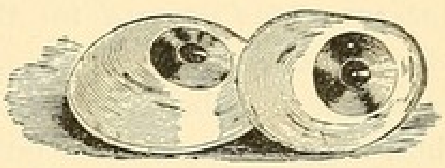


Fig. 1103. Artificial Eyes

A still *better supporting base* for the artificial eye is obtained by the simpler and less dangerous

EXENTERATION OF THE BULB (*von Gräfe*),

that is, *the evisceration of the eyeball*, which at times may be *substituted* for enucleation, and which, moreover, becomes necessary in serious *injuries*, *in inflammation and degeneration of the bulb.*

For this purpose the *corneoscleral junction is punctured* with a pointed knife down to the suprachoroidal space. Into the opening a blade of *Cooper's* scissors is introduced, and the *cornea is removed by a circular incision.* Then a *sharp spoon* is introduced close to the inner side of the sclera, and *all the contents of the bulb are scooped out.* After the slight hemorrhage has been arrested, the opening in the sclera is *sutured* horizontally. A button consisting of sclera thus remains in position, serving as a support for the artificial eye.

B. IN THE EAR

FOREIGN BODIES IN THE EXTERNAL AUDITORY MEATUS

which by their presence cause deafness, pain, and inflammation, must be removed in the gentlest manner possible. By an awkward manipulation, they very easily penetrate still *deeper* into the meatùs, endangering the *tympanic membrane.*

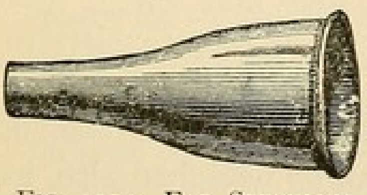


Fig. 1104. Ear Speculum

Restless children, who move the head to and fro, and twitch with pain at being touched, should be *chloroformed;* in the adult, a few drops of *cocaine* can be instilled.

The examination and the removal of the foreign body must be made very cautiously by means of an *ear speculum* (Fig. 1104) and with the best light.

In most cases it is sufficient to irrigate the meatus with a *small syringe*, producing a small but *forcible* stream. The point of the syringe need not be introduced into the ear for that purpose. The auricle, however, is drawn *backward and upward* for the purpose of straightening the canal. The jet of water enters at *the side of* the foreign body, and *behind it* in front of the tympanic membrane, when it dislodges and ejects the foreign body. The fluid which escapes must be examined for substances removed by the stream.

If this procedure does not yield the desired result, either fine instruments are used, which grasp the body anteriorly (forceps bent at an angle, fine dressing forceps), or, still better, such instruments are used as *remove it from behind* (hooks, ear scoops, wire loops). The latter can quickly be extemporized from a hairpin. *Leroy d'Etiolles'* adjustable curette (Fig. 1105) consists of a small staff, the spoonlike end of which can be placed perpendicularly to its axis by pressure upon a lever on its handle. With this instrument the operator attempts to reach behind the foreign body by keeping close to the lower wall of the meatus, or wherever a small space may be detected with the speculum. If *hard bodies fill the whale space*, an attempt can be made to *bore into them* and break them into small pieces. Pearls and other bodies as hard as stone can be extracted by cementing them (brush with molten alum powder, a match with sealing-wax, etc.). Swollen bodies (beans, peas, etc.) are freed from their husks by small scarifications or shrivelled by *instilling a few drops of glycerine*, which extracts the moisture from them. The operator may try to grasp and extract softer fruits with a very fine hook. *Insects* in the meatus are destroyed by introducing a small compress of cotton dipped in chloroform, after which they are syringed out. Oil poured into the meatus causes them to come quickly to the surface for air.

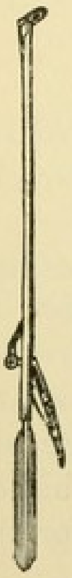


FIG. 1105 LEROY D'ETIOLLES' ADJUSTABLE CURETTE

If all these attempts prove fruitless, it is best temporarily to abstain from *forcible measures*, instil some oil, and advise the patient to lie down on the side of the affected ear. Sometimes the foreign body then falls out.

If the object to be removed (as in the majority of cases) consists of *hardened cerumen*, it is removed, after a sufficient *softening* with oil or glycerine, in the gentlest manner with a *jet of water*. If the brownish masses of the same are not lodged too firmly, they can be detached also, as a whole, from the wall of the meatus with small ear scoops.

In case of necessity, if nothing else proves effective, the *cartilaginous meatus, together with the auricle, must be detached* by a curved incision, made at its posterior insertion and temporarily turned forward so that the tympanic membrane is exposed (*Paul von Aegina*).

Only in the most serious cases should the mastoid process and the tympanic cavity be opened.

C. IN THE NARES

INSPECTION OF THE NARES

The tip of the nose is turned upward with the finger; and at the same time, the ala of the nose by backward pressure is distended somewhat. Sometimes it is possible to inspect the lateral walls as far as the turbinated bones and the septum. In most cases, however, special dilating instruments are required for this purpose.

The simplest is that of *Juracz* (Fig. 1106), with which the margin of the nostril can be distended outward, upward, or in any desired direction. In case of necessity, it can be rapidly improvised with a hairpin, bent in the required manner. In *Fränckel's* nasal speculum, the fenestrated arms can be distended by screw pressure for any distance. They remain fixed of their own accord to the margins of the nostril. According as its arms are applied to the ala of the nose and the septum, or to both alæ, one-half of the nose only or both halves can be rendered accessible for inspection at the same time (Figs. 1107, 1108).

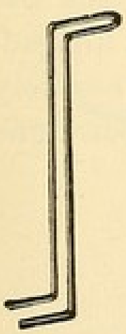


Fig. 1106 Juracz's Nasal Speculum

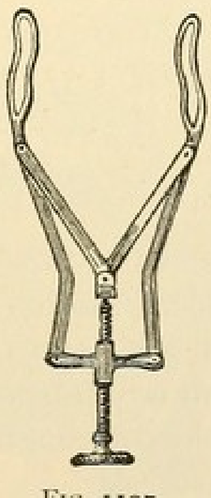


Fig. 1107

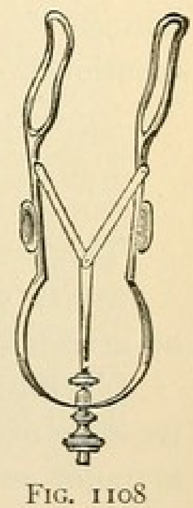


Fig. 1108

Fränckel's Nasal Speculum

Likewise tubular specula (*Zaufal's nose funnel*) have been used for inspection, especially for the lower meatus; they are similar to the urethroscope illustrated below.

For inspecting the nares *posteriorly*, especially the *nasopharyngeal cavity* (**posterior rhinoscopy**), small laryngoscopes are used. The patient sits before the surgeon with his head slightly bent forward; the base of the tongue is depressed with a tongue depressor (*e.g. Türck's*, Fig. 1144), which the patient can hold himself; next, the small laryngoscope, with its reflecting surface turned upward, is carefully introduced behind the velum without touching the pharyngeal surface. If this is not successful, or if the uvula is in the way of a free inspection, it can be drawn forward with a blunt hook or a pair of uvula forceps (*Fränckel, Voltolini*). Under some circumstances the application of cocaine is necessary.

Only a skilful practitioner can succeed in informing himself with respect to the changes existing in the nasopharyngeal cavity by making an inspection with the speculum alone. It is, therefore, always advisable to have the inspection followed immediately by *palpation with the finger*, which is made with the slightly curved forefinger introduced behind the soft palate as far as the posterior nares (choanæ). The finger is protected by a *metal sheath*, either straight or provided with joints (Figs. 1109 and 1113), to prevent the patient from biting it.

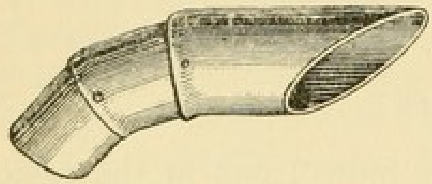


FIG. 1109. METAL SHEATH FOR PROTECTING FINGER

If it is desirable, however, to gain still more space for palpation and inspection, it is advisable, according to *Kocher*, **to divide the septum longitudinally,** — a little operation in which the operator introduces an open pair of strong scissors as far into the nostrils as possible, and thus divides the cartilaginous septum. Thereby the small arteries of the septum are injured. Two sutures finally unite the wound so exactly that the cicatrix is scarcely noticeable. Still greater access to the nares is created by the operations mentioned on pages 572 and 573.

TAMPONING THE NARES

This becomes necessary: —

(*a*) In violent continuous *hemorrhages* from the nose itself, if they cannot be arrested in a simpler manner.

(*b*) Preliminary to some operations on the face and the nose, to prevent the flow of blood through the nose into the air passages while the patient is under anæsthesia.

In some cases it is sufficient *to pack* the nostril from which the blood escapes *anteriorly* with gauze or cotton, and to compress the alæ of the nose externally. If the pieces of gauze or cotton are dipped into a 20% cocaine solution, the hemorrhage is usually arrested. (Antipyrine and tincture of chloride of iron are also excellent styptics.)

If the hemorrhage is not arrested thereby, the posterior nares must be tamponed. This is done by means of *Bellocq's canula* (Figs. 1110, 1111).

The small canula, somewhat curved anteriorly, is introduced through the nostril, along the floor of the nares and toward the pharynx. The watch-spring concealed in the canula is then pushed forward until it slips around the soft palate and becomes visible in the mouth; in the eye, which is at its probe-pointed end, a thread loop has been previously fastened; into this loop one end of a long silk thread is introduced; to the middle of this thread the tampon for closing the posterior naris (choana) is fastened; next, the canula, together with the silk thread, is withdrawn from the nostril. The tampon slips behind the soft palate, and, guided by the left forefinger, which has been introduced, is brought into the choana from behind; by pulling the thread hanging from the nostril, it is still more firmly drawn into the same. The other end of the silk thread hanging from the mouth serves for withdrawing the tampon, and during its position is fastened to the ear or the cheek with adhesive plaster.

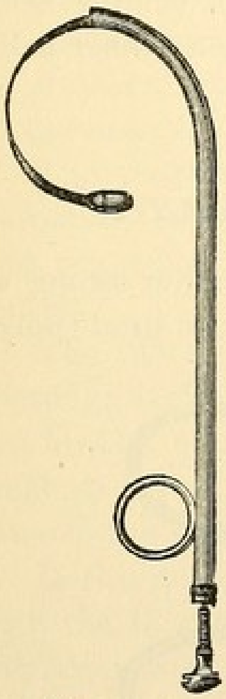


FIG. 1110

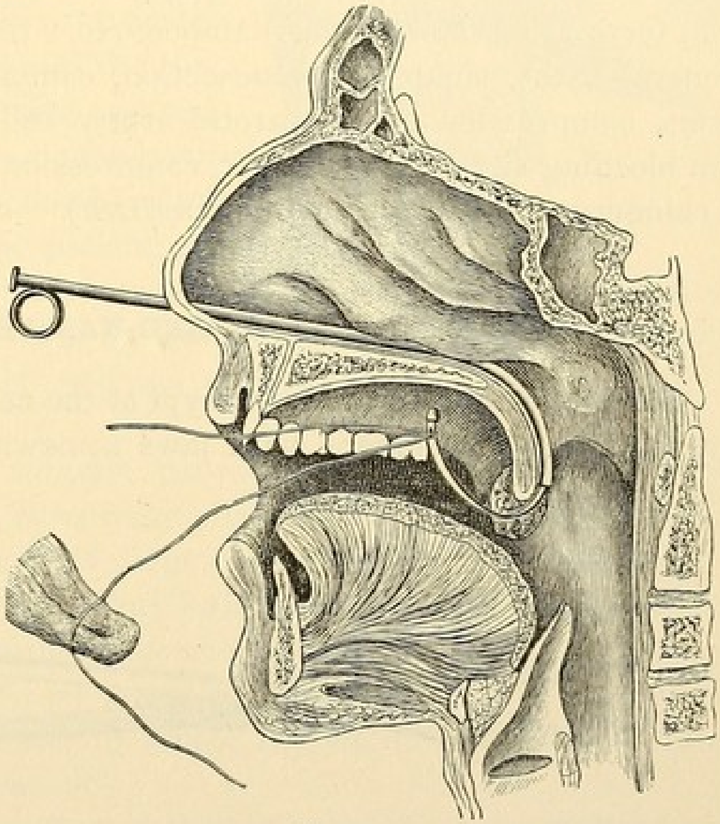


FIG. 1111

BELLOCQ'S CANULA IN POSITION

If, in addition, the nostril is tamponed anteriorly, *the entrance and the exit* of the bleeding side of the nose are occluded, and the hemorrhage is arrested.

The tampon may be removed after about two days; previously it is loosened by injecting lukewarm disinfecting solutions.

In the absence of a *Bellocq's canula*, an *elastic catheter* can be used, or *a catgut string* or *a thread thoroughly waxed*. If the site of the hemorrhage is known, it can be arrested still more rapidly by pressing a compress of absorbent cotton with the dressing forceps upon the bleeding point for several minutes, and by leaving it in position for 24 hours (*Hartmann*). *Macnamara* packed the whole nose anteriorly with strips of linen (handkerchief); but iodoform gauze is better. A strip a finger's breadth wide and half a meter long is wrapped around a probe to produce a thick plug. This is pushed through the nostril as far as the posterior naris. The probe is then withdrawn, and the remainder of the strip, which hangs out of the nostril, is packed into the nares.

Of the many *remedies for violent nasal hemorrhage* may be mentioned: Deep breathing, ice water, vinegar, alum, cocaine, tannin, ferric chloride cotton, ferripyrine, Penghawar-Yambee, etc.; revulsion by hot foot baths and general baths, sinapisms, venesection, cauterization, enemas, elevating the arms, compression of the carotid artery and jugular vein, compression of the bleeding site with the finger, compression of the alæ by a rubber ball, by a rhineurynter (*Küchenmeister*, *Englisch*).

REMOVAL OF NASAL AND NASOPHARYNGEAL POLYPI

For the removal of mucoid polypi of the nose, a pair of rather strong well-grasping straight forceps, with jaws somewhat excavated, is used (polypus forceps, Fig. 1112).

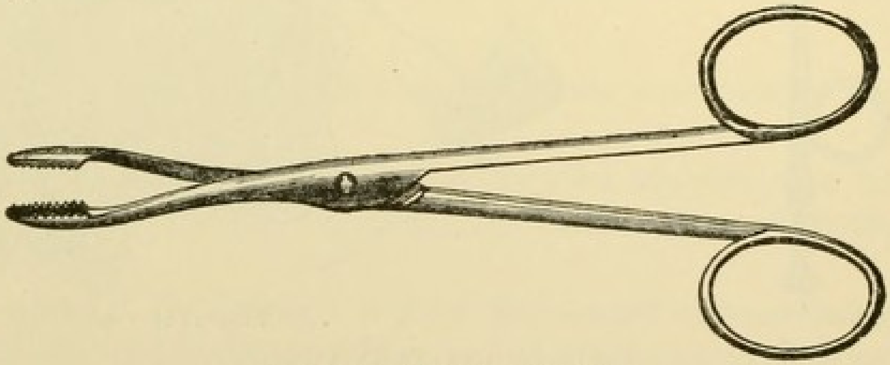


FIG. 1112. POLYPUS FORCEPS

The patient sits on a chair with his head bent slightly forward and held by an assistant from behind; on the left side of the patient a basin with carbolic solution is placed. After the nares have been made anæsthetic, if necessary, by brushing them with a 5%–10% solution of cocaine, the left forefinger is introduced through the mouth behind the soft palate, and the point of the finger is curved toward the posterior nares; next, the pair of forceps is quickly introduced anteriorly through the nostril and on the floor of the nares along the septum pushed forward toward the point of the finger; as soon as the pair of forceps is opened, the polypus falls between its blades; the forceps are then closed, rotated a little around their axis, and withdrawn with a jerk. The grasped portions of the polypus are quickly dropped into the water by shaking movements from the open forceps; the pair of forceps is immediately introduced again in the same manner, and the operator attempts to grasp any remaining portions and to remove them, while the point of the finger, placed in the posterior naris, presses forward toward the forceps any polypi which may have escaped the first seizure. Polypi still remaining can be projected forward by a forcible blowing of the nose, on the part of the patient.

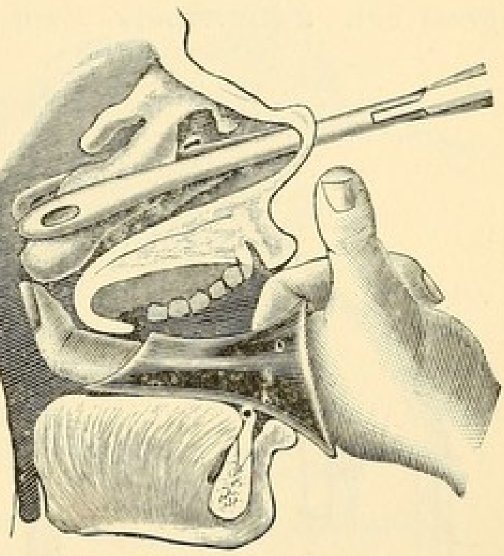


FIG. 1113. REMOVING POLYPUS

The surgeon continues this procedure *with the greatest rapidity possible*, palpating the whole nares in a systematic manner from below upward, and removing portions of the polypus until the forceps fail to grasp any more.

The more radically the surgeon proceeds, the quicker and the more thorough is the success. If *portions of the margins of the turbinated bones* are broken off, not much harm is done; *Pirogoff*, in cases of nasal polypi, went so far as to break out "a priori" all the turbinated bones, in order to remove the soil for any subsequent recurrence.

If the nose is filled with *very many small polypi*, little is accomplished with the forceps, and it is better to scrape the whole mucous membrane of the nares *with the sharp spoon*.

The *hemorrhage*, at first *rather violent*, is arrested almost without exception, after some time, by irrigation with ice water. In more obstinate and more violent hemorrhages, solutions of tannic acid or ergotine-glycerine alcohol and other styptics should be used. In more urgent cases, the nose must be tamponed (see page 566).

This procedure produces just as quick and as safe results as *ligating* the several pedicles of the polypus by means of the *galvano-cautery loop* or the so-called *cold wire snare* (Figs. 1114, 1115), which can be performed only by experts. The latter is especially adapted to smaller polypi lodged in the upper half of the nasal cavity; although the operation is more gentle, it is more tedious. To prevent recurrence the whole mucous membrane can be cauterized superficially with the galvano-cautery.

In solitary, large nasopharyngeal polypi, with a *thin pedicle*, the surgeon can also *remove them by ligation*. The presence of putrefying

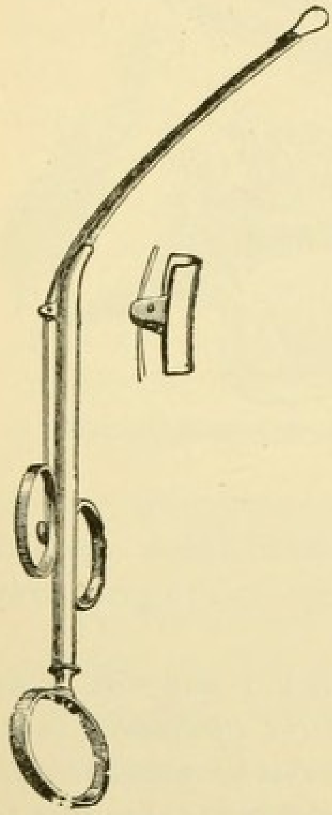


Fig. 1114. Wilde-Duplay's Cold Wire Snare

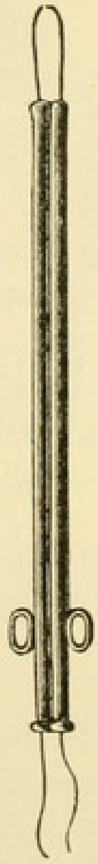


Fig. 1115. Loret Wire Snare

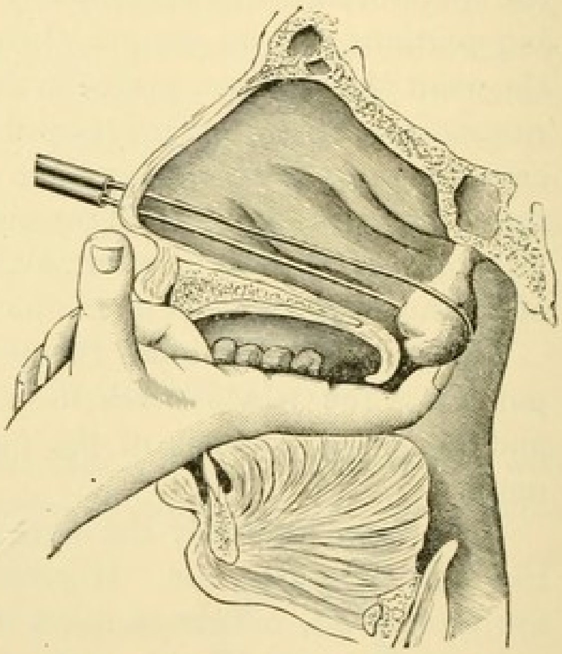


Fig. 1116. Removing Polypus by Ligation

substances and the remaining of the stump of the pedicle, from which recurrence can result, constitute the disadvantages of this method, which *von Langenbeck*, with two silk ligatures (Ricord), performed in the following manner: —

1. An elastic *catheter*, transversely perforated, is introduced into the pharynx through the nostril, and with the left forefinger carried into the mouth so far that the first folded thread forming an even loop can be inserted with its open end into the fenestra of the catheter.

2. The catheter is withdrawn, and with it the loop, guided by the left forefinger, slips over the body of the polypus so as to be still visible in the mouth while the free ends hang out of the nostril.

3. Into the catheter, which is again introduced, the second loop with the *closed end* (in the form of a loop) is inserted and carried back through the nose so that the free ends come to lie in the mouth, while the loop lies in front of the nostril.

4. Next, the free ends, both in the mouth and in front of the nostril, are placed through the loop; and while the loop in the mouth is carried with the finger as high as possible and around the polypus, both ends are drawn tight (Fig. 1117).

5. After the pedicle has been ligated in this manner, the polypus is cut off close to the ligature. The ligature can be removed safely after two or three days.

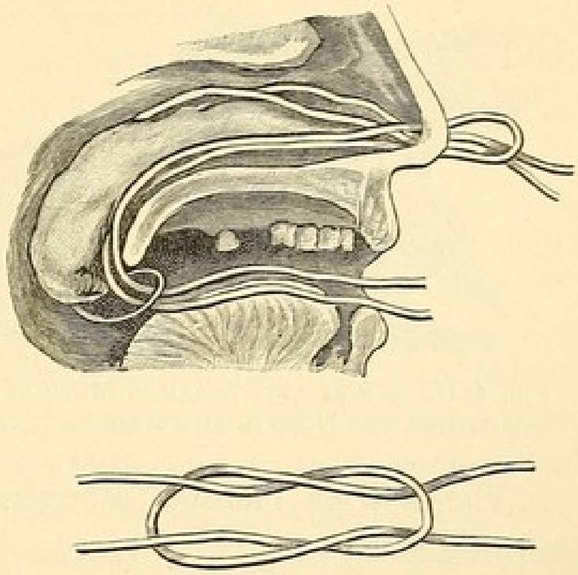


FIG. 1117. VON LANGENBECK'S METHOD OF REMOVING POLYPUS BY LIGATION

REMOVAL OF FIBROUS POLYPI (NASOPHARYNGEAL POLYPI)

is a much more difficult procedure. Mostly with very broad pedicles, they take their origin from the periosteum or the bone of the base of the skull itself, and their favorite site is in the *posterior parts* of the nose and in the pharynx.

They can project *anteriorly into the nares*, laterally behind the upper jaw into *the pterygopalatine fossa*, *the temporal fossa*, and superiorly through the sphenoid bone into the cavity of the cranium. These neoplasms must be extirpated as thoroughly as possible; to render them accessible, **preliminary operations** varying according to their site and size are required.

These preliminary operations are intended to secure as free an access as possible to the nares, so that the *posterior portions* can also be inspected and palpated with facility and rendered accessible for the required treatment. Hence, they are employed not only *for extirpating tumors*, but also in *necrosis*, *caries*, *ulcers* (lupus), and firmly impacted *foreign bodies*.

DIVISION OF THE NOSE IN THE MEDIAN LINE (*Dieffenbach*, *König*)

suffices under certain circumstances, and is quickly performed, if necessary, without anæsthesia. A curved pointed knife is introduced through the nostril of the side involved as high as possible and as far as the nasal bone along the septum; the bridge of the nose close to the median line is then divided longitudinally from within outward (Fig. 1118). If this incision does not afford sufficient space, the *nasal process* may, in addition, be resected *osteoplastically* from the wound; and, if necessary, the upper lip may also be divided; by dissecting it back, the *access to the pyriform aperture* can be enlarged (*Jordan*, *Baracz*). *König* removes the polypi by *vigorous* leverlike traction with large, somewhat dull, spoons.

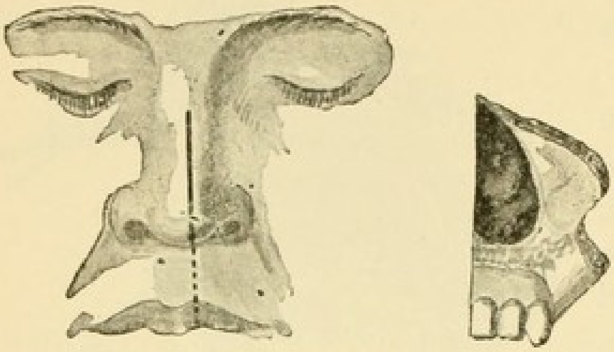
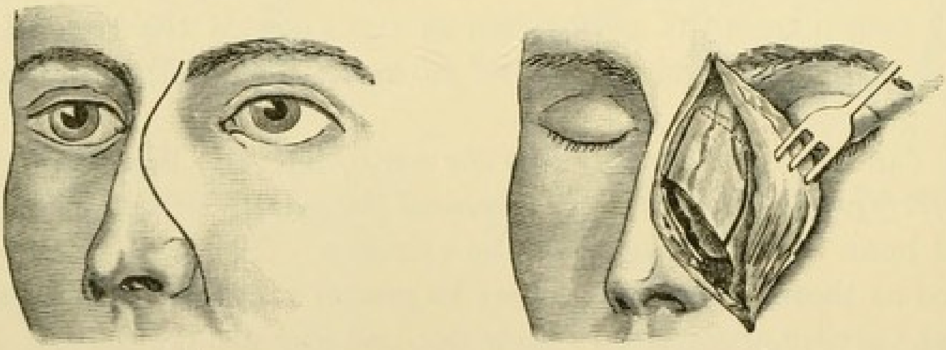


Fig. 1118. König and Baracz's Method of dividing the Nose in the Median Line

The line of incision, afterward carefully sutured, heals with a scar scarcely visible.

RESECTION OF THE NASAL PROCESS OF THE UPPER JAW (*von Langenbeck*, 1854)

1. Curved *external incision* from the internal lower margin of the eyebrow to the bridge of the nose and thence to the process of the ala of the nose in the nasolabial fold (Fig. 1119).



a *b*

Fig. 1119 Fig. 1120

Resection of the Nasal Process of the Upper Jaw (von Langenbeck)
a, external incision; *b*, saw incisions

2. The flap is dissected off toward the eye.

3. The *nasal cartilage* is *detached* from its union with the bone; and into this opening, closely below the insertion of the lower turbinated bone, a thin, short, but strong metacarpal saw is introduced. With this, the nasal process is sawed through outward and upward as far as the lachrymal sac; then straight upward as far as the nose, and, finally, downward, the nasal bone itself or its connection with the nasal process is divided longitudinally.

The removal of this detached bone plate, consisting of the nasal process of the upper jaw, a piece of the lachrymal bone, the nasal bone, and the inferior turbinated bone, produces sufficient space for inspecting the whole interior of the nares, the posterior nares, and the inferior surface of the body of the sphenoid. Finally, the external wound in its whole extent is united by suture.

Although, as a rule, no change in form of the face results from the removal of the portion of bone, *von Langenbeck* himself subsequently (1859) made a *temporary* (osteoplastic) *resection*, in order not to remove the nasal process entirely. This operation he made in the following manner: —

He sawed through the bone covered by the periosteum, only from below, as far as the lachrymal bone and above in its connection with the nasal bone (Fig. 1120); then, by means of an elevator introduced into the lower incision made by the saw, he lifted up the bone plate whereby the thin bone lamella of the region of the lachrymal bone *was fractured*. The portion thus turned up *like a cover*, at the end of the operation, he turned back into its former position, in which position it again united.

In many cases the

TEMPORARY DETACHMENT OF THE NOSE (*Rouge*)

may be advantageous, in which case the soft parts of the nose and the upper lip are displaced upward.

Owing to the somewhat severe hemorrhage which attends this operation, the patient is placed either in a *lateral position* with the head turned toward the right or in a dependent position, in which case, though the hemorrhage is even more violent, the blood is less liable to enter the air passages and cannot be aspired.

1. The upper lip, forcibly stretched, is raised upward at both angles of the mouth by the operator and an assistant. After the mucous membrane at the duplicature has been divided *down to the bone* by an *incision* commencing above the first left molar and ending above the right molar, the soft parts are detached from the latter in an upper direction as far as *the anterior nasal spine*.

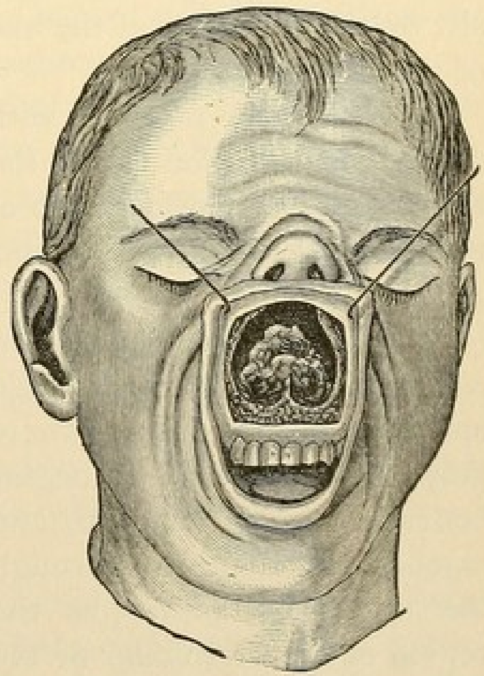


FIG. 1121. TEMPORARY DETACHMENT OF THE NOSE (Rouge's Method)

2. From this, the cartilaginous septum is detached; then, from the upper jaw, the alar cartilages are divided with scissors by an incision on each side. *The lip and the nose, then completely detached, are turned up toward the forehead;* if the bony septum is in the way, it is also divided with bone-cutting forceps.

It is then easy to remove all diseased parts from the nose; likewise, deeply seated ulcers and granulations become visible and can be subjected to direct treatment. At the end of the operation, the detached nose is *replaced* into its normal position like a curtain. Union by sutures is not necessary. No disfiguration follows this operation.

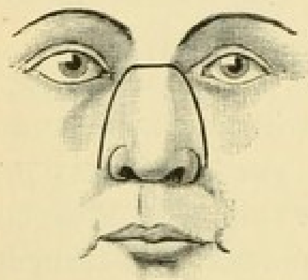
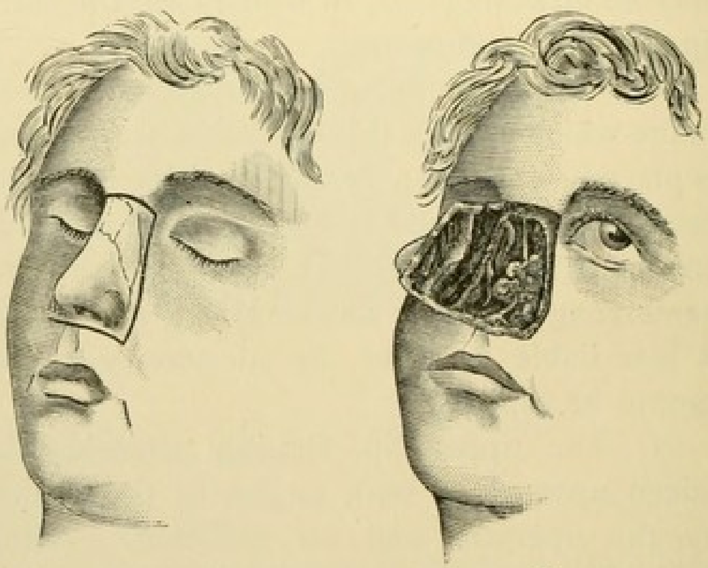


Fig. 1122. Ollier's Temporary Resection of the Nose

The field of operation becomes very accessible by **turning up the whole nose together with the entire nasal skeleton.** For this purpose the latter must be divided from its surroundings with a pointed saw. With a knife, *Lawrence* circumscribed the nose laterally and below, and turned it *upward.* A better procedure is that of *Ollier*, who, by a skin incision in the form of a horseshoe, detached the lateral margins and the root of the nose; next he sawed through the bony skeleton of the nose on the same level, and turned the nose *downward.* The vascular bridges then consist of the septum and the alæ of the nose (Fig. 1122).

A still better prospect with respect to nutrition is offered **by the lateral displacement of the external nose** (*Chassaignac-Bruns*).



a — b

Fig. 1123 — Fig. 1124

Von Bruns's Temporary Resection of the Nose
a, external incision; *b*, nose turned up

1. *The external incision encircles the nose on three sides,* and penetrates everywhere down to the bone. It begins beneath one alar margin, and extends horizontally through the upper lip as far as the region of the first molar of the other side; next, the skin of the root of the nose, above the nasofrontal suture, is detached by a transverse incision which, on each side, remains

about 1 centimeter distant from the inner angle of the eye. The terminal points of these two incisions are connected on one side by an oblique incision extending exteriorly and inferiorly along the side of the nose (Fig. 1123).

2. With the metacarpal saw the *anterior nasal spine* is detached horizontally; and with the bone-cutting forceps *the bony septum* is *divided* in the same direction for some distance.

3. The metacarpal saw is applied with its point in the nares at the lower margin of the pyriform aperture, and *the nasal process of the superior maxillary bone*, together with the anterior end of the inferior turbinated bone, is *sawed through*, corresponding to the skin incision, as far as the nasal bone.

4. Both nasal bones *are sawed off transversely* in the nasofrontal suture; and the septum, if necessary, is divided, with bone-cutting forceps, partly from the inferior and partly from the superior transverse incisions with two incisions meeting posteriorly in the form of an obtuse angle.

5. By introducing an elevator into the upper end of the lateral incision, the union of the nasal bone with the upper jaw of the other side is infracted, and the whole nose is then turned over toward the opposite cheek.

A very satisfactory view of the interior of the nose as far as the posterior pharyngeal wall is then obtained.

If it is desirable to maintain those parts for some time accessible for the eye and the finger, the nose may remain in this dislocated position *for several weeks* (without injury to its nutrition). At the end of this period, of course, a superficial vivification of the margins of the wound will be required on account of their being then in a state of cicatrization.

If it is desirable to turn over only *one-half* of the nares, the transverse skin incisions do not extend beyond the median line. The sawing of the upper jaw is done as described above. The nasofrontal suture is sawed through as far as the median line, and the union of the two nasal bones is infracted in the median line by the use of the elevator.

TEMPORARY RESECTION OF THE NOSE

according to Gussenbauer (Fig. 1125), for exposing the frontal sinuses, the ethmoid sinuses, the sphenoidal sinuses, and the orbits: —

1. Tamponing the nares.

2. *External incision* down to the bone from the inner half of the eyebrow along the nasal process of the frontal bone and the superior maxilla downward; next, transversely across the bridge of the nose corresponding to the borders of the nasal bones, and upward to the inner half of the other eyebrow.

3. The nasal process of the upper jaw as far as the inferior edge of the orbit; the two nasal processes of the frontal bone, in connection with the lachrymal bone; the orbital plate of the ethmoid bone; and finally, the connection of the perpendicular plate of the ethmoid bone and of the palate bone (the vomer), are all divided with the chisel.

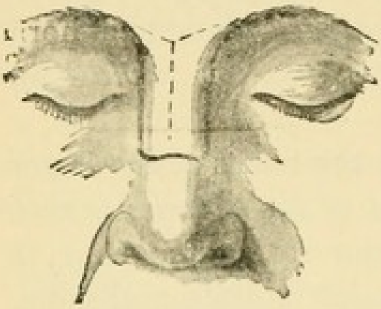


FIG. 1125. GUSSENBAUER'S TEMPORARY RESECTION OF THE NOSE

4. The flap of bone and soft parts is turned in an upward direction, the tumor is removed, the cavity of the wound is packed with iodoform gauze, and the latter brought out of the nostrils; the flap is turned down again, and sutured in its whole extent.

When *the tumors are attached to the wall of the pharynx or the cervical vertebræ*, it may be easier, under certain circumstances, to reach the root of the polypus **from the pharynx** instead of from the nose.

Manne, and afterward *Dieffenbach*, divided longitudinally the *whole soft palate*, together with the uvula, *in the median line;* the two halves were then drawn apart and subsequently closed again by staphylorrhaphy. *Maisonneuve* used the same incision, but left the uvula intact (*boutonnière palatine*), whereby the subsequent reunion of the soft parts was more easily obtained. *Böckel* divided the soft palate from the hard palate by a transverse incision. *Nélaton* removed, from a T-incision, the posterior part of the hard palate; and *Gussenbauer* divided the mucoperiosteal membrane (" Überzug ") of the palate in the median line, detached it toward both sides, and chiselled open the bony roof of the palate. By this procedure the *sphenoidal sinuses* can also be successfully exposed.

Chalot and Habs chiselled from the hard palate a kind of artificial fissure palate, by dividing, with the wire saw, the vomer from an incision similar to that of Fig. 1121. From the cavities of the rapidly extracted canine teeth they chiselled off the hard palate along the alveolar margin as far as the insertion of the soft palate; next they divided the alveolar process between the alveoli of the canine teeth and the nares, and then turned down the middle portion, adhering only to the soft palate *like a trap-door. Partsch's* procedure is easier, and without the considerable hemorrhage occurring during this operation. From a similar incision of the soft parts extending from the second molar tooth of one side to the second molar tooth of the other, the soft parts are drawn forcibly upward, the bone is rapidly exposed with the elevator, and with a broad chisel the upper jaw above the roots of the teeth, the mucous membrane of the base of the nose, and the mucous membrane of the antrum of Highmore are divided horizontally as far as the tuberosity of the superior maxilla until the **whole palate** under moderate pressure can be turned downward like a visor. After the extirpation of the tumor, the temporarily detached palate is replaced in its former position, and fastened by superficial sutures. The reunion takes place very rapidly, — beyond expectation, — and without any disturbance of function.

For *exposing the base of the skull, according to Kocher*, by turning up the lower half of the two upper jaws, see page 484.

Finally, those tumors which spring from the *pterygoid processes of the sphenoid bone* have their seat in the pterygopalatine fossa behind the upper jaw, and which grow into the *temporal fossa* (**retromaxillary tumors**, *von Langenbeck*), cannot be extirpated either from the mouth or from the nose, and must be exposed by the *osteoplastic resection of the upper jaw* (see p. 474).

EXTIRPATION OF NASOPHARYNGEAL POLYPI,

to which access must be obtained in some way or other, is made according to the nature of the tumor present and its degree of vascularity. Hard tumors are removed with *knife and scissors;* the base is thoroughly cleared away with *the sharp spoon and the raspatory*. Sometimes it is possible with these instruments *to free* the tumor "in toto" from its attachment. If violent hemorrhage occurs, and if the tumor is soft in structure, the *thermo-cautery* must be employed, with which even the last vestiges of the stump of the tumor can be destroyed. These tumors have also been destroyed by electrolytic treatment, and in some cases with a permanent result.

Whether the painting of the stump with *Lugol's* solution protects from recurrence is questionable; on the other hand, with advancing age, these tumors often decrease or disappear of their own accord (*Gosselin, Hueter*).

ADENOID VEGETATIONS IN THE NASOPHARYNGEAL CAVITY (*Meyer*)

Their presence is at once recognized *from the expression of the face and the manner of speech* of the patients (children). But concerning their extent and nature reliable information is obtained only by the finger, introduced behind the soft palate for *palpating* the pharyngeal space. The granulations can be easily removed by scraping. The procedure is as follows: —

After the operator has *pointed*, to about a right angle, the nails of both his forefingers (the nails, of course, must be somewhat long), the child is placed on a chair, to which his arms and his legs are strapped. The surgeon, having under some pretext persuaded the unsuspecting child to open his mouth, quickly introduces his finger protected by a metal sheath. He now has free play. Standing at the side and behind the patient's head, he first scrapes with the forefinger, which has been introduced behind the soft palate, the corresponding side of the pharyngeal space; next, he removes the finger from the sheath, inserts the other forefinger, and performs the same operation on the other side until smooth walls can be felt everywhere.

Above all, it is necessary to proceed as *radically as possible* during the *first* operation; for, a second time, it might not be easy to persuade the child to consent to the operation.

During the operation the hemorrhage, though violent, is never alarming, and is arrested by cold nasal douches. The patient is confined to his room and his bed during the next few days, and receives cold fluid nourishment, such as milk and eggs.

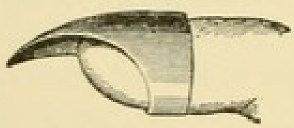
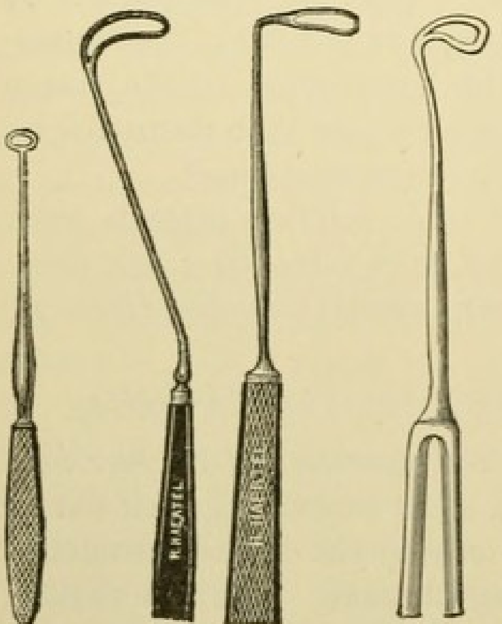


FIG. 1126. POINTED INSTRUMENT FOR SUPPLYING FINGERNAIL

If the operator's nail is not long or hard enough, instruments can be substituted (*e.g.* Fig. 1126), in which case, of course, the control by the sense of touch is not by any means as perfect.

This operation loses much of its barbarous character if the patient is partially anæsthetized, so that, when requested, he coughs out the blood flowing into the larynx; the use of instruments is preferred by some surgeons.



a b c d

FIG. 1127. CIRCULAR KNIVES According to *a*, Meyer; *b*, Schoelz; *c*, Lange; *d*, Gottstein

FIG. 1128 MICHAEL'S NASO-PHARYNGEAL FORCEPS

For the removal of these vegetations, *Meyer* invented his *circular knife* (Fig. 1127, *a*). *Lange* and many others modified it, and now there are knives shaped even like a plane. *Meyer's* instrument is introduced into the pharyngeal space from the lower meatus of the nose; the instruments bent at an angle are introduced from the mouth. In all cases, the finger introduced by the side of the instrument should serve as a guide. At the present time, the favorite circular knife is probably *Gottstein's* (Fig. 1127, *d*), a curette bent on the flat. It is introduced from the mouth high into the pharyngeal space, and then by vigorous downward pressure the masses are scraped away, downward if possible, in a connected piece, and the scraping is continued until the palpating finger cannot detect any more diseased tissue.

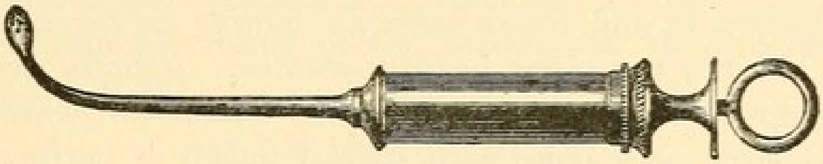


Fig. 1129. Brown's Pharyngeal Syringe

Granulations have also been *crushed with forceps* (Fig. 1128), or destroyed by the galvano-cautery.

Douching the nose with either the irrigator or the pharyngeal syringe (*Brown*, Fig. 1129) may be used during the after treatment.

CONTRACTION OF THE NOSTRILS,

originating from plastic operations or from ulcerations, can be removed permanently only by lining the enlarging incisions with skin.

The *bloodless dilatation* with *dilating bougies* is tedious; *tubes* must be worn for years.

If the nostril has contracted to a small fistulous opening, the skin duplication may be reached, to some extent, by an *oblique T incision* (*Dieffenbach*). The upper line of the T incision extends along the margin of the ala, while its base comes to lie in the corner between the septum and the upper lip. The flaps thus formed are pushed into the nostril by a tube.

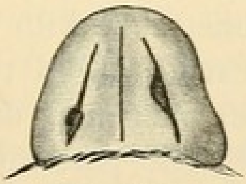


Fig. 1130

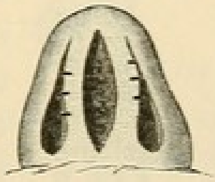


Fig. 1131

Dilating Contracted Nostrils

Or the stricture is *divided longitudinally* in *an upward and downward direction*, corresponding to the shape of a normal nostril. At the middle of the septum, a *tension-relieving incision* is made, and the median flap, made more movable thereby, is stitched on each side to the mucous membrane (Figs. 1130, 1131).

A small flap (*Roser*) (see page 527) may also be formed at the extremity of the dilating incision. In serious cases, partial rhinoplasty must be made.

IN DEVIATIONS (SCOLIOSIS) OF THE SEPTUM OF THE NOSE,

originating from *injuries* and from *abnormal longitudinal growth* of the same (combined with catarrh of the nose, or producing it), various methods have been tried to render the meatus (contracted by the convex side of the septum) again free for the entrance of air.

Blandin, *Rupprecht*, and *Roser* made an *opening* in the septum for the admission of air into the other healthy meatus. *Blandin* perforated the curved cartilage with an *awl*, while *Rupprecht and Roser punched a hole* in the septum as large as a lentil with special punch or perforating forceps similar to a conductor's punch.

Others resected the projecting cartilaginous portion, but avoided perforation.

Dieffenbach excised a correspondingly large oval piece. *Chassaignac and Roser* proceeded in a similar manner.

The most conservative procedure is the

SUBPERICHONDRIAL RESECTION OF THE SEPTUM (*Petersen*)

Under anæsthesia, with the nostril held widely open, with a narrow-bladed knife, a ⊔-shaped flap with its base upward is circumscribed in the *mucoperichondrial covering* on the convex side. This is dissected back carefully in an upward direction with a fine elevator, and the cartilage now exposed, corresponding to the lower incision, is divided transversely with the knife. From this incision, always from the same nostril, the operator penetrates with the elevator between the cartilage and the perichondrium on the other side, and detaches the same sufficiently. The portion of cartilage, now freed on both sides, is cut out with the scissors in the form of a Gothic window. The mucoperichondrial flap is *turned down* and fastened by two sutures to the angles of the wound.

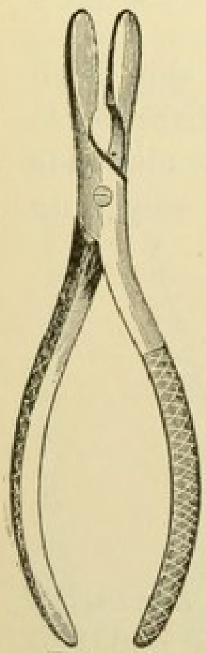


FIG. 1132
ADAMS' RHINOPLASTOS

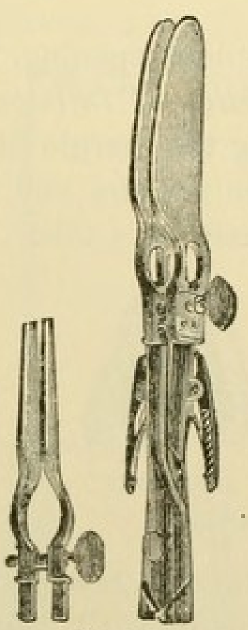


FIG. 1133
JURACZ'S FORCEPS

This method is especially adapted to deviations of the anterior portion of the septum, since the small size of the field of operation, as well as the rather considerable hemorrhage, makes operating at a greater depth impossible, since the surgeon cannot see what he is doing. The *bloodless straightening* of the curved septum has also been attempted with a special kind of forceps.

Adams, with his "*rhinoplastos*" (Fig. 1132), straightened the septum by pressure, and subsequently inserted for three to five days a *compressor* consisting of two parallel plates. *Juracz* improved the forceps in this manner: the anterior part holding the plates can be *removed* after reposition has been produced by closure of the blades, and remains in position as a compressor (Fig. 1133).

D. IN THE ORAL CAVITY

FOR INSPECTING THE CAVITY OF THE MOUTH

a number of instruments are used, — the so-called **oral specula**.

Separate the *lips* with the fingers, or use the common lip-holder of metal or wood (*Lüer*), or blunt retractors (*von Langenbeck*), or similar instruments.

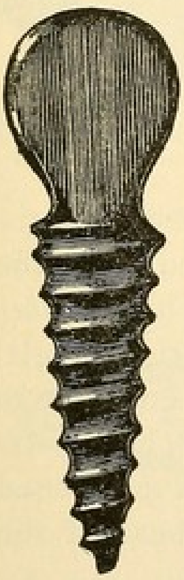


FIG. 1134
SCREW WEDGE

The *rows of teeth*, especially when they are tightly compressed, either intentionally or in anæsthesia, are forced apart by wedge-shaped instruments (dilators). The simplest of these is a *wedge* of soft wood, which is forced laterally between the molar teeth. It has a coarse screw-thread, which is very practical (Fig. 1134). The introduction of this *screw wedge* succeeds more gently and easily by boring movements.

Heister's mouth gag consists of two steel arms tapering anteriorly, which are forced apart by screw power (Fig. 1136).

Of similar construction is *König-Roser's mouth gag*. Its arms (bent at an angle and lined at their ends with plates of lead) are forced apart by compressing the handle. When in position and opened, the dilated mouth can be kept open *for any length of time*.

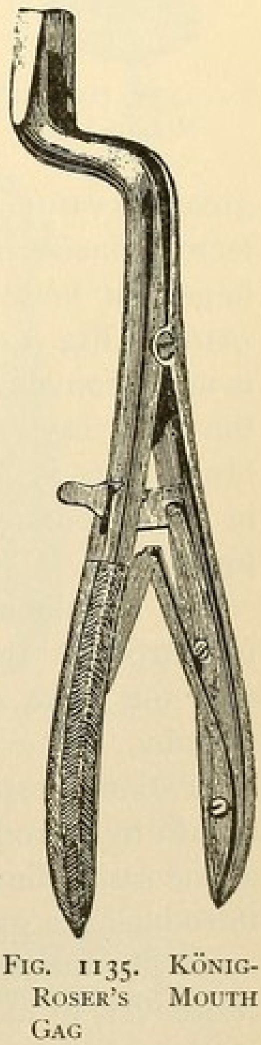


FIG. 1135. KÖNIG-ROSER'S MOUTH GAG

When, after the patient opens his mouth of his own accord, it is necessary *to keep it open for some time*, the operator simply inserts between the rows of molar teeth *a cork* or *Pitha's mouth wedge*, a piece of caoutchouc doubly grooved and fastened to a thread. *Weinlechner's gag* is of similar construction, but it is provided with a handle.

Excellent for inspecting the mouth and for keeping it open during some operations (*e.g.* on the tongue, palate) is *Whitehead's oral speculum*, the two arms of which are kept apart by adjustable serrated stops or bars; the part intended for the lower jaw has also an adjustable tongue plate. (Figs. 1138, 1139 show the instrument closed, opened, and applied.)

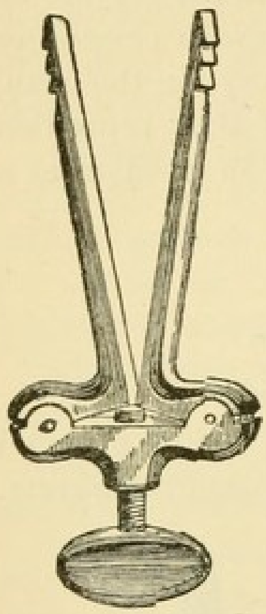


Fig. 1136. Heister's Mouth Gag

The English speculum is built on a similar plan (Fig. 1140), the arms of which can be screwed apart by a spiral coil (*Tillmans*).

Bruns's automatic mouth gag consists of two adjustable furrowed plates, which come to lie upon the rows of teeth, and which, by means of curved arms provided with a spring, constantly provide an elastic (springy) movement. Its closing is prevented by a stop, which can be removed by the pressure of the finger.

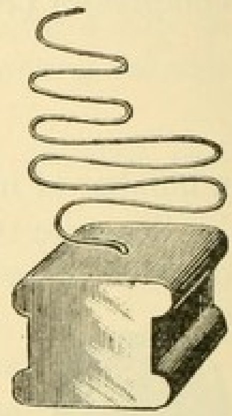


Fig. 1137. Pitha's Mouth Wedge

In some patients the *tongue* curves considerably, and, on account of this great curvature, as well as on account of its movements, prevents a satisfactory inspection of the pharynx. The tongue is depressed with the finger, or better with a *spatula* or the handle of a spoon. The *angular spatula* (Fig. 1142), the arms of which can be opened only at a right angle, is more convenient. The hand holding it does not shade the entrance to the oral cavity. *Türck's tongue spatula* must be mentioned here. Its broad plate is affixed laterally at an angle to the handle. It was mentioned in the discussion of posterior rhinoscopy for depressing the base of the tongue.

In employing tongue depressors it is of especial importance not to introduce them deeply enough to touch the pillars of the pharynx and the base of the tongue, because choking sensations are produced thereby.

Patients, especially children, who offer resistance, are forced to open the mouth by introducing the finger between the rows of teeth, and by folding at the same time the margin of the lower lip between them (*Hueter*), or by introducing a gag in the aperture behind the molar teeth. Small children open the mouth at once if the surgeon closes the nose with his fingers. Moreover, in most cases, success is obtained more rapidly by kindness than by force.

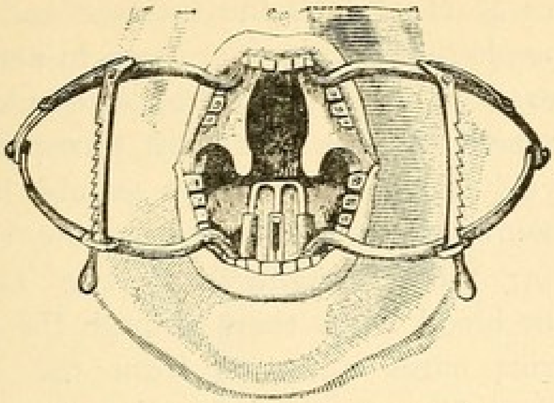


FIG. 1138. Front view when applied

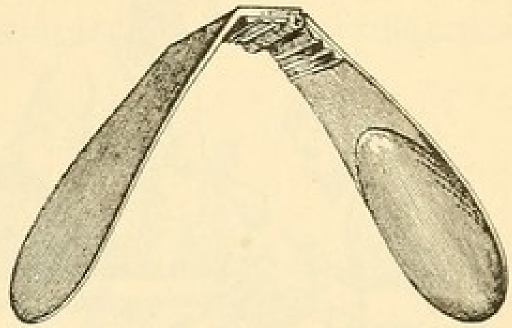


FIG. 1142. TONGUE SPATULA

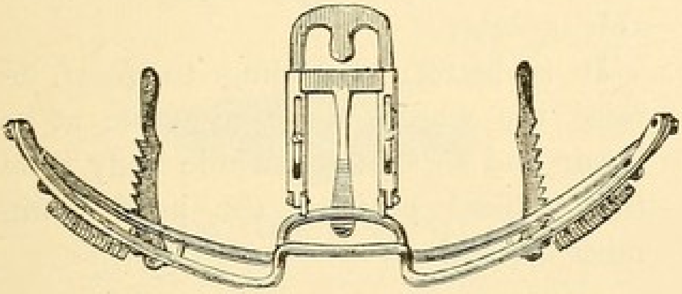


FIG. 1139. WHITEHEAD'S ORAL SPECULUM
Closed and viewed from above

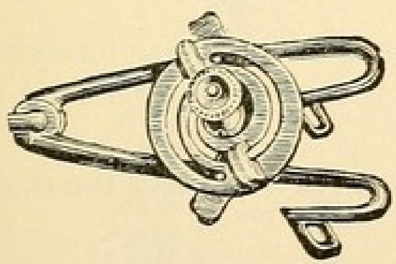


FIG. 1140. TILLMANNS'S ENGLISH SPECULUM

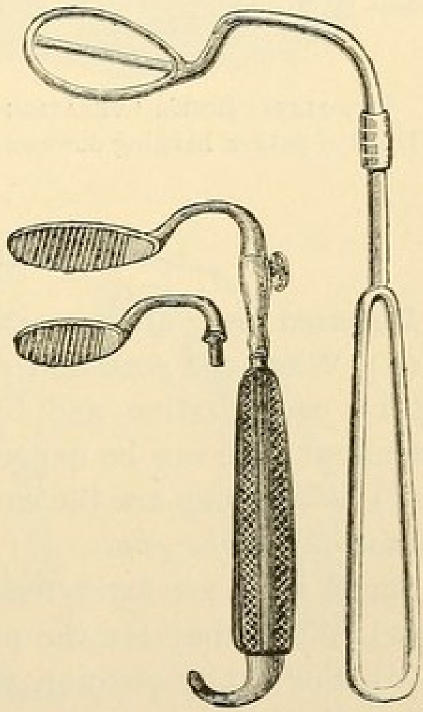


FIG. 1143. TÜRCK'S TONGUE SPATULA

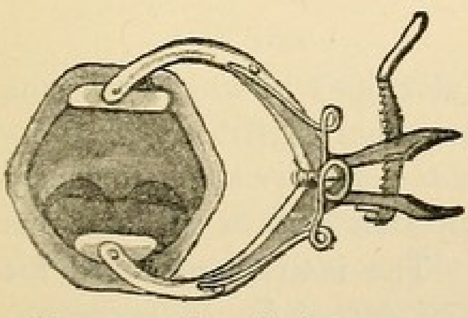


FIG. 1141. BRUNS'S AUTOMATIC MOUTH GAG

FIG. 1144. TONGUE SPATULA OF GLASS

For the prevention of *the entrance of blood* into the trachea and the œsophagus during operations in and on the cavity of the mouth, *Rose* recommends that the head of the patient (lying flat on his back) should hang downward over the end of the operating table (**hanging head**, Fig. 1145). The blood flows then through the posterior nares and out from the nostrils. The hemorrhage, however, on account of the venous stasis in the blood vessels of the neck, is considerably greater.

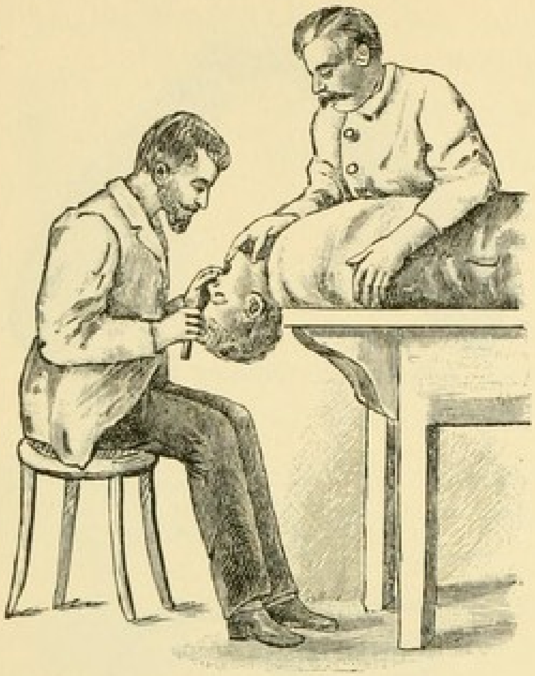


FIG. 1145. ROSE'S OPERATION
(Head of patient hanging downward)

It is better, according to *Ried*, to raise the whole operating table at its lower end so that the whole body is in the inclined position, the head being most dependent.

EXTRACTION OF TEETH

Diseased teeth are extracted : —

(*a*) When the *pain* and disease (*caries*) has progressed so far (*pulpitis*) that by cauterization and by suitable filling of the cavity (*plombage*) no permanent cure can be expected.

(*b*) When they are the cause of *alveolar abscesses* (periostitis of the roots) and *fistulas of the gums*.

Sound teeth are extracted only : —

(*a*) When they are the probable cause of violent *neuralgia*.

(*b*) For faulty position when they interfere with the eruption of other teeth and with speech.

(*c*) *Preliminary* to some operations.

A tooth can be extracted from its socket (alveolus), in which its roots are firmly impacted, only after it has been somewhat separated from its alveolar attachments or walls. For *forcing apart the alveolar walls*, formerly the tooth was *inclined laterally*, whereby mostly that side of the alveolus toward which the tooth was turned broke off. The instruments used for this purpose operated largely by leverage : the *tooth key*, or *key of Garengeot*, the " Überwurf," the pelican, and the *elevator*, etc. (Figs. 1146, 1147).

Tooth forceps, acting more conservatively, are the instruments now generally used. They grasp the *neck of the tooth;* and, since this is variously shaped in the different teeth, owing to the shape and arrangement of the roots, different forceps are used.

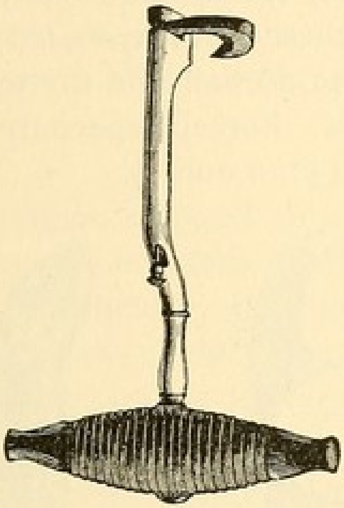


FIG. 1146. TOOTH KEY

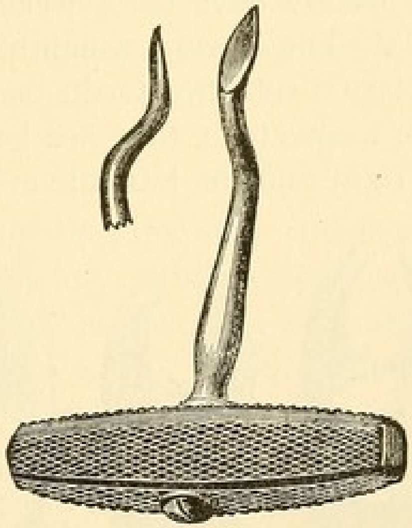


FIG. 1147. LÉCLUSE'S ELEVATOR

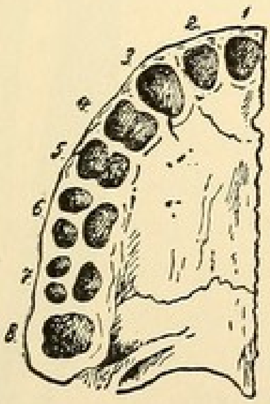


FIG. 1148
ALVEOLI OF THE UPPER JAW
1, 2, incisors

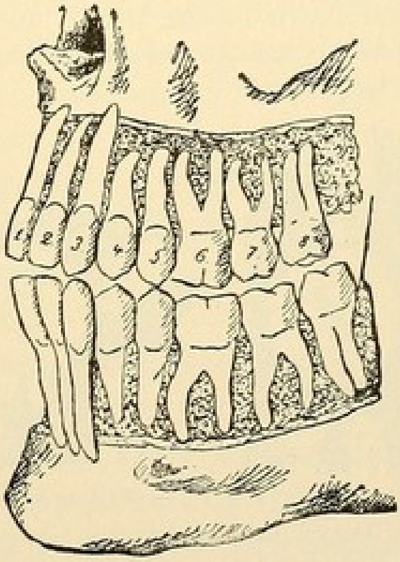


FIG. 1149
3, canine tooth;
4, 5, bicuspids;
6, 7, molars

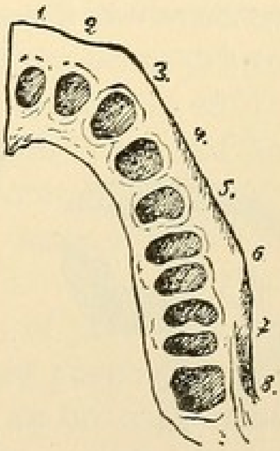


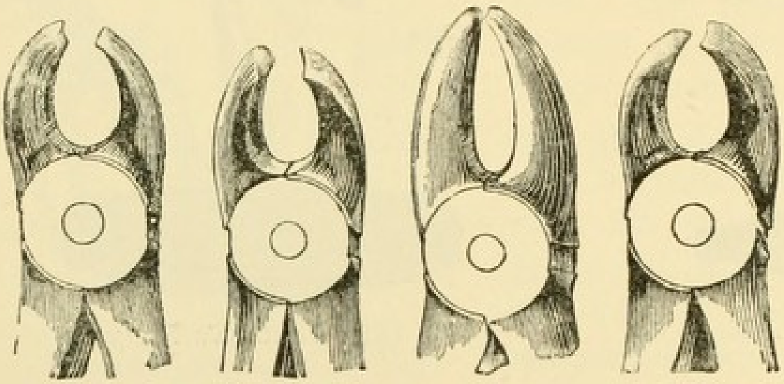
FIG. 1150
ALVEOLI OF THE LOWER JAW
8, wisdom tooth

The roots of the several teeth are arranged as follows: —

In the upper jaw: *The incisor teeth and the canine teeth* have necks nearly round; they are grasped with straight forceps with smooth margins (Fig. 1151, *c*).

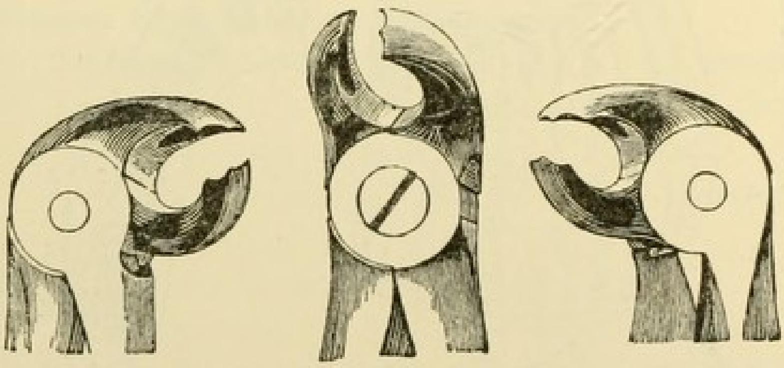
The *bicuspids* have two roots (often grown together) outside and inside respectively (labial and lingual). For their somewhat rectangular necks, forceps have been made with smooth blades but bent a little on the flat (Fig. 1151, *b*).

The *molars* have three roots, two externally (labial) and one internally (lingual). The forceps which fit the neck of these teeth (trefoiled) have on their external side two facets, separated by a projection; on the inner side, they are excavated; they are bent on the flat. Forceps specially adapted for the right and the left side are used (Fig. 1151, *a* and *b*).



a *b* *c* *d*

FIG. 1151. FORCEPS FOR TEETH IN THE UPPER JAW
a, right molars; *b*, bicuspids; *c*, incisors and canine teeth; *d*, left molars



a *b* *c*

FIG. 1152. FORCEPS FOR TEETH IN THE LOWER JAW
a, right molars; *b*, molars of both sides; *c*, left molars

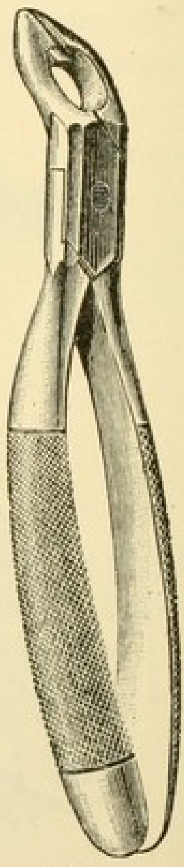


FIG. 1153
UNIVERSAL FORCEPS

For the *wisdom teeth*, the roots of which are almost grown together (cone-shaped), forceps with smooth blades but well curved are adapted.

In the lower jaw: *Incisor teeth and canine teeth* have round necks, as in the upper jaw; hence, the same forceps are used, only they are bent more conveniently on the edge. The same holds good for the *bicuspids*.

All *molars*, however, have two roots which lie in the axis of the jaw from before backward (proximal and distal); the forceps fitted for the neck of these teeth have on both blades two grooves separated by a spine, and are well curved on the edge and on the flat. With them, the operator can extract *wisdom teeth* also (Fig. 1152).

In order not to necessitate too large a number of forceps, the so-called *universal forceps* (*en-tout-cas*) have been invented, the smooth margins and slight curve of which are approximately adapted to every neck of the different teeth (Fig. 1153).

EXTRACTION

The patient is placed on a chair, firmly holding the seat with his hands; if the operator proceeds rapidly and energetically, it is hardly necessary to have the head held by an assistant (in the upper jaw, slightly bent backward, in the lower jaw, slightly bent forward).

Nevertheless, if it appears necessary, the operator takes his position at the right side of the patient, places his left arm around his head, while the fingers of his left hand are free for opening the mouth, lips, etc. With his right hand he manipulates the forceps. In this position, most teeth can be extracted. But if it is more convenient, and if the forceps can be applied more advantageously, the operator takes his position *in front*, and at the patient's left side, in which case, however, the holding of the head must be omitted (this, moreover, can be prevented "a priori" from being drawn back by pressing the head against the wall, the back of the chair, etc.). The forceps are grasped with the whole hand. The thumb is applied on both blades near the lock; the fourth and fifth fingers enter between the arms of the forceps and force them apart, guarding thus against a too forcible pressure of the forceps.

The open forceps are introduced over the crown of the tooth, and are applied close to the tooth under the gums (which are pushed aside by the sharp margins of the forceps). They are inserted as far as the neck of the tooth and closed. By a few lateral movements outward and inward, the alveolar walls are somewhat freed from the tooth, and the tooth is finally extracted vertically; the operation occupies from two to three seconds.

With some precaution, after the forceps have been correctly applied, the danger of the tooth's breaking off is almost obviated; for the tooth sometimes slips of its own accord into the opening of the forceps, when its blades are closed, owing to their tapering shape. But if the forceps are closed *above* the neck of the tooth, they operate like a pair of nippers, and easily break off the crown. Hence, it is above all important to insert the forceps *as deeply as possible under the gums*. The forceps must not be closed with too great force, else the tooth likewise breaks off; the amount of strength to be used to make the tooth follow the long arm of the forceps must be acquired by practice.

In teeth with one root, in addition to *lateral* movements, also a slight rotation around the axis may be made; for teeth with several roots, this procedure, of course, is not adapted.

Anæsthesia can generally be dispensed with in a rapid skilful extraction, else a small cotton compress dipped in a 5% to 10% solution of cocaine may be applied like a cap over the tooth and the margins of the gums; or an injection into the gums may be made with the same solution. A 5% eucaine solution produces the same effect. Moreover, *Schleich's* infiltration and ethyl-chloride are to be recommended. If, in very difficult extractions, especially of *several* teeth, the operator finds it advisable to administer *chloroform* or *ethyl-bromide*, the danger of aspiration of blood in the state of tolerance must be considered. The following procedure is very practical: The patient is told to hold up one arm and to inspire chloroform; after a few inhalations the arm begins to stagger, and falls limp. The operator quickly removes the tooth; for at this moment the patient feels no pain, although the state of excitation *has not yet set in*. In a short time the chloroform intoxication passes off completely.

The **hemorrhage** from the alveolus is usually arrested by irrigations with cold, weak antiseptic solutions; if it continues, the alveolar margins are somewhat pressed together with the fingers, or the alveolus is closed with a small piece of cork shaped like the root of the tooth, or with a small cotton compress (like a bottle with a cork). Or the *alveolus is packed with iodoform gauze*, or peroxide of hydrogen is injected. This is nearly always sufficient, else the operator has to resort to ferric chloride and the thermo-cautery. In persons subject to hæmophilia or leucæmia, no extraction should be made.

As **accidents** in extracting teeth are to be considered: —

Breaking off the crown, caused either by awkward manipulation on the part of the surgeon or by abnormal brittleness of the tooth; *breaking off one root*, the extensive *comminution of an alveolus* with subsequent necrosis; finally, the extraction of the *wrong tooth*. This accident can happen from too great haste on the part of the operator or from false information on the part of the patient; hence, the operator should never neglect, before applying the forceps, to examine the tooth carefully, to percuss it with the forceps, and to probe various portions with a strabismus hook. After the accident has happened, the attempt can be made, after careful cleansing and disinfection, to reimplant the healthy root into the alveolus (*reimplantation*), a procedure which sometimes proves successful.

The removal of roots which do not project at all over the alveolar margin is more difficult only from the fact that they cannot be easily grasped. Roots which have recently been broken off are the most difficult to extract, because they are firmly attached to the alveolus; older roots are looser from frequent attacks of inflammation (periostitis), and can be more easily extracted after the gums have receded. *Root forceps*, or stump forceps, made less solid and having smooth sharp lips, are employed in the same manner as the tooth forceps (Fig. 1154, *a* and *b*). But if the operator does not succeed in extracting the root with them, he may use *elevators* (Fig. 1154, *c* and *d*). They are inserted perpendicularly. By inclining the handle the root is elevated from the alveolus; or he may use the *root screw* (Fig. 1155, *a*), which is screwed into the axis of the root, thereby obtaining a hold on the same; or he may use the *claw foot*, a leverlike instrument formerly used extensively (Fig. 1154, *e*).

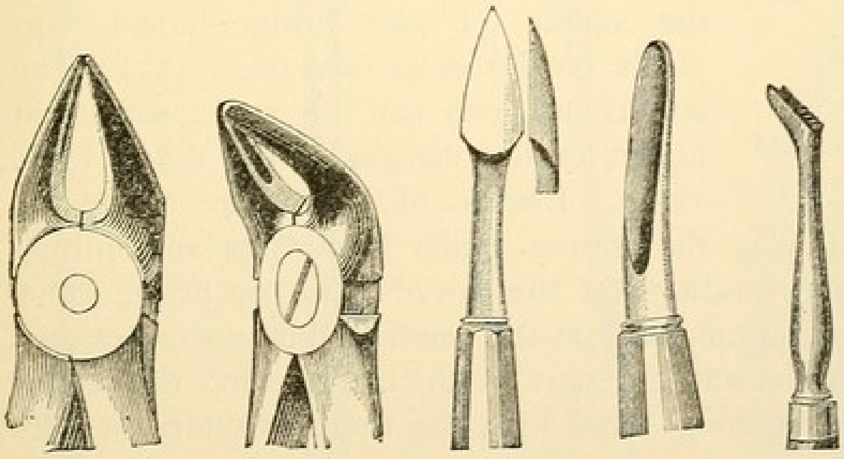


FIG. 1154. INSTRUMENTS FOR EXTRACTING ROOTS OF TEETH
a, straight; *b*, curved root forceps; *c*, *d*, elevators (American); *e*, claw foot

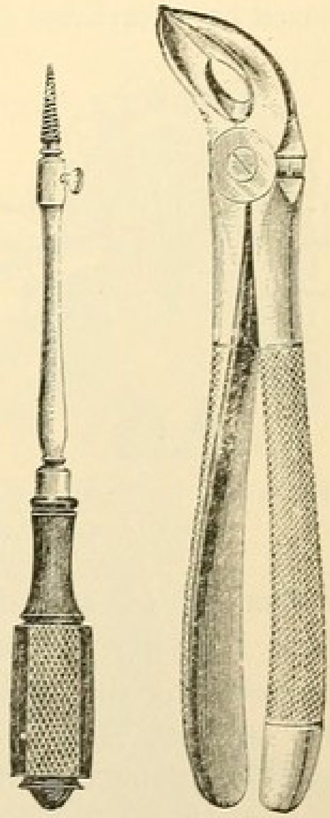


FIG. 1155. *a*, root screw; *b*, Roser's bone-cutting forceps

If the root still offers resistance to all these instruments, no other alternative is left than to divide the alveolus longitudinally and remove the root. *Roser* has invented for this purpose *bone-cutting forceps* (similar to *Liston's*) with which the alveolar margin and the gums are divided perpendicularly (Fig. 1155, *b*).

ACQUIRED DEFECTS OF THE PALATE

Openings in the palate caused by *injuries*, *neoplasms*, *chronic inflammations* (tubercular and *syphilitic* ostitis and necrosis) are closed essentially in the same manner as in the operation of staphylorrhaphy previously described (see page 552). If the surgeon expects to have any success with the operation, he must be very careful, especially in syphilitic defects, to eradicate the *disease* completely and to postpone the operation until the defect has cicatrized; otherwise, the margins of the wound very frequently become necrotic.

Clefts of the soft palate are vivified and sutured. Smaller clefts may be closed by a repeated careful application of the cautery iron or the thermo-cautery, securing by this treatment cicatricial closure of the defect. Many of these defects in the course of time close of their own accord.

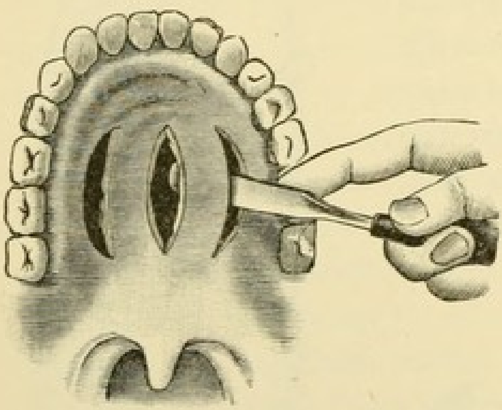


FIG. 1156. URANOPLASTY IN PERFORATIONS OF THE PALATE

For clefts of the hard palate occupying the median line (as is generally the case in syphilis), according to *von Langenbeck*, the sliding of two bridge-shaped flaps yields good results (see page 555). The lateral incisions can be made somewhat nearer to the margin of the defect (Fig. 1156). Instead of the suture above described, *Roser* advises carrying the sutures under both flaps and uniting them by tying. Smaller perforations (of the size of a pin) occurring sometimes during the healing of uranoplasty at the needle punctures or between two sutures, especially in the anterior part of the cleft behind the incisor teeth, may be closed by touching them with the thermo-cautery or with a needle heated to a dull red heat.

If the defects are some distance from the median line, an attempt must be made to close them by transplanting a *pedunculated flap* from the surrounding tissues; *von Langenbeck* effected closure by *lining*. He inserted first a small inverted flap into the defect, and over it he placed a second flap. If sufficient healthy tissue cannot be obtained from the palate, the soft parts must be taken from the neighboring tissues. Thus *Rose* used the mucous membrane of the lips; *Blasius*, the skin of the forehead; and *Thiersch*, *the cheek* in its whole thickness.

If, by a *great cicatricial contraction*, the pillars of the fauces and the soft palate have been distorted to such a degree that disturbances similar to those of clefts of the palate are caused thereby, *staphylopharyngorrhaphy* and *staphyloplasty* would be indicated (see page 557). Of course, there is always great risk that the flap may become gangrenous either partly or entirely.

TONSILLOTOMY

Excision of the tonsils for *hyperplasia* of the same is performed in the following manner:—

The patient sits on a chair, facing the light; if it seems necessary, on account of very great irritability, the tonsillar region may be made anæsthetic by brushing it with a solution of cocaine.

All oral specula and gags for opening the mouth are superfluous; for in performing this operation, it is especially important to utilize the right moment and to act rapidly just "as if one were in the act of shooting a swallow on the wing" (*Dieffenbach*).

Holding a double hook or *tenaculum forceps* (*Museux, Fröhlich*) (Fig. 1157) with the left hand and a long, slightly curved *probe-pointed knife* (tonsillo-

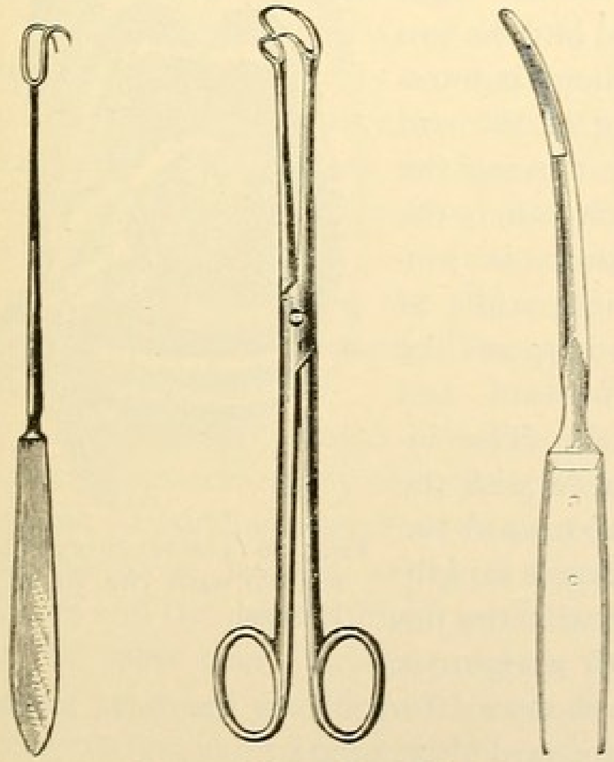


FIG. 1157. DOUBLE HOOK, HOOK FORCEPS, AND PROBE-POINTED KNIFE TONSILLOTOME

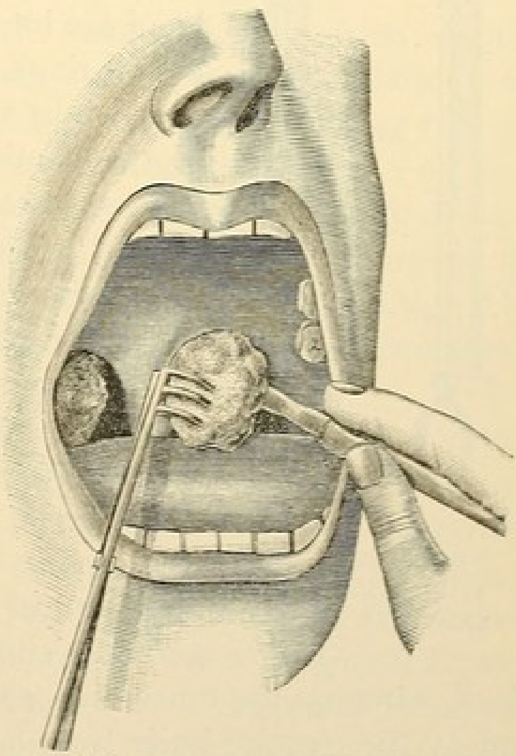


FIG. 1158. TONSILLOTOMY PERFORMED WITH SCALPEL AND HOOK FORCEPS

tome) with the right hand, the surgeon takes his place at the right side behind the patient. Into the mouth of the patient, widely open, he introduces the hook (forceps); he grasps the right tonsil, and draws it out from its depression; next, he quickly raises the soft palate somewhat with the back of the knife, applies its edge at the superior border of the tonsil, and cuts it off with rapid sawing movements from above downward along the pillars of the pharynx. The operator then takes his position *in front* of the patient and repeats the operation on the left tonsil; should he desire to cut off also the right tonsil *from the front*, he would be obliged either to cross *the right hand* over the left and thus operate over his own hand, or to hold the scalpel in his left hand. The selection of position depends on practice. If the operation is made rapidly and safely, it is hardly necessary to press down the tongue with a spatula, for an assistant would be required for this purpose.

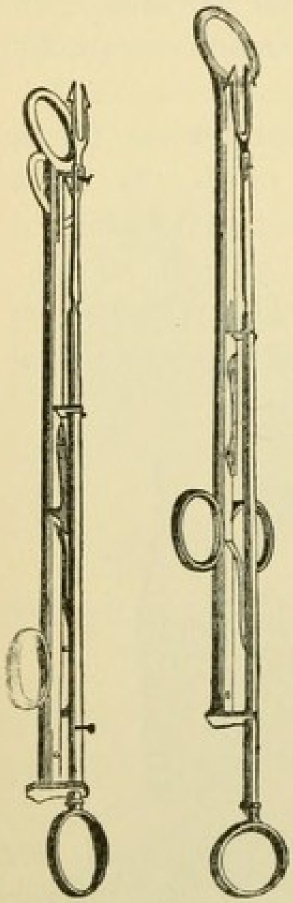


Fig. 1159. Tonsillotome before and after the Operation

The operation with *Fahnestock-Mathieu's* (Fig. 1159) *guillotine-like tonsillotome* (*cutting circular knife*) in children and very timid adults is very convenient. The forefinger and the middle finger of the right hand are introduced into the two lateral rings, the thumb is introduced into the ring at the end of the handle; by moving the fingers toward each other, the cutting circular knife is projected from the ring, while at the same time the harpoon-like fork is pushed forward and transfixes the tonsil. The instrument is introduced with the fork turned *inward* toward the median line. The ring is rapidly applied over the tonsil; the fingers are closed with a vigorous jerk, whereby the tonsil, harpooned and drawn forward by the fork, is cut off by the circular knife from behind forward (Fig. 1160).

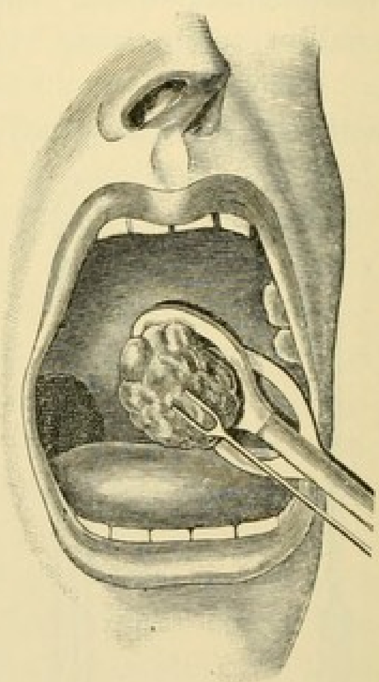


Fig. 1160. Tonsillotomy performed with the Tonsillotome

Although by this procedure the little operation can be made very conveniently and rapidly, still by employing the circular knife *unpleasant accidents* may occur, which prevent the completion of the operation (viz., bending of the fork, breaking of the circular knife, tonsillar lithiasis). Since the instrument cannot be freed from a harpooned tonsil, the operator should always have in readiness a probe-pointed knife, to meet such emergencies.

Very soft tonsils, which cannot be grasped either with the hook or with the circular knife, are *scraped* away with the sharp spoon or are *crushed* either with blunt instruments or with the fingers (**tonsillothlipsis**).

(Ignipuncture with the needle point of the Paquelin cautery often suffices in reducing the swelling in such cases. In the use of the different kinds of tonsillotomes the sense of touch is usually more reliable and useful than sight in guiding the instrument.)

An old procedure, otherwise little practised, for these easily tearable forms is the **enucleation of the tonsil**: The surgeon applies the point of his forefinger between the superior posterior part of the tonsil and the posterior pillar of the pharynx, tears at this place the mucous membrane, and enucleates the tonsil out of its recess from the pharyngeal wall until it hangs down with its inferior anterior part loosely attached, as if from a pedicle, into the pharynx. The pedicle is twisted or cut off; the little operation is almost bloodless (*Pollard*).

Simple also is *Hoffmann and M. Schmidt's* **longitudinal division of the tonsils**, which is heartily recommended, namely, tearing open all follicles and pouches on their surface, to effect the removal of all the germinating foci of bacteria. With a sharp strabismus hook, all lacunæ are torn open in an upward and downward direction until the hook glides along smoothly everywhere; any folds of mucous membrane produced thereby and a portion of the anterior pillars of the pharynx, covering the tonsil like a valve, are removed with the scissors. The opened recesses are finally disinfected with some antiseptic.

The parenchymatous *hemorrhage* caused by tonsillotomy is, as a rule, arrested spontaneously or by irrigation with cold water or ice water; more violent hemorrhage, such as would occur in blood disease or any injury of the *ascending palatine artery*, is arrested by compression. Apply the forefinger and the middle finger in the mouth on the bleeding surface, and make at the same time counter pressure from the outside (*von Langenbeck*), or apply a tampon provided with a handle; finally, in very obstinate and violent hemorrhage, suture together the two pillars of the pharynx and thus compress the bleeding surface. (An excellent local styptic is spirits of turpentine, with which a small compress is moistened and held firmly against the bleeding surface until hemorrhage ceases.) Injury of the *internal carotid* artery, so much feared, should hardly ever occur, since this artery generally courses more than 1 centimeter distant from the tonsil. The various compressing instruments which are said to be useful substitutes for digital compression (Fig. 1161), are, as a rule, not available when they are needed.

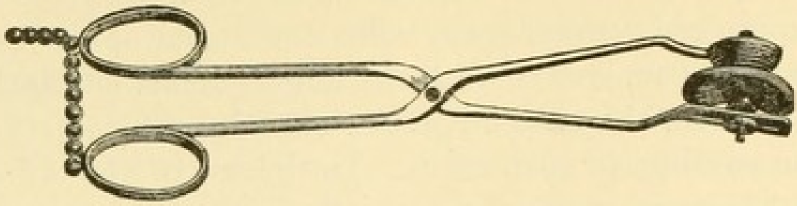


FIG. 1161. MICULICZ'S COMPRESSING INSTRUMENT FOR ARRESTING HEMORRHAGE AFTER TONSILLOTOMY

Tonsillar abscesses are opened by inserting a pointed knife, in which case the operator has to guard against any injury to the palatine artery, if he pushes the knife too far in an outward direction through the pillar of the pharynx. Amputation of the tonsil may become necessary in such a case for opening widely the abscess cavity (*Rotter*).

EXTIRPATION OF THE TONSILS,

for *malignant neoplasms*, can be made successfully from the mouth only in rare cases. Hence, from the outside, access must be obtained to the tonsil by **temporary resection of the ascending ramus of the jaw** (*von Langenbeck*): —

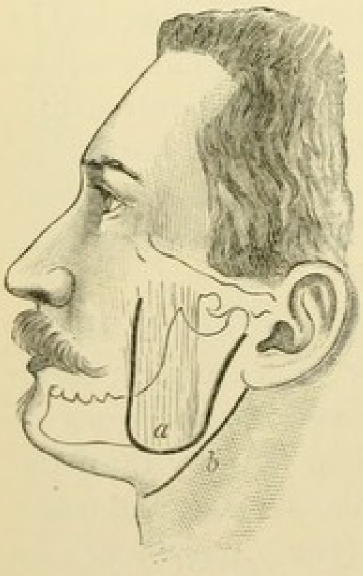


FIG. 1162. EXTERNAL INCISIONS FOR EXTIRPATION OF THE TONSILS

1. *External incision*, tongue-shaped, with an upper base, extends along the anterior and the posterior margin of the ascending ramus of the jaw, around the maxillary angle, including the masseter muscle (Fig. 1162, *a*).

2. After ligation of the *external maxillary artery* (facial artery) and division of the periosteum, corresponding to the anterior incision, the jaw is *sawed through* with a metacarpal saw closely in front of the insertion of the masseter. The ascending ramus of the lower jaw, freed thereby, is *drawn upward*, after a previous careful detachment of the connective tissue on its inner side and preservation of the muscles of mastication; the mucous membrane of the oral cavity still remains *uninjured*.

3. The tumor is then exposed; externally and behind it lies the *external carotid*.

After the tumor has been thoroughly removed with knife and scissors, in which case the opening of the cavity of the mouth is to be made, *if* *possible, last of all*, the luxated part of the lower jaw is replaced into its normal position and united with the maxillary arch by a bone suture.

Very similar is *the procedure of Miculicz;* the *external incision* takes its course along the anterior margin of the sternocleidomastoid from the level of the angle of the mouth as far as the great cornu of the hyoid bone (Fig. 1162, *b*).

After a division in layers of the soft parts and of the periosteum along the posterior mandibular border, the posterior part of the ascending ramus of the inferior maxillary bone is laid bare from the periosteum as far as the sigmoid notch, and divided with the chain saw at the posterior border of the masseter. The sawed-off portion of the lower jaw is completely disarticulated from its joint without injuring the mucous membrane of the mouth. All diseased tissues can then be extirpated down to the mucous membrane; finally, the latter is also divided, and thereby the pharynx is opened. The cavity thus produced is packed with iodoform gauze.

The defect remaining from this operation is inconsiderable; the function of the muscles of mastication is partly preserved; later on even a new formation of the enucleated portion may take place from the preserved periosteum.

In some cases it is safer to perform tracheotomy previously to the operation, and to tampon the trachea to avoid broncho-pneumonia, caused by aspiration of particles of food, etc., into the air passages.

AMPUTATION OF THE UVULA

(KIONOTOMY)

Amputation of an excessively long uvula (*hypertrophic*) is made in a few seconds by a single clip with the scissors.

The uvula is grasped at its extremity with a pair of tenaculum forceps and drawn forward. It is then removed with a strong pair of *Cooper's* scissors (the blades of which *are wide open*), either only one-half or close to its insertion of the soft palate (completely). Since the easily movable and slippery uvula readily *slips backward* from the pressure of the scissor blades, it is frequently only incised. Hence, it is

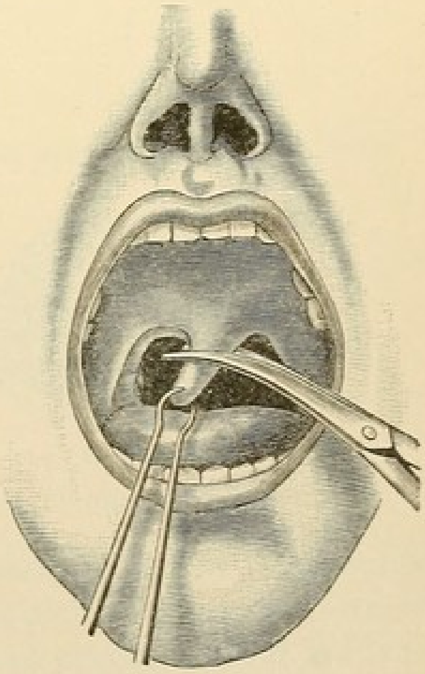


FIG. 1163. AMPUTATION OF THE UVULA

important in this little operation to draw the part grasped with the forceps for a moment *forcibly* in an anterior direction, and to press the same as *deeply* as possible into the widely opened blades of the scissors before the cut is made.

The hemorrhage, in most cases inconsiderable, ceases spontaneously; the wound heals in a few days.

(The editor prefers to excise the hypertrophied uvula in such a way that the base of the excised portion presents the form of a wedge; he unites the two little flaps with a fine catgut suture. In this operation the knife is used in place of the scissors.)

OPERATIONS ON THE TONGUE

The excision of a wedge-shaped portion from the tip of the tongue may be made rapidly in the removal of *tumors* of the tongue, without great loss of blood, in the following manner (*Dieffenbach*): —

After a *Whitehead-Mason* gag (Fig. 1138) has been applied, the tip of the tongue is grasped with toothed forceps and stretched by drawing it forward.

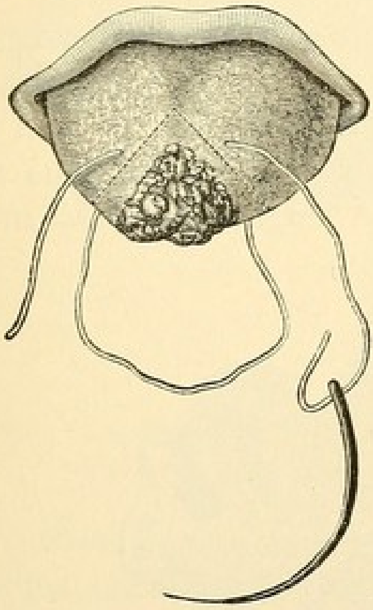


FIG. 1164. Applying silk ligature

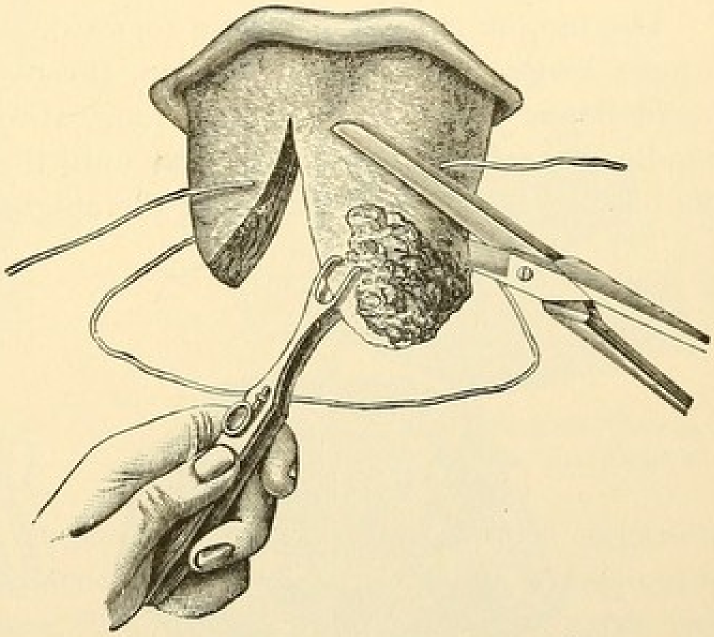


FIG. 1165. Excision of the tumor

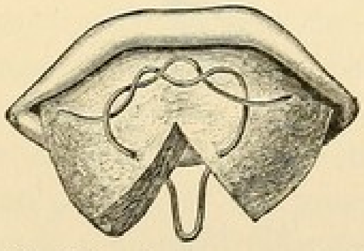


FIG. 1166. Tying the two ends of the thread

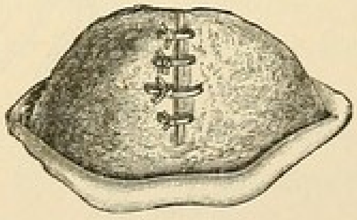


FIG. 1167. Suture

EXCISION OF A WEDGE-SHAPED PORTION FROM THE TIP OF THE TONGUE

1. On both sides of the intended incisions (which should be made at least $1\frac{1}{2}$ centimeters distant from the limit of the neoplasm) a long, strong *silk ligature* is passed through with a large well-curved needle, so that the lower surface of the middle portion hangs down in the form of a loop (Fig. 1164).

2. While an assistant draws each end of the ligature with one-half of the loop in *a lateral direction*, and thereby stretches the tongue transversely, the operator, by two converging incisions with a pair of strong scissors or a small knife, rapidly excises from the tip of the tongue the wedge containing the tumor. Immediately he closes the cleft by drawing and tying together the two ends of the thread, which serves the purpose of a deep suture (Figs. 1165, 1166).

3. The rest of the wound is united by several fine interrupted sutures (Fig. 1167).

If *larger portions must be removed from the anterior half of the tongue, the hemorrhage* **may be arrested by temporary constriction of the whole tongue at its root**: —

The tongue is forcibly drawn forward. An incision about half a centimeter long is made under the chin, closely in front of the middle of the hyoid bone. At this incision, a long, straight *needle with an eye* and a handle *is passed through the tongue* until the point with the eye appears at the base of the tongue just above the epiglottis. A long, thick *double silk*

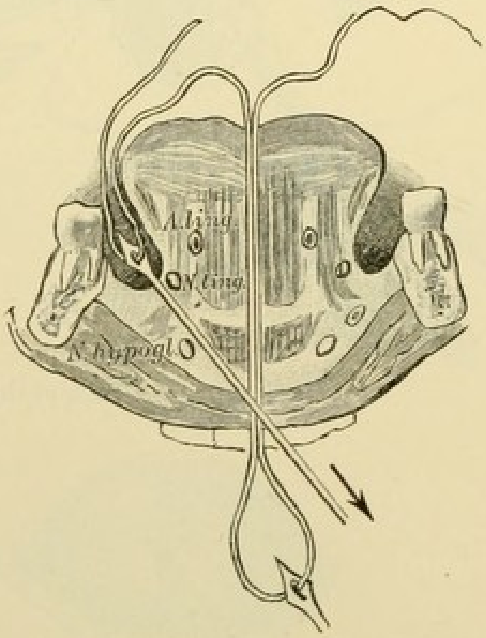


Fig. 1168

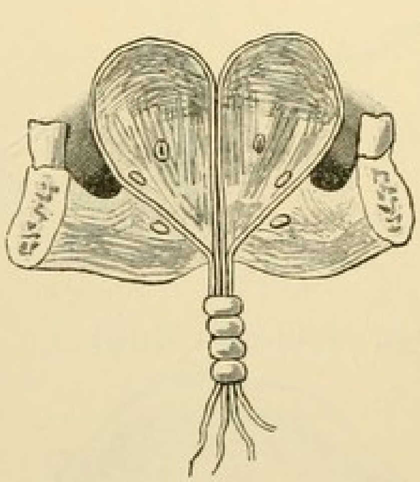


Fig. 1169

Temporary Constriction of the Whole Tongue at its Root

thread is inserted into the eye, and drawn out with the needle through the needle puncture. Next, the needle is again passed through the same opening, and, *past the side of the tongue*, drawn in an opposite direction, until the point appears in the oral cavity in front of the pillars of the pharynx. The thread passed through the root of the tongue is then inserted into the eye of the needle and drawn out with it in a downward direction toward the chin (Fig. 1168). The same procedure is repeated on the opposite side. The four threads, hanging down under the chin from the puncture opening, are passed through the rosary of *Gräfe's loop tightener;* and, after the two ends have been fastened, the two loops are so tightened by means of the screw that the blood supply to the tongue is completely interrupted (Fig. 1169).

If the disease involves *only one side of the tongue*, the constriction of that side alone is sufficient (Fig. 1170).

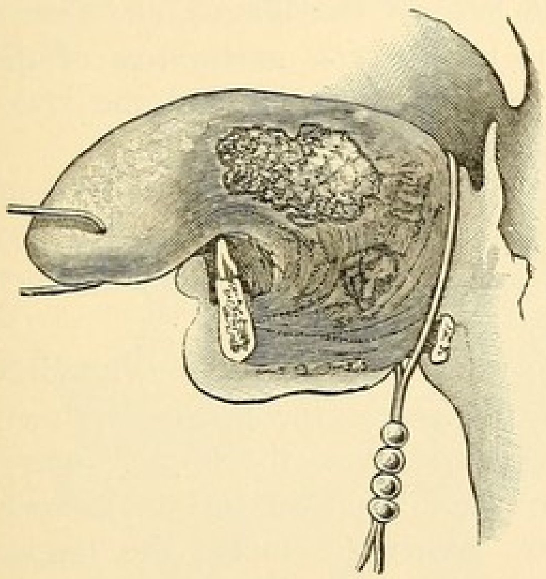


FIG. 1170. TEMPORARY CONSTRICTION OF ONE SIDE OF THE TONGUE

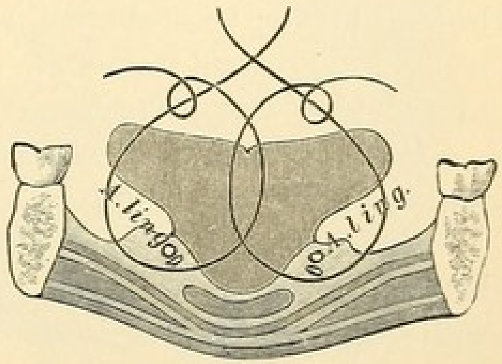


FIG. 1171. LANGENBUCH'S TEMPORARY CONSTRICTION OF THE TONGUE

From the *oral cavity*, *smaller portions of the tongue* can be constricted in the same manner by passing, according to *Langenbuch*, a strong curved needle with a double silk ligature through the middle of the tongue from above downward, and by constricting each half of the tongue with one of the ligatures. To prevent the threads from slipping, *Langenbuch* passes the threads once more through the tongue at its lateral margins from below upward (Fig. 1171).

It is still safer to carry each thread singly, with a curved needle, through the median portion of the tongue and out of the floor of the mouth, so that both threads somewhat overlap in the middle.

AMPUTATION OF THE TONGUE

If, on account of *malignant disease*, *one-half of the tongue*, or even *the whole tongue*, must be amputated (*amputatio linguæ*), the operation may be performed from the oral cavity without any loss of blood, provided preliminary **ligation** of one or both **lingual arteries** is made (see page 258). Likewise, the *facial artery,* supplying the floor of the mouth, may be ligated at the same time in the wound.

The tongue is then cut off with knife or scissors; next, the cut surfaces of the stump are sutured in a suitable direction with strongly curved needles and strong catgut. Thus, for example, after the removal of one-half of the tongue, the remaining tip may be stitched laterally by turning it backward to the wound surface of the base of the tongue, and thus a new but smaller tongue may be formed; in a *transverse amputation* of the whole tongue, it is best to suture transversely the upper and the lower margins of the wound.

Von Langenbeck recommended cutting off the tongue slowly and bloodlessly with the hook-shaped, red-hot blade of the *thermo-cautery.* He protected the lips and the palate by applying a *Whitehead* oral speculum, which he provided with protective plates.

Bottini has amputated from the wide-open mouth more than a hundred tongues, some of them very extensive operations, with the *galvano-cautery.*

Whitehead does not resort to preliminary ligation of the lingual artery, but makes the amputation of the tongue (forcibly drawn forward) slowly with *small careful incisions with scissors.* When he meets the lingual artery, he grasps it with torsion forceps before its division. He next divides it and twists both ends.

Very often, especially when the disease of the tongue has also invaded the neighboring parts, the surgeon is compelled to obtain a freer access to the field of operation by **preliminary operations.**

The **transverse division of the cheek** from the angle of the mouth to the ascending ramus of the jaw causes disfiguration after successful healing, and does *not give sufficient space,* especially when (as is frequently the case) the disease has passed from the tongue to the palate, the tonsils, and the floor of the mouth as far as the epiglottis. In these cases, the

TEMPORARY LATERAL RESECTION OF THE LOWER JAW (*von Langenbeck*)

offers the best access to this region.

1. *External incision* from the angle of the mouth of the diseased side *perpendicularly downward to a point on a level with the thyroid cartilage;* ligation of the *external maxillary artery* (facial).

2. From the lower angle of the wound the submaxillary fossa is opened, and any diseased lymphatic glands are enucleated; next, the *digastric*

muscle is divided, likewise the *hypoglossal nerve;* the hypoglossus muscle is divided longitudinally, and the *lingual artery* is *ligated.*

3. After the *first molar* has been extracted and the floor of the mouth has been perforated at this place with a pointed knife, closely along the lower jaw, the submaxillary bone *is sawed through* with the metacarpal saw *obliquely* from behind and above downward and forward, or it is sawed through in a <-shaped or ┌┘-shaped manner (Fig. 928). The hemorrhage from the dental canal is arrested by pressing a little ball of carbolized wax into it.

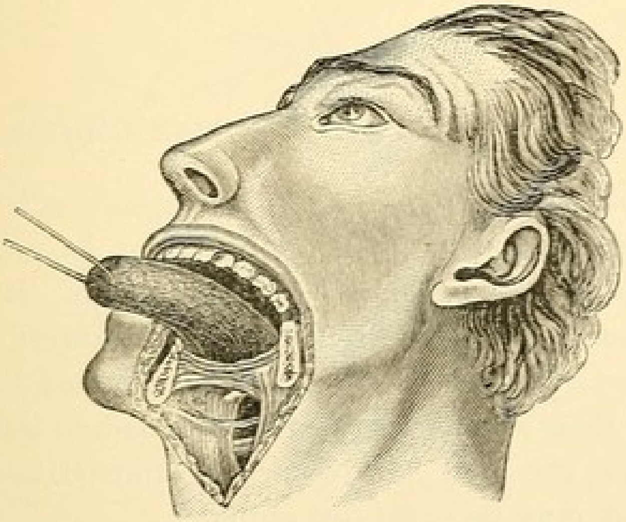


FIG. 1172. Division of the skin and the lower jaw

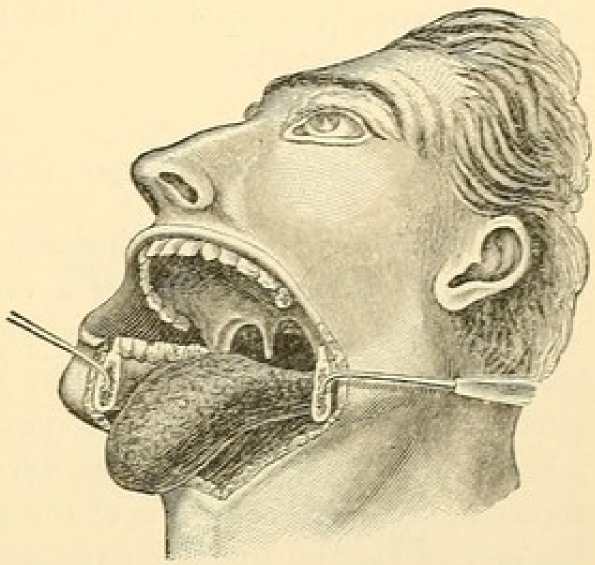


FIG. 1173. Dividing floor of the mouth; the tongue is drawn forward

VON LANGENBECK'S TEMPORARY RESECTION OF THE LOWER JAW

4. The sawed surfaces are drawn apart with two sharp bone hooks (Fig. 1172); with hooked forceps or with a strong thread loop, passed through the tongue, the latter is drawn upward toward *the healthy side;* the mucous membrane of the floor of the mouth is divided as far as the *anterior pillar of the pharynx* and detached from the lower jaw. The *lingual nerve* is divided.

5. It is now comparatively easy to remove the diseased parts. The pillars of the fauces, if invaded by the disease, are cut off from the soft palate and amputated in a downward direction; likewise the tonsil and the pharyngeal wall (*carotid artery!*) may be removed with care. The tongue is drawn *downward* toward the *diseased side,* and divided in its healthy part according to the seat of the tumor. In a transverse amputation closely in front of the epiglottis, it is cut off from above downward and backward, and the *glosso-epiglottic ligament* or fold is divided last of all. Should the ligation

of the other lingual artery be necessary, it can be easily made from below, whilst the tongue is drawn in an upward direction toward the diseased side (Fig. 1173).

6. At the end of the operation, the ends of the jaw, divided by sawing, are reunited *by a bone suture of silver wire;* the external wound is closed by interrupted sutures and *drained* at its most dependent point. The wound of the tongue is best covered with *adhesive iodoform gauze*, or brushed with a *benzoate mixture* recommended by *Whitehead.*

During the first days, nourishment is administered through a pharyngeal tube. Frequent irrigation of the mouth (with hydrogen dioxide or boric solution) is imperative.

TEMPORARY RESECTION OF THE LOWER JAW IN THE MEDIAN LINE (*Sédillot*)

is applicable only for rarer diseases of the *lower surface of the tongue and of the floor of the mouth.* After a vertical division of the lip, as far as and under the chin, the lower jaw is sawed through as described on page 488. By turning aside the two halves of the jaw, access is easily gained to the anterior parts of the mouth. After the necessary operation, the jaw is reunited by a bone suture. Since, however, very little tendency exists in the median line for a dislocation of the parts of the jaw, the bone suture may be omitted, and the *periosteum* and the soft parts *alone* may be carefully united.

Since sawing through the jaw as a preliminary operation always results in an additional injury, and since the healing of the sawed surfaces is not always accomplished by primary intention on account of the constant irrigation with the fluids of the mouth, the attempt has been made by others to make the operating field more accessible by *dividing the soft parts only.*

Billroth exposes, according to *Regnoli's* procedure, the anterior region of the tongue and the floor of the mouth **from the chin**; a curved external incision along the lower margin of the chin penetrates to the internal surface of the jaw. Next follows the separation of the periosteum; then, division of the genioglossus muscle, of the geniohyoid, and of the digastric; and likewise division of the mucous membrane of the mouth behind the alveolar margin. From each extremity of this incision, a lateral incision is carried straight downward and outward to the hyoid bone, and extended to the oral cavity. From this opening, the tongue may be drawn down (of course, with difficulty) almost as far as the epiglottis (Fig. 1174).

Kocher makes **the extirpation of the tongue from the base** by *a lateral angular incision* extending from the chin, in the median line, to the middle between the hyoid bone and the margin of the chin, then transversely and posteriorly in the cervical fold of the floor of the mouth (" Hals-Mundboden falte") as far as the anterior margin of the sternocleidomastoid muscle, thence along the sternocleidomastoid muscle upward to the lobule of the external ear. After the flap has been turned up toward the face and stitched to the cheek, in the exposed submaxillary fossa, the lingual, the maxillary, and the external carotid arteries can be ligated, and any diseased glands can be removed. The whole side of the tongue, as far as the epiglottis, is made easily accessible (Fig. 1175).

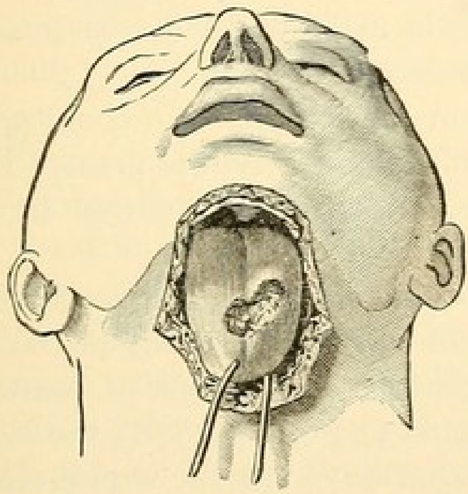


Fig. 1174. Regnoli-Billroth's Extirpation of the Tongue from the Chin

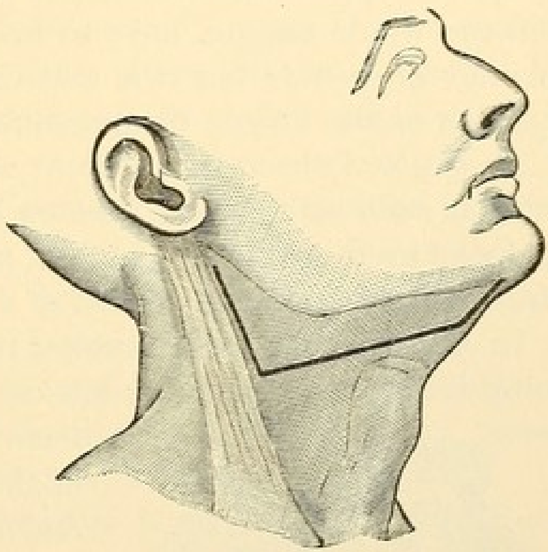


Fig. 1175. Kocher's Extirpation of the Tongue from the Base

Similar to this operation but simpler, and furnishing less space, is *Verneuil-Maunoury's* "**lower oral route,**" from which tumors of the tongue and the cheek, of the alveolar margin, and of the palate can be rendered accessible.

The external incision extends from the angle of the mouth to the lower border of the submaxillary bone and along the same as far as its angle. The soft parts are divided in layers, and the facial artery is ligated; the mucous membrane of the oral cavity, however, so far is not invaded. The submaxillary fossa can then be cleared out, and the *external carotid can be ligated* at the external angle of the wound. Only then the *opening of the oral cavity* along the jaw, if necessary, after the removal of a portion of the jaw, is made and kept wide open by a pair of spring-catch forceps. The tumor in the cavity of the mouth can now be removed easily and without much hemorrhage.

Since, in cancer of the tongue, the glands and lymphatic vessels of the side involved are always, and those of the other side generally, diseased

(*Küttner*), it is advisable, for a thorough extirpation of the malignant disease, first to perform the **complete clearing out of the floor of the mouth**, and, from a curved incision somewhat below the inframaxillary bone, to remove all the glands and the diseased connective tissue; the lingual arteries are ligated during this procedure. The tongue can then be amputated through the cavity of the mouth as described above.

It is advisable, moreover, to facilitate anæsthesia, previously to inject morphine and to make tracheotomy; directly after the opening of the oral cavity, the upper entrance to the larynx is tamponed. If larger parts, or even the whole tongue, have to be removed, *speech*, of course, *becomes considerably impaired;* but it is still intelligible in many cases, if ever so small a portion of the tongue has remained in position (*Schultén*).

Dieffenbach observed a patient with amputated tongue, who could speak better as soon as he took a wooden ladle in his mouth. At the present time, we have even **artificial tongues**, protheses, which are supported by the inframaxillary bone and consist of a piece of soft caoutchouc.

In *cystic tumors*, located under the tongue, **ranula** (most frequently originating from *Blandin-Nuhn's* mucous glands of the tip of the tongue, but also from an obstruction of the duct of Bartholin of the sublingual gland, Fig. 1176), the *simple longitudinal division* of the sac with drainage or the partial removal of its anterior wall only rarely produces a permanent cure, since, after some time, a recurrence frequently takes place, even from small remaining fragments of the wall. Attempts to *destroy* the walls of the cyst by applying chloride of zinc, solid nitrate of silver, tincture of iodine, alcohol, etc., have not yielded very satisfactory results. (A free exposure of the interior of the cyst, followed by a vigorous application of the actual cautery and tamponade, have given better results.)

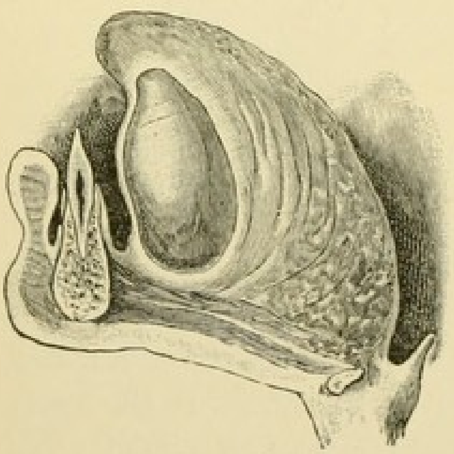


FIG. 1176. RANULA

Much better and more practical is the *extirpation of the cyst* (*Schuh*). The operation is made without anæsthesia, or with local anæsthesia. After a longitudinal division of the thin covering of the mucous membrane on the anterior wall of the cyst, which may be made in the simplest manner by raising a small fold between two forceps and dividing it on a grooved director, the operator penetrates bluntly between the mucous membrane and the wall of the cyst. The extirpation, as a rule, offers no great difficulties, since the wall of the cyst in some places adheres *so loosely* to the surrounding tissues that it may be detached or enucleated by mere traction. If the extirpation offers any difficulties, as a result of former futile operations in consequence of which the adhesions have become firmer, it is sufficient to remove the anterior wall with curved scissors ("Hohlscheere") and to suture the margins of *the remainder of the cyst to the mucous membrane of the mouth.*

EXTIRPATION OF THE PAROTID

is to be made in the removal of malignant *tumors;* if the tumors are of a benign character (fibroma, chondroma), their extirpation is sufficient; but in malignant neoplasms (sarcoma, carcinoma), *the whole gland* must be removed.

A *total extirpation* of the parotid, on account of its anatomical position, involves great difficulties; and, since the *facial nerve* which passes through the gland is thereby always *injured* to a greater or less extent, permanent paralysis of this nerve is the inevitable consequence of this operation.

(In undertaking an operation on the parotid gland for malignant disease, a distinct understanding should be had between the operator and patient concerning this inevitable and permanent complication.)

(Professor Daniel Brainard, the founder of Rush Medical College, was the first surgeon who performed this operation and argued its feasibility in appropriate cases.)

The procedure is as follows: —

1. After the auditory meatus of the external ear has been protected by a tampon of common cotton, the *external incision* is carried over the most prominent part of the tumor, according to requirements, either straight and parallel to the ascending ramus of the jaw, or in the form of a flap, or elliptically, encircling diseased portions of the skin.

2. If, by a cautious procedure, the operator has penetrated to the *capsule*, it should be exposed on its entire anterior surface. Next, **from below**, along the external carotid, the operator tries to reach its posterior surface. This is best done *bluntly* with the fingers, or with a *Kocher's* director. If it is necessary to divide any adhesions with the knife, the edge of the knife must always be directed toward the gland. The glandular capsule is held only with blunt hooks or the fingers; if sharp hooks are applied, it is easily torn. In this procedure, along the posterior surface from below upward, there must be divided, one after another, the anterior and posterior facial veins, the temporal artery under the zygomatic arch, the auricular artery in front

of the auditory meatus, the transverse facial artery under the condyle, the posterior auricular artery, and the occipital artery at the margin of the sternocleidomastoid muscle. Under some circumstances, it is necessary to ligate even the external carotid (Figs. 1177, 1178).

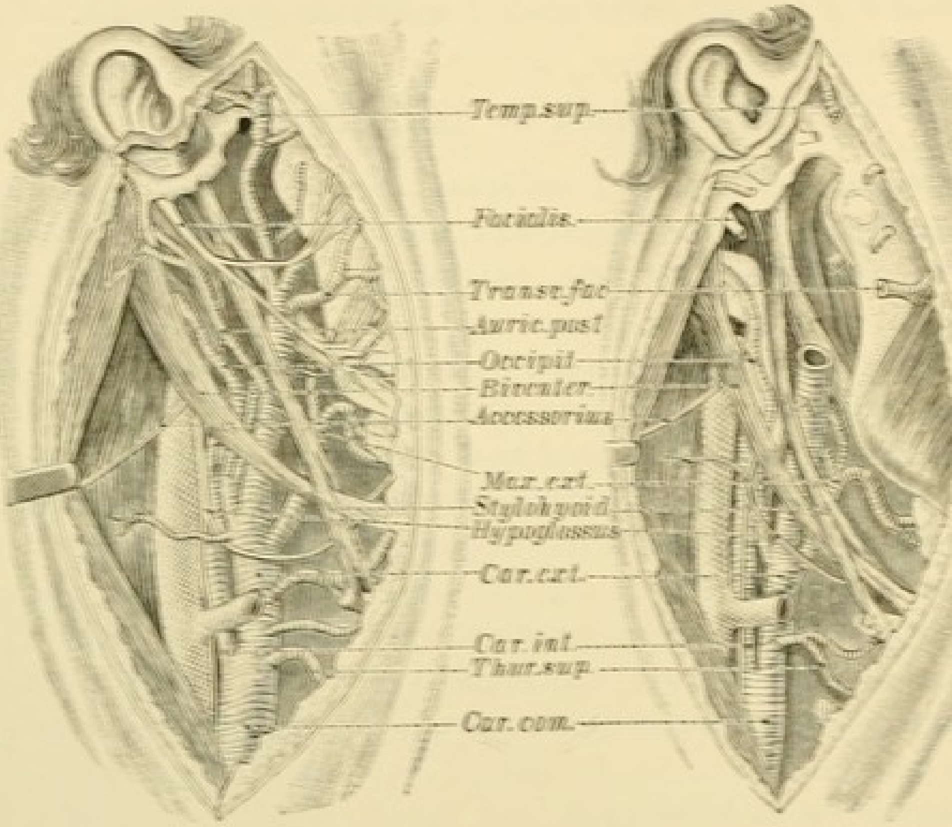


FIG. 1177 FIG. 1178

ANATOMY OF THE REGION OF THE PAROTID GLAND ACCORDING TO VON BRUNS

3. After the parotid gland has thus been exposed on all sides, it is enucleated *as bluntly as possible* from its recess behind the lower jaw, in which procedure, after its detachment from the styloid process, the internal maxillary artery and the ascending pharyngeal artery must be ligated. The ramifications of the facial nerve must be divided in most cases; if possible, however, the main trunk is preserved.

Schüller finds the access to the parotid fossa easier and better for inspection by attacking with the knife the tumor *from above*, below the lobule of the ear, and from *its anterior limit* in the face; by this means, each vessel, as it appears to view, is divided after double ligature. The tumor mass gravitating backward leaves the field of operation free and easy of inspection.

4. The wound cavity is sutured and drained according to its size. In the *after treatment*, attention should be paid to the timely closure of the eye, to prevent complications caused by the paralysis of the eyelids.

If the operation is thus performed in *an extracapsular manner, bluntly*, and guided by the eye, the gland may be enucleated in a tolerably clean manner and *without great loss of blood*. These advantages are lost if the incisions are made *intracapsular* into the frangible loose tissue of the gland itself, or if incisions *must* be made when the capsule is perforated; in such a case, a clean extirpation is almost impossible.

If the operation however consists only in the enucleation of well-circumscribed tumors (enchondromata) from the glandular tissue, it may be accomplished in a comparatively easy manner *after splitting the common capsule*. Likewise, the facial nerve may be more or less preserved, according to the seat of the tumor.

(In the removal of benign tumors of the parotid gland it is advisable to always split the capsule in the direction of the branches of the facial nerve, and largely to make use of blunt instruments in performing the enucleation.)

EXTIRPATION OF THE SUBMAXILLARY GLAND

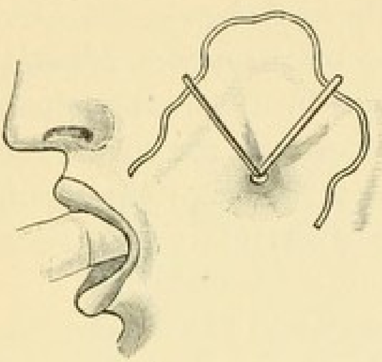
can be made more easily, since the gland lies rather superficially between the margin of the lower jaw and the digastric muscle, covered only by the *platysma and the cervical fascia*. At its external margin lies the *facial artery*; at its superior, the *lingual nerve*; at its inferior margin, the *hypoglossal nerve*. The surgeon may facilitate the enucleation, if he pushes the gland forward with the finger from the floor of the mouth, or if, proceeding from the skin of the chin, he turns it around the border of the lower jaw.

SALIVARY FISTULA

Fistulæ of the cheek of Steno's duct, resulting from injuries of the same, or ulcerations, often heal of their own accord after some time. The healing may be aided by cauterization with Paquelin's needle-point cautery or with the solid stick of nitrate of silver.

If the peripheral end has become obliterated, and if a lip-shaped fistulous opening exists, care must be taken to maintain an artificial drainage toward the mouth. For example, perforate the cheek from the fistula with a trocar or a thick needle; next, vivify the margins of the fistula and suture them.

De Guise's procedure promises good results. From the fistulous opening he passes two needles (fastened to the ends of a silk thread) through the cheek (Fig. 1179) in such a manner that their points of exit in the mucous membrane of the cheek are about half a centimeter distant from each other. The thread is drawn after them and knotted in the mouth (Fig. 1180); next, the margins of the fistulous opening are vivified elliptically and sutured.



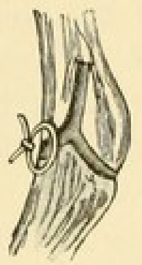


Fig. 1179 Fig. 1180
De Guise's Operation for Salivary Fistula

The saliva can flow into the cavity of the mouth through the perforations that have been made and through the defect produced between them *by the linear pressure of the thread.* The external salivary fistula is thereby changed into an internal one.

In fistulous formations of the *masseteric tract*, an attempt should be made to obliterate and render atrophic the parotid gland, which effect *Desault* accomplished by a permanent compression of the gland, and *Viborg* by ligation of the salivary duct.

SUBHYOID PHARYNGOTOMY (*Malgaigne, von Langenbeck*)

is made for removing *tumors* or *firmly impacted foreign bodies* which are in the posterior or the lateral wall of the pharynx or at the upper entrance to the larynx.

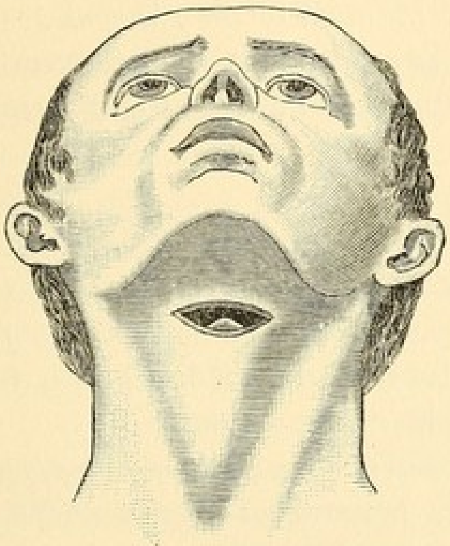
Three days previously to this operation, especially in removing tumors, *tracheotomy* is always made, and the trachea is tamponed (see page 619).

1. *External incision* 5–6 centimeters long, with the head strongly bent backward or hanging down, parallel to the lower margin of the hyoid bone transversely across the neck (Fig. 1181).

2. Division of the superficial *cervical fascia* and of the *sternohyoid and thyrohyoid muscles* until the strong *middle thyrohyoid ligament* is exposed.

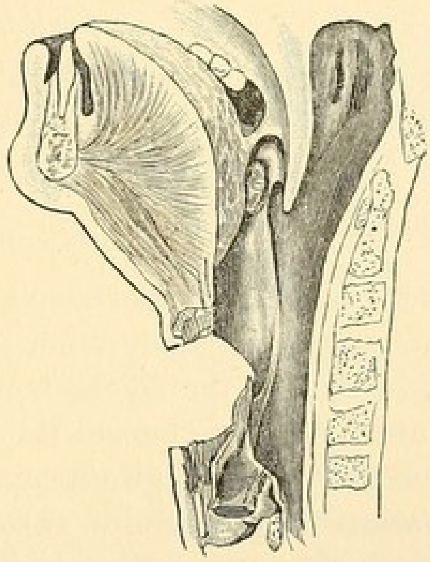
3. The ligament is divided with the *thyrohyoid membrane* between two forceps by incisions always directed vertically downward; or a pointed knife having been inserted at the lower extremity of the hyoid bone obliquely upward, the ligament is divided in its whole thickness with a probe-pointed knife toward the forefinger introduced from the mouth, and detached from the posterior surface of the hyoid bone. The *mucous membrane of the pharynx* thereby exposed is divided transversely and parallel to the lower

margin of the hyoid bone in the whole extent of the skin incision, whereby the *glosso-epiglottic fossa* is opened. The upper entrance to the pharynx and the larynx can be made still more accessible after division of the two great cornua of the hyoid bone 1–2 centimeters from their free extremity. (Avoid the lingual artery and the superior laryngeal nerve.)



a

FIG. 1181



b

FIG. 1182

SUBHYOID PHARYNGOTOMY. *a*, front view; *b*, sectional view

4. After division of the tense ligamentous connections, the lower margin of the incision sinks downward, and the wound gapes; the *epiglottis* becomes visible in it, is grasped with forceps ("Klauenzange"), and drawn out of the wound; thereby the aryepiglottic ligaments, as well as the posterior surface of the epiglottis and the whole *upper entrance to the larynx*, with the *arytenoid cartilages*, appear to view, and are easily accessible for the removal of any tumors present. For better inspection, and for avoiding the superior laryngeal nerve, *Sallas* divides even the hyoid bone by a sagittal incision. The wound of the bone, even without being sutured, leaves no functional disturbance.

5. In the same manner the lateral and the posterior wall of the pharynx may be easily surveyed and reached if the larynx is detached to some extent from the pharynx. If any diseased portions must be excised from the same, it is advisable, after a rapid ligation of the ascending pharyngeal artery, — if divided, — first to tampon the upper entrance to the larynx, and, if necessary, to extend the external incision as far as the lateral *thyrohyoid ligaments*. If the margins of the wound of the pharynx cannot be united by suture after

the hemorrhage has been arrested, the defect produced is left to heal by granulation. It is covered with antiseptic gauze, and an *æsophageal tube* is inserted from the nose, past the defect, into the stomach.

6. After the removal of the tampon from the upper entrance to the larynx, *the thyrohyoid ligament* is reunited by a few interrupted sutures, and the external wound is sutured in its whole extent.

If the extirpation of larger portions of the wall of the pharynx is necessary, another lateral longitudinal incision can be made upon this transverse incision for obtaining better access, or the operator may attempt to reach *the pharynx laterally* or from the front.

LATERAL PHARYNGECTOMY (*von Langenbeck*)

1. After tracheotomy has been made and the trachea has been tamponed, the *external incision* is made from the middle of one half of the jaw across the greater cornu of the hyoid bone downward to a level with the cricoid cartilage, and extended close to the tracheotomy wound.

2. After cutting through the superficial cervical fascia, the *platysma*, and *omohyoid muscle*, the operator carefully penetrates deeply and ligates the *lingual artery*, *the superior thyroid*, and several branches of the *facial vein;* the two branches of the *superior laryngeal nerve* must also be divided.

3. The posterior belly of the *digastric muscle* and of the *stylohyoid muscle* is detached from the hyoid bone so that the lateral pharyngeal wall is exposed.

It is divided lengthwise in the whole extent of the wound, and while the larynx is drawn toward the healthy side and rotated a little around its axis, sufficient space has been gained for detaching with blunt instruments the wall of the pharynx from the larynx and from the vertebral column. The surgeon must avoid making a *circular resection* of the pharynx on account of the subsequent liability to stenosis (*Küster*).

In this manner even the larynx and the pharynx have been removed. Until recently, in most cases after the operation death from mediastinitis and subcutaneous phlegmon ensued.

RETROPHARYNGEAL ABSCESSES

Collections of pus between the pharynx (and œsophagus) and the cervical vertebræ are opened as early as possible for the evacuation of pus and to prevent laryngeal stenosis.

The patient, who has not been anæsthetized, is seated with his head slightly bent forward (under anæsthesia aspiration must be prevented by the head hanging down). While the introduced forefinger of the left hand palpates the fluctuating site, it is used as a guide to a pointed knife wrapped almost to its point with adhesive plaster, etc., which is pushed into the pharyngeal wall, if possible, *at the most dependent place* of the abscess. The opening may be somewhat enlarged so that the pus has free drainage.

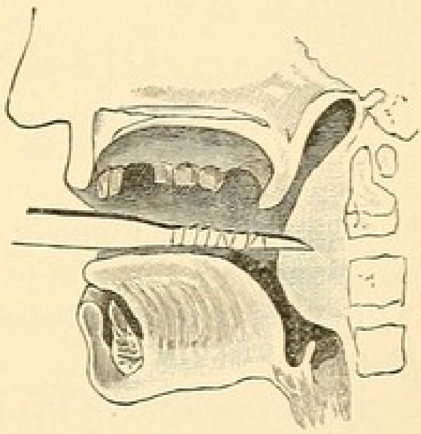


FIG. 1183. OPENING A RETROPHARYNGEAL ABSCESS

(A much safer way to open such abscesses is by tunnelling the soft inflamed abscess wall with a small pair of locked hemostatic forceps, using the finger as a guide. The perforation can be enlarged to the requisite extent by dilating the blades of the forceps in withdrawing the instrument.)

If the opening heals too soon, it must be reopened by puncturing with a probe or by a new incision. Gargling and irrigating the pharynx with nontoxic antiseptics and insufflations of iodoform, etc., promote the healing of the wound.

For the purpose of securing better drainage, and with a view of facilitating a more thorough examination of the cavity with the finger, *Burkhardt* opens retropharyngeal abscesses **from the neck** as long as they are still retrovisceral.

The *external incision* along the inner margin of the sternocleidomastoid at a level with the larynx penetrates through the platysma.

Between the blood vessels — coursing on a level with the cricoid cartilage, which vessels are drawn outward — and the larynx, the operator penetrates bluntly the loose cellular tissue as far as the inner circumference of the common carotid, which gives off small branches at this place. Close to the larynx, a small opening is made with the knife in the retropharyngeal (thick) tissue. This opening is enlarged bluntly, until the cavity of the abscess is sufficiently exposed. It is drained externally.

In the same manner, also, the retro-œsophageal abscesses (vertebral tuberculosis) can be opened and drained.

(In the treatment of retropharyngeal tubercular abscesses, puncture, evacuation, and injection of iodoform glycerine emulsion should invariably be given a fair trial before incision and drainage are resorted to, as this treatment combined with immobilization of the spine often proves successful, while incision and drainage, in spite of all precautions, are not infrequently followed by pyogenic infection with all its disastrous consequences.)

OPERATIONS ON THE NECK

OPENING OF THE AIR PASSAGES, BRONCHOTOMY

is necessary for removing or preventing suffocation (asphyxia) from a constriction or obstruction of the larynx.

(*a*) In *diseases* of the air passages (croup, diphtheria, œdema of the glottis).

(*b*) In *injuries* of the cartilages of the larynx (fractures, hemorrhage).

(*c*) In case of *foreign bodies.*

(*d*) In *tumors* and *cicatricial* contractions.

(*e*) For *artificial respiration.*

(*f*) *Preliminary to some operations* in the mouth and the pharynx.

The air passages can be opened in various places; surgeons differentiate: —

I. LARYNGOTOMY

Median thyrotomy, the **longitudinal division of the thyroid cartilages**, is made in *injuries* (fractures) of the cartilages of the larynx and for removing *foreign* bodies and *tumors* (papillomata and tuberculomata) in the larynx.

The operation is *always* preceded by *tracheotomy* (inferior) and *tamponade of the trachea* for the entrance of sufficient air during the operation and to guard against aspiration of blood.

The patient is placed on a neck cushion with his head well extended.

1. The *external incision* extends exactly in the median line from the upper limit of the thyroid cartilage as far as the upper margin of the cricoid cartilage; the skin is stretched with the left thumb and forefinger of the operator.

2. The cervical fascia is divided in the whitish line between the two *sternohyoid muscles;* above the *cricothyroid ligament* is found the *cricothyroid artery*, which should be either ligated double or drawn downward with a small blunt hook (together with any prominent portion of the median lobe of the thyroid gland present).

3. On the lower margin of the thyroid cartilage (after it has been transfixed with a sharp tenaculum hook) a pointed knife with its edge turned

upward is pushed into the *cricothyroid ligament*, and the thyroid cartilage is divided in an upward direction with sawing movements; if possible, the upper margin is preserved (insertion of the vocal cords); it is still better and more convenient to make the longitudinal division with a pair of strong, *straight scissors*, or with a probe-pointed knife upon a grooved director. Under some circumstances, in *ossification* of the commissure, the division of the same with *Liston's* bone-cutting forceps or a fine saw becomes necessary.

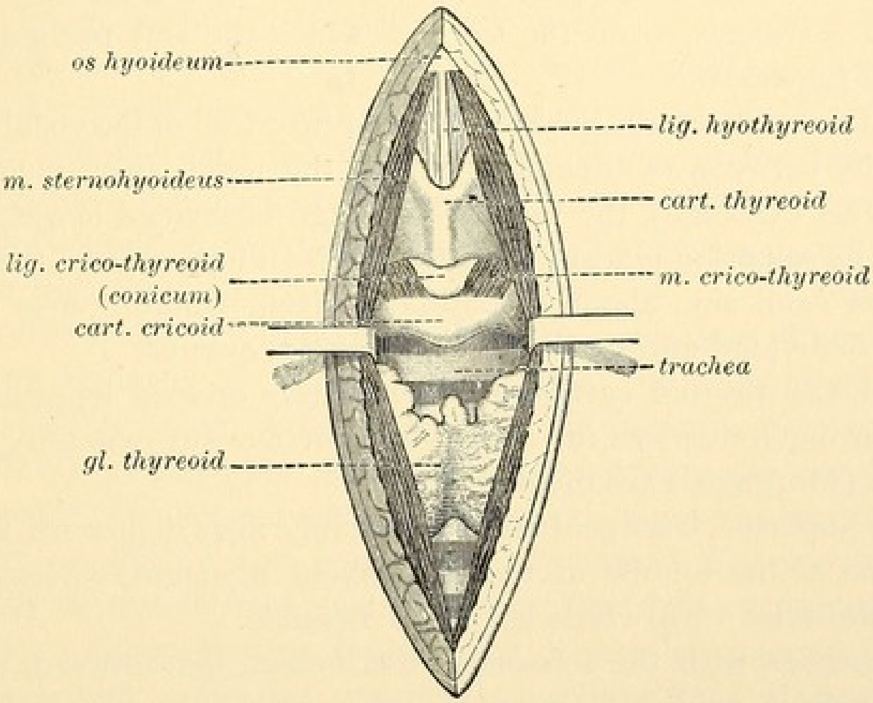


FIG. 1184. ANTERIOR VIEW OF LARYNX AND TRACHEA

4. Immediately, two small sharp hooks are inserted into the margins of the fissure. When they are drawn apart, the interior of the larynx appears to view. After the purposed operation in the interior of the larynx — during which operation brushing with cocaine is sometimes advantageous for abolishing reflexes — has been completed, the thyroid cartilage is again united by a few sutures including the perichondrial tissue, and the wound of the skin is sutured separately.

In the reunion, it is especially important to place the *vocal cords in correct apposition;* to accomplish this better, the upper portion of the thyroid cartilage may be left *undivided*, whereby the divided cartilaginous parts are more easily replaced into their former position (**partial thyrotomy**).

This object is attained with a greater degree of certainty by

TRANSVERSE THYROTOMY (*Gersuny*)

That is, the *transverse* division of the thyroid cartilage closely above the anterior commissure of the vocal cords, which remain uninjured. The superior half of the thyroid cartilage is turned upward, and thereby the superior laryngeal cavity is rendered accessible to inspection, palpation, and direct operative interference.

1. A *median incision* from the hyoid bone to the cricoid cartilage exposes the thyroid cartilages, from the sides of which the soft parts are detached bluntly and retracted.

2. One to 2 millimeters above the anterior insertion of the vocal cords (lying in the middle between the deepest point of the notch and the lower margin of the thyroid cartilage), the thyroid cartilage is divided longitudinally and parallel to its superior margin by a transverse incision with the knife (or a fine saw) on each side about 1 centimeter deep, whereby also the mucous membrane is divided and the laryngeal cavity is opened.

3. Next, the thyroid cartilage is completely divided longitudinally with the bone-cutting forceps as far as its posterior margin, whereby the sinuses of Valsalva (Morgagni) are divided.

4. The superior laryngeal half is forcibly drawn upward with a little hook applied at the middle of the thyrohyoid ligament, whereby the vocal cords and the false vocal cords become accessible.

By an incision with the scissors in the median line upward, the operator easily succeeds in exposing the space above the false vocal cords and the aryepiglottic folds; by extending this incision one-half of the cartilage can finally be turned in an outward direction, and the epiglottis and the root of the tongue can be reached through this large opening.

If the parts drawn apart are again approximated, they assume their normal relations; and only a few sutures are required in holding them in proper position.

INFRATHYROID LARYNGOTOMY

(*Longitudinal incision of the crico-thyroid ligament only*)

In *sudden asphyxia in adults* this operation can be made very easily and very rapidly, but furnishes sufficient space for introducing a canula only when the larynx is very large. If the ligament is divided vertically the artery coursing transversely over it must be secured between two ligatures or acupressure applied); more space is gained by a T or + incision.

In most cases, however, it is necessary to extend the wound in a downward direction, and *to divide the cricoid cartilage* also (**cricotomy**). If the cricoid cartilage is very hard, or even ossified, after the perichondrium has been retracted, a piece of the cartilage must be resected (**cricectomy**) to make a space sufficiently large for the introduction of the canula.

SUBHYOID LARYNGOTOMY

is the name given by *Langenbuch* to an operation intended for the removal of small tumors on the anterior commissure of the vocal cords. He made a transverse skin incision closely above the thyroid cartilage, detached the muscles from the hyoid bone, and divided toward the median line (at a right angle to the skin incision) the ligamentous triangle in the upper thyroid notch. From there the root of the epiglottis was divided transversely, the larynx was drawn out by two hooks downward and forward, and the tumor was removed with the scissors.

If it becomes necessary to make a *thorough extirpation* of non-malignant *tumors* or the removal of *foreign bodies*, then, on account of the freer accessibility, the larynx should be divided longitudinally from the *superior margin of the thyroid cartilage to the inferior margin of the cricoid cartilage* (**laryngo-fissure**). If necessary, the first tracheal rings are also divided; and, on the upper margin of the wound, the *thyrohyoid ligament* is detached transversely from the thyroid cartilage. In this field of operation, which can be easily surveyed, foreign bodies that cannot be grasped from above (endolaryngeal) can easily be removed; papillomatous (tubercular) proliferations are removed with the sharp spoon, and the site of their attachment is destroyed with the cautery iron. After the margins of the cleft have been carefully sutured, the tampon in the trachea, which, as mentioned above, must always be inserted before the operation, is removed; the voice is then soon restored.

II. TRACHEOTOMY

The **opening of the trachea** can be made *above* or *below* the isthmus of the *thyroid gland*. The former, the easier operation, is most frequently made in establishing a new passage for respiration in case of obstruction and constriction of the larynx; the latter, considerably more difficult, is indicated when the superior tracheal rings are covered by the thyroid gland (as is mostly the case in children), or when tumors in the interior of the larynx have extended to the trachea. It is also very much preferred as a preliminary step to many operations on the upper air passages.

HIGH TRACHEOTOMY

The patient lies with his head well extended over a neck pillow (or over the edge of the operating table). The head is held firmly by an assistant, who, if possible, superintends at the same time the anæsthesia, by which the violent respiratory movements and the restless ascent and descent of the larynx are somewhat subdued. Infiltration anæsthesia is very much to be recommended for this short operation. The hands of the patient are fastened at both sides of the chest by a bandage, which surrounds the trunk.

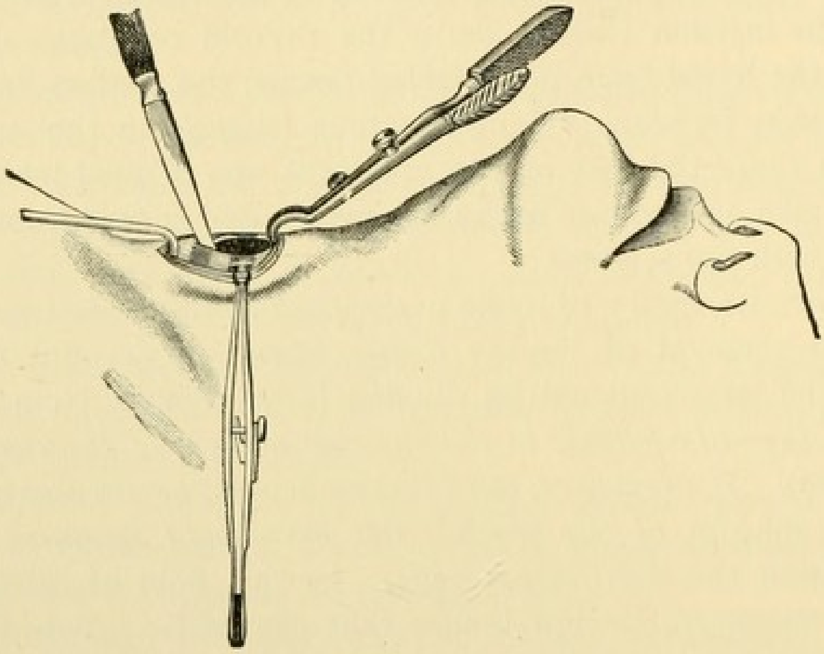


FIG. 1185. TRACHEOTOMY

After the location of the thyroid and the cricoid cartilages, which can be easily felt, has been ascertained: —

1. The **external incision** *is made exactly in the median line*, about 3 or 4 centimeters long, from the cricoid cartilage downward.

2. The cellular tissue in the intermuscular space is raised between two dissecting forceps and divided; (as in the ligation of arteries) the *sterno-hyoid muscles* are equally drawn apart toward both sides with blunt hooks; *if Bose's retractor* (Fig. 1186, *a*) is used, an assistant can be dispensed with; and, at the same time, the hemorrhage is lessened by the traction. *Reismann* temporarily stitches the margins of the wound with eight sutures applied as closely to the trachea as possible; these sutures are tightened, not by knots, but simple loops.

3. Next, the exposed *median cervical fascia* is opened by a small transverse incision at a level with the cricoid cartilage. The inferior margin of

this incision is detached from the trachea by a blunt instrument placed under it (grooved director, tenaculum, handle of a knife), and thus, *behind* the median layer of the fascia, the operator penetrates on the trachea *behind the isthmus of the thyroid gland.* The same is retracted downward with a blunt hook without causing any hemorrhage; the anterior tracheal wall is then freely exposed (*Bose's* **retrofascial separation of the thyroid gland**).

4. *Before the trachea is opened, every bleeding vessel must be grasped with hemostatic forceps;* not all the vessels need be ligated, since the venous hemorrhage, after the normal respiration has been restored, is nearly always considerably lessened; besides, the two hemostatic forceps hanging down on each side serve to keep the surfaces of the wound apart.

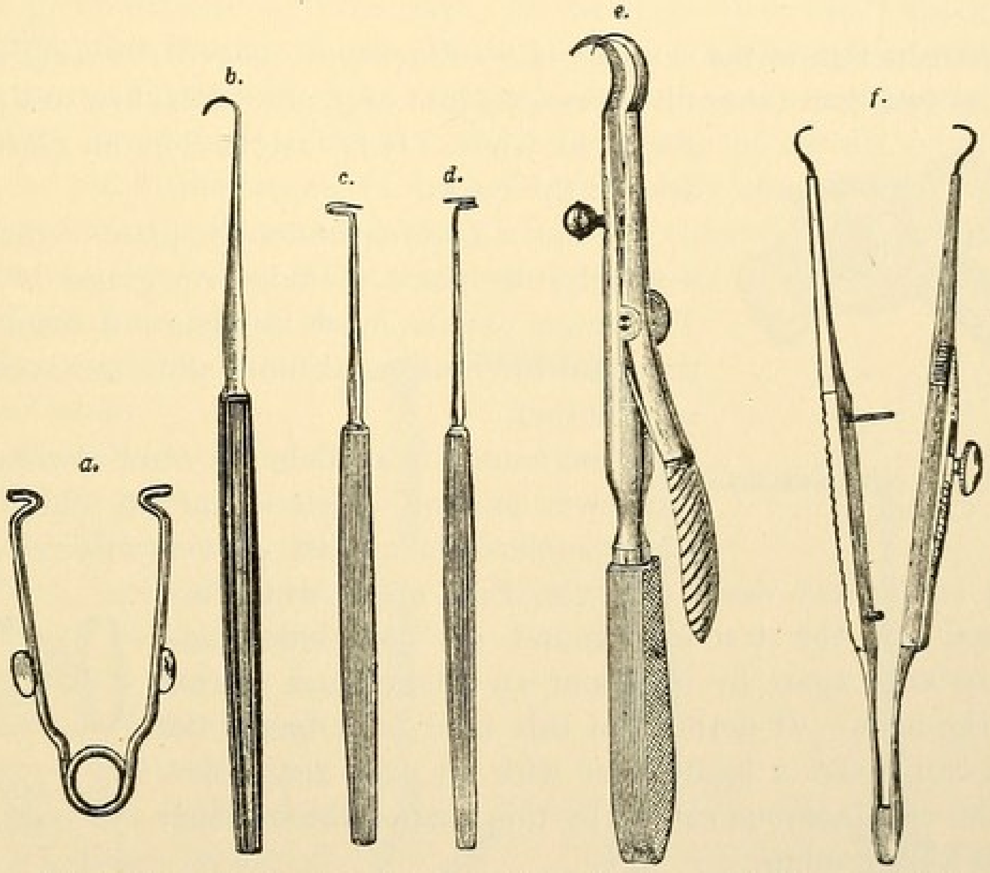


FIG. 1186. *a*, Bose's retractor; *b*, *c*, *d*, sharp hooks; *e*, Von Langenbeck's double hook; *f*, sharp-toothed sliding forceps

5. **Opening of the trachea**: The same must be *held* with sufficient firmness by inserting a simple sharp hook. It is still better to insert in the median line two small *sharp hooks* bent laterally (Fig. 1186, *c*, *d*) in the wall of the trachea on both sides of the intended incision; one of the hooks—viz. that on the right side—is held by the operator, the other by his assistant. The application of *Langenbeck's double hook* (Fig. 1186, *e*), the sharp points

of which can be opened by pressure upon the lever on the handle, renders an assistant unnecessary. If the operator has two *sharp-toothed sliding forceps* (Fig. 1186, *f*), he can apply them in the same manner as the small sharp hooks; the trachea is drawn apart by their weight alone. At the place thus doubly fixed, the pointed knife is pushed in *perpendicularly* through the first tracheal ring and carried downward with sawing movements; from the incision, which gapes at once from the traction of the hooks, *the air escapes with a hissing sound*, a sure sign that the tracheal wall has been completely divided. For creating sufficient space in small larynges (children), the necessity of enlarging the incision in an upward direction by dividing the cricoid cartilage (**cricotracheotomy**) cannot, in the majority of cases, be avoided.

6. **Introduction of the canula**: *Lüer-Hagedorn's double canula* (Fig. 1187) consists of two bent tubes fitting exactly into each other attached to a movable shield in front. It is fastened by an elastic band around the neck.

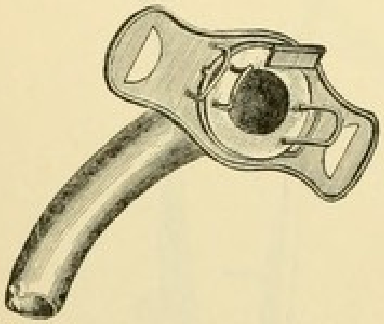


FIG. 1187. LÜER'S DOUBLE CANULA

7. For a *dressing* under the plate of the canula, a small split piece of iodoform gauze is applied. The inner canula must be removed from time to time and the mucous accumulation removed with a soft feather.

If no canula is available, a *thick drainage tube*, the lower end of which is cut off obliquely, an *elastic catheter*, or a *thick quill* is inserted; or the surgeon makes two *hooks* (hairpin, Fig. 1188), which are introduced into the tracheal wound on both sides, and which are kept apart by means of an elastic band carried around the neck. If nothing of this kind is at hand, the surgeon can insert a ligature or wire on each side below one of the cartilaginous rings; by this means, the tracheal wound is kept gaping.

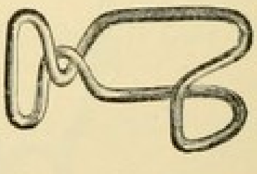


FIG. 1188. WIRE HOOKS

There are cases in which it is advisable to postpone inserting the canula *until the first paroxysms of coughing have subsided;* generally membranes, aspirated blood, and mucus are ejected with great force. The trachea may also be probed with a wire, which is slightly bent in the form of a hook, and with which any floating membranes can be caught and removed.

Although, in the majority of cases, the operation must be performed *as rapidly as possible*, the surgeon should never lose self-control and presence of mind, since **sad consequences** and *serious technical errors* may ensue from imprudent haste. For instance: *violent hemorrhage* with aspiration of blood, if no precautions for thoroughly arresting the hemorrhage have been taken before opening the trachea; furthermore, *incomplete division* of the anterior tracheal wall so that the canula enters between the mucous membrane and the cartilage, aggravating the asphyxia; *lateral opening of the trachea; injury of the posterior tracheal wall, or even of the œsophagus.*

To reëstablish suspended respiration immediately in cases in which life is in imminent danger from asphyxia, the operator should not hesitate either to divide the trachea transversely to admit air or to make an inferior tracheotomy.

The canula remains in position until the cause for its introduction is removed, generally two or three days; in the majority of other cases, it may be removed after the first week; the wound then heals rapidly. Most frequently, **the granulations** forming at the places where the canula touches the tracheotomy wound cause difficulties in removing the canula. Sometimes they are lodged in the tracheal tube itself, especially when the mucous membrane grows into a fenestrated canula (speech canula). In extracting the canula, these polypus-like formations turn into the wound or into the tracheal tube, and cause an attack of suffocation until the canula is inserted again.

The wound is enlarged slightly in an upward and downward direction; the granulations are removed with scissors or destroyed with the actual cautery.

Intubation of the larynx (*O'Dwyer*) — *the endolaryngeal* introduction of flat canulas for removing laryngeal stenoses without tracheotomy — requires a large number of instruments (instrumentarium), much practice, and constant supervision; in spite of many good successes, it is very little employed in Germany.

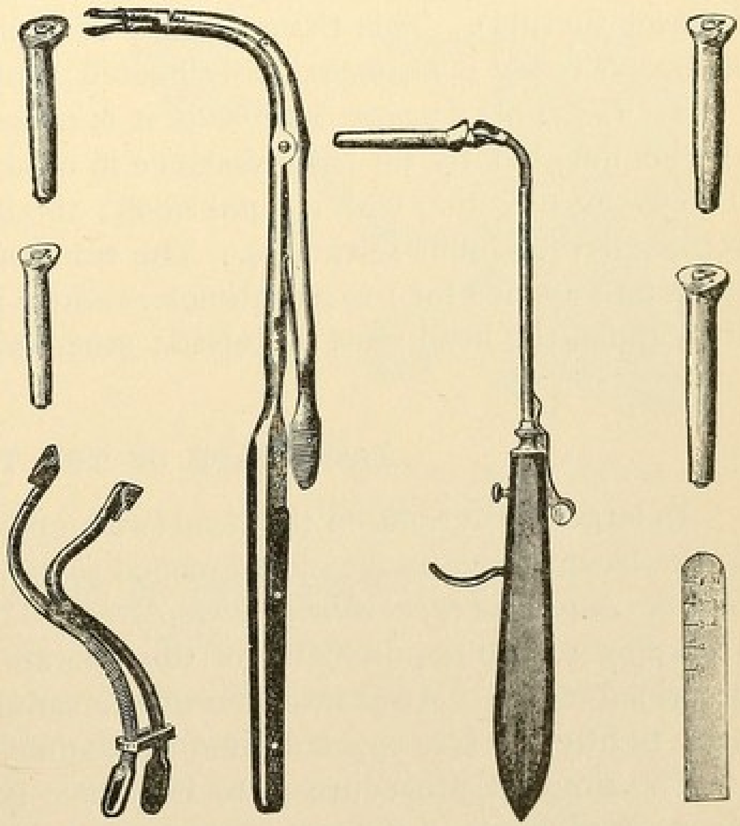


Fig. 1189. Instruments for Intubation of the Larynx

INFERIOR TRACHEOTOMY,

the opening of the trachea below the isthmus of the thyroid gland, is made in the following manner: —

1. *The external incision* extends from the cricoid cartilage to the suprasternal fossa (jugulum, superior margin of the sternum).

2. After cutting through the loose cellular tissue and the superficial fascia, the underlying *tissues, very rich in veins*, are divided as bluntly as possible; before their division, blood vessels that cannot be saved are divided between two ligatures or acupressure is applied. (The temporary clamping of blood vessels with hemostatic forceps renders the operation almost bloodless, requires little time, and reduces the use of the ligatures to a minimum.)

3. Next, *the deep layer of fascia* is divided; and its margins, together with the sternohyoid muscles, are drawn apart with *Bose's* elastic retractor.

4. The cellular tissue lying in front of the trachea and containing *very many large veins*, must now be divided; the abnormal course of the numerous blood vessels in the cellular tissue renders this operation more dangerous (innominate artery, carotid, superior thyroid, vena jugularis media, and the inferior thyroid). This tissue is very carefully dissected off on both sides, and each vessel is at once doubly ligated; none should be torn.

5. *When the trachea is exposed*, it is necessary, in most cases, to detach the isthmus bluntly for some distance in an upward direction and draw it in an upward direction with a blunt hook; the deep margins of the wound are retracted with blunt retractors. The trachea is then grasped with a small hook and opened for 1 to 2 centimeters with a pointed knife. In introducing the canula, the head must be raised; otherwise the trachea is too flat.

TAMPONADE OF THE TRACHEA

In larger operations on the head (with opening of the cavity of the mouth or the larynx), the trachea is tamponed to *prevent the blood from gravitating into the bronchial tubes during anæsthesia*. The opening of the air passages, according to the requirements of this operation, is made at one of the sites described above. After insertion of the canula, it is especially important to pack tightly the free space around the canula.

The simplest procedure is to introduce gauze compresses or small *compressed iodoformized sponges, of the size of a bean*, attached to a thread. With these the space above the canula is tamponed. When they swell in consequence of the absorption of secretions, they occlude the trachea completely. It is, however, safer to pack also the space around the respiratory canula. *Michael* covered the canula with a *thick rubber tube*. At the present time, *Michael-Hahn's* **compressed sponge canula**, wrapped with iodoformized compressed sponge, is most frequently used. This, introduced dry, swells considerably from the absorption of secretions of the wound and trachea (Fig. 1191). Very practical and unique is *Trendelenburg's* **tampon canula**. He was the first to conceive the idea of tamponing the trachea. The canula is surrounded by a rubber bag insufflated with air through a small tube so that it applies itself everywhere to the tracheal wall. Since the air soon escapes to some extent, it is still better to fill the bag with water, etc.

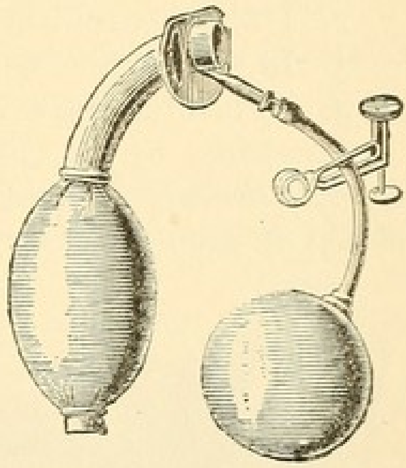


FIG. 1190. TRENDELENBURG'S TAMPON CANULA

After the introduction of the canula, the inhalation of chloroform is made through a tin funnel over which some flannel has been stretched. The funnel is connected with the tracheal canula by a rubber tube (Figs. 1190, 1192).

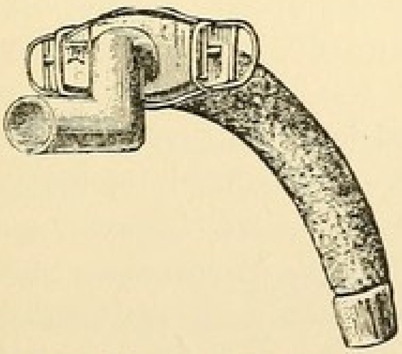


FIG. 1191. MICHAEL-HAHN'S COMPRESSED SPONGE CANULA

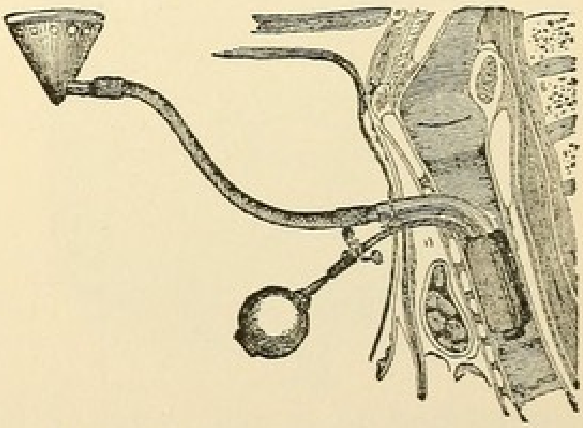


FIG. 1192. TRENDELENBURG'S TAMPON CANULA (in situ)

EXTIRPATION OF THE LARYNX

(*Czerny*, 1870; *Billroth*, 1873)

The *total extirpation of the larynx* should be made only in such *malignant diseases* as render a partial extirpation *insufficient*.

The partial extirpation of the larynx is made:—

1. In malignant but circumscribed tumors.
2. In circular unyielding stenoses of a high degree.

But *it is not made:* —

1. If the patient is too advanced in years and if the respiratory organs are diseased.

2. If the disease has become too extensive.

3. In elastic stenoses.

4. In tuberculomata and syphilomata.

Previously to the operation, it is imperative to establish the diagnosis *beyond all doubt* with the laryngoscope, as well as by a microscopical examination of endolaryngeal portions of the tumor which have been extracted.

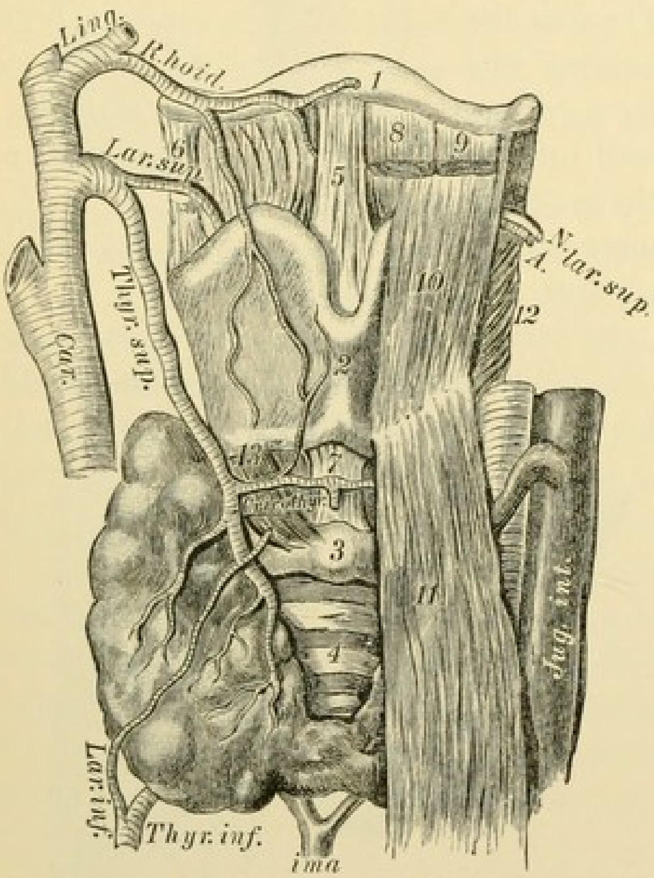


FIG. 1193. ANATOMY OF THE REGION OF THE LARYNX (to the left in situ; to the right ramification of arteries). 1, os hyoides; 2, cartilago thyreoidea; 3, cartilago cricoidea; 4, trachea; 5, ligam. thyreohyoid. med.; 6, ligam. thyreohyoid laterale; 7, ligam. cricothyreoid; 8, musc. sternohyoideus; 9, musc. omohyoideus; 10, musc. thyreohyoideus; 11, musc. sternothyreoideus; 12, musc. thyreopharyngeus; 13, musc. cricothyreoideus; art. carotis; art. thyreoidea sup.; art. laryngea sup.; art. lingualis et Ramus hyoideus; art. cricothyreoidea; art. thyreoidea inf.; art. laryngea inf.; vena jugularis int.; vena thyreoidea ima.; *N.* laryngeus sup.

In cases in which the surgeon is in doubt concerning the extent of the disease in the interior of the larynx, the **diagnostic laryngo-fissure** is made directly before the operation. If only one side is found to be diseased after the vertical division of the larynx, and if the progress of the tumor has not extended beyond the median line, extirpation of *one-half* of the larynx is sufficient. If, however, the proliferations of the tumor have already invaded the tissues beyond the median line, or if only a suspicious infiltration appears on the other side, it is better to remove *the whole* larynx.

After the *preliminary tracheotomy*, which has preceded the operation for some time, and after *the tamponade of the trachea* (with *Hahn's* canula), the operation is performed as follows: —

1. *External incision* perpendicular from the middle of the hyoid bone as far as the second and third tracheal rings. (If necessary, horizontal incisions are made at the upper extremity or

at both extremities; T incision; ⌶ incisions like a double door, *Bardenheuer.*)

2. After cutting through the *superficial fascia*, the operator penetrates between the sternohyoid muscles down to the thyroid cartilage (double ligation of the *cricothyroid artery*). Having divided the thyroid cartilage, it is advisable once more to make a careful inspection, to make sure of the necessity of total extirpation.

3. With the elevator the soft parts are bluntly detached from the sides of the larynx. The tendinous connection of *the sternothyroid and thyrohyoid muscles* is dissected off laterally, and, together with the lateral horns of the thyroid gland, is drawn outward with blunt hooks and kept open. The inferior laryngeal and the cricothyroid arteries are ligated on both sides.

4. *Separation of the larynx from the pharynx* by small, careful incisions with the scissors, keeping always close to the cartilage in order not to injure the external carotid and the superior thyroid arteries, which are in close proximity.

5. The *larynx now exposed* is drawn *to one side*, the soft parts are drawn *to the other.* After ligation of the *superior laryngeal artery*, the *lateral hyothyroid ligament* is divided. The same procedure is followed on the other side.

6. Division of the *middle hyothyroid ligament* and the mucous membrane of the pharynx behind the arytenoid cartilages; ligation of the two *inferior laryngeal arteries;* the larynx, made completely movable on all sides below the cricoid cartilage, is cut off transversely from the trachea, which is held by a ligature loop.

Preservation of the epiglottis in most cases offers no advantage.

On the other hand, *Maas* advises leaving an annular portion of the cricoid cartilage in position if possible, because it facilitates very much the introduction of the canula, and secures a wide communicating opening between mouth and trachea, even without any apparatus.

In case the larynx is to be extirpated from *below upward* (*Billroth*), it is detached from the trachea, first below the cricoid cartilage, after the lateral soft parts have been separated; next it is drawn forward and upward with a sharp hook applied in the cricoid cartilage; then its union with the pharynx and finally that with the hyoid bone are severed by incisions with scissors always closely directed against the larynx.

If, in an advanced state of the disease, the tissues surrounding the larynx must also be removed, the operation becomes much more bloody and dangerous. The blood vessels to be divided in this operation are, in their order, counted from above downward: the hyoid branch of the lingual artery, the superior laryngeal artery, the cricothyroid artery (a branch of the superior thyroid artery), the inferior laryngeal artery (a branch of the inferior thyroid artery), and the corresponding veins.

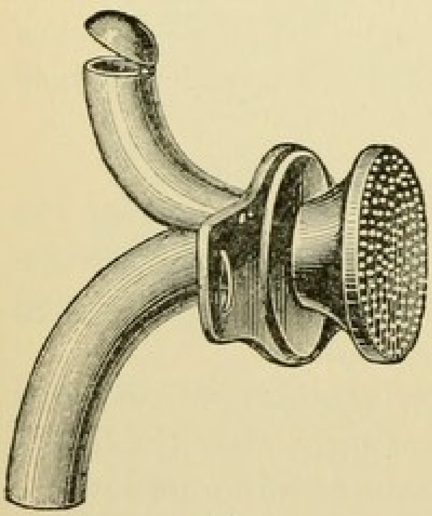
Next the muscles are cut off from the larynx. The same is extirpated, and the surrounding parts are cleared of diseased glands lying along the inner margin of the sternocleidomastoid muscle on the sheath of the large vessels and below the submaxillary bone. The **unilateral extirpation of the larynx** is confined to the diseased side. In all other respects, however, it is made essentially according to the rules given for total extirpation.

It is less dangerous, and the patient can speak distinctly even without a canula.

The lateral incisions are sutured; the median incision is only tamponed.

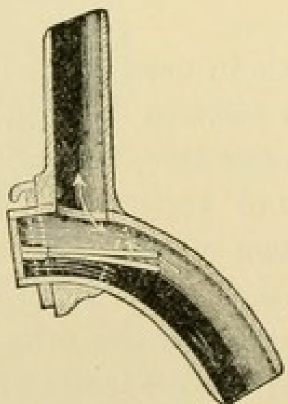
The wound of the pharynx is *not sutured;* from it an *œsophageal tube* is introduced into the stomach, and the wound cavity is *tamponed* with iodoform gauze. The patient remains in bed on his back; the dressings are changed daily. Even on the next day, an ordinary canula (*Hahn*) may be substituted for the tampon canula; the wound *above* the canula is *tamponed* with antiseptic gauze.

The cavity of the wound rapidly decreases in size if the case runs a favorable course; patients are able to speak audibly in a whispering tone of voice. If it is desirable to wear a phonetic canula, an "*artificial larynx*" (*Bruns-Beyerle's*, *Gussenbauer's*, or *Julius Wolff's*) is to be recommended (Figs. 1194, 1195).



a

Fig. 1194



b

Fig. 1195

Phonetic Canula (Artificial Larynx). *a*, according to Gussenbauer; *b*, according to von Bruns

The patient can speak through these apparatuses with a loud voice. On account of the irritation produced by the canula, however, many content themselves with whispering speech.

Aside from recurrence, most patients that have been subjected to this operation have died from aspiration of secretions; the greatest care, therefore, must be bestowed upon **the after treatment**.

Bardenheuer obtained very good success by forming a *septum between the oral cavity and the cavity of the wound* after removal of the larynx. The anterior wall of the œsophagus is sutured to the margin of the mucous membrane (which is preserved as much as possible) below the epiglottis, or with the vivified free margin of the epiglottis. The cavity of the wound is tamponed. The patient is placed with his head lowered backward in such a position that the tracheal stump forms the highest point of the wound and no secretions can flow into the tracheal wound. Since the patient can swallow, he does not insert any œsophageal tube for the introduction of food, and thus the first tampon can remain in position as long as eight days without irritating the wound.

J. Wolff employs the œsophageal tube, but removes the tampon canula directly after the operation, and sutures the tracheotomy wound. The superior margin of the tracheal stump is sutured all around to the skin, and a common canula is introduced into the trachea from above.

Rotter closed the pharyngeal defect by a double row of sutures including the mucous membrane, sewed over it the muscles detached from the larynx in a second layer, and the skin as far as the angles in a third layer. The patient could swallow very well immediately after the operation.

OPERATIONS FOR GOITRE

(STRUMA)

I. **Parenchymatous injections.**

Injections of tincture of iodine or of Lugol's solution (or alcohol, osmic acid, iodoform oil) may sometimes effect a decrease in simple, not too large, goitres (parenchymatous) (after a preceding inflammatory reaction); sometimes, however, they meet with no success.

They are administered *in intervals of from* two *to* three *days*, in doses beginning with half a *Pravaz's* syringeful, but gradually increasing to a full syringe. Whether the syringe has been properly inserted into the tumor is recognized from the movements of the canula in an upward and downward direction during deglutition. It is dangerous to inject the solution into a vein, because sudden death (embolism) may ensue. Hence, it is necessary first to draw the needle a little before making the injection.

The injection must be made *very slowly*.

II. **Puncture with subsequent injection** of tincture of iodine or *Lugol's* solution is of some value in *struma cystica*, only when the walls of the cyst are rather thin and have not too many pouch-like distensions of the cyst wall.

The puncture is made with a trocar under most careful aseptic precautions with the skin drawn tense. The trocar must not be too small, because the contents of the cyst are often composed of a thick (colloid) fluid. The evacuation must be made slowly, because by relieving the pressure too rapidly, hemorrhages are easily caused in the interior of the cyst. For dressing, iodoform-collodion and a light compressive bandage are used.

(Parenchymatous injections are useless in adenomata of the thyroid gland and seldom of signal value in cystic goitre. In miasmatic goitre parenchymatous injections of a 5% solution of carbolic acid repeated at intervals of a week and combined with the internal and external use of iodine seldom fails in reducing the swelling.)

III. **Incision with suturing of cyst wall to skin** (*Chelius*). In *struma cystica and abscesses.*

1. *External incision* over the most prominent part of the swelling with avoidance or double ligation of the larger veins.

2. Cutting through the *superficial cervical fascia.*

3. *Stitching* the exposed wall of the cyst and fascia to the margins of the skin by a *continuous quilt suture.*

4. *Incision* of the cyst in the line of the external incision, cleansing, tamponing. In larger cysts, if necessary, the exposed portion of the anterior wall is *resected;* under some circumstances, thorough *drainage* without free incision proves successful in very large cysts.

Profuse parenchymatous hemorrhage (in struma cystica parenchymatosa — *Stromeyer*) is arrested by firm packing with iodoform gauze, peroxide of hydrogen gauze, or zinc chloride gauze.

If the *extirpation* of isolated cysts can be made easily, it is to be preferred to incision (*Müller*).

IV. **Extirpation of Struma (Strumectomy)** (*Billroth*, *Rose*, 1878). The **total extirpation** of the thyroid gland, according to present experience, is no longer permissible, since, in consequence of the operation, epileptic fits, paralysis of the muscles of the larynx, cachexia, myxœdema, fatal tetany, and idiocy are caused or threatened (**cachexia thyreopriva** — *Kocher*).

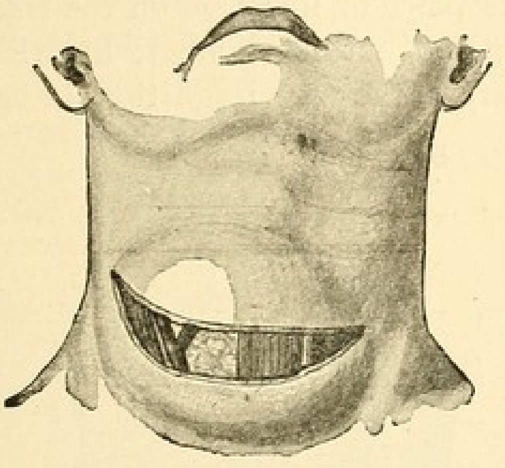
It should be considered only in the surgical treatment of malignant disease (sarcoma, carcinoma); and then the implantation of fresh glandular substance into the abdominal walls may prevent cachexia after complete extirpation, as well as the administration of the fresh gland or its extracts (thyroidin, iodothyrin — *Baumann*).

Hence, in all other cases, only the

Unilateral extirpation is considered, and this only when still sufficient healthy glandular substance is present on *the other* side.

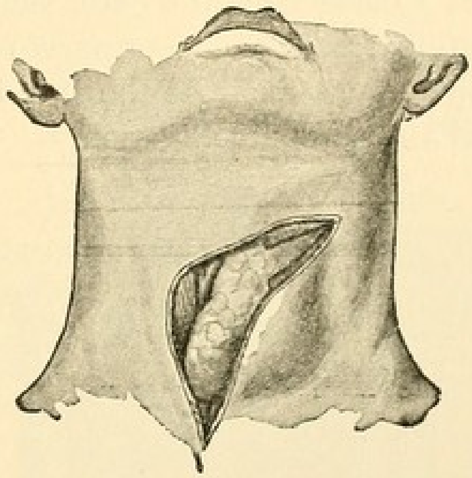
Kocher proceeds as follows: —

1. *External incision* according to the seat and the size of the tumor in the median line of the neck along the inner margin of the sternocleidomastoid;



a

Fig. 1196



b

Fig. 1197

Kocher's Extirpation of Struma (Strumectomy). *a*, transverse incision; *b*, angular incision

in very large strumas, *angular incision* or *trap-door incision*. A *simple transverse incision*, "*Kragenschnitt*," ascending more on the diseased side than on the healthy side, is followed by the slightest cicatrix (Figs. 1196, 1197).

(A curved transverse incision with the convexity directed downward and following the lower border of the swelling is the one which is now generally resorted to in performing partial and complete strumectomy.)

2. After division of the platysma and the superficial fascia, and after a careful double ligation and division of all visible blood vessels, the sternohyoid, the sternothyroid, and the omohyoid muscles, if necessary, are separated in the median line close to their insertion into the larynx. If possible, they are divided only *partly* and in a transverse manner. The sternocleidomastoid, freed sufficiently at its anterior margin, is drawn aside with blunt retractors. The external *capsule of the goitre* now exposed as a thin layer of connective tissue is incised. It is separated with the goitre probe (Fig. 1198) from the struma (ligation of the veins), so

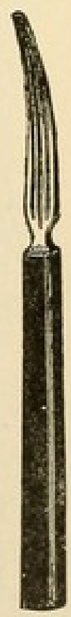


Fig. 1198
Kocher's
Goitre
Probe

that its posterior surface can be reached by passing one finger along the external margin of the goitre.

3. The goitre *is turned out toward the median line* (luxated) very carefully and cautiously, in order not to lacerate the blood vessels, which are exposed to great tension.

4. *The inferior thyroid artery*, lying behind the turned-out goitre in the form of a curve from the outer side to its place of insertion on the trachea, is carefully freed (recurrent nerve) and ligated, but not divided; likewise the accompanying vein. At the inferior margin, the very large thyroid vein is divided after a double ligation.

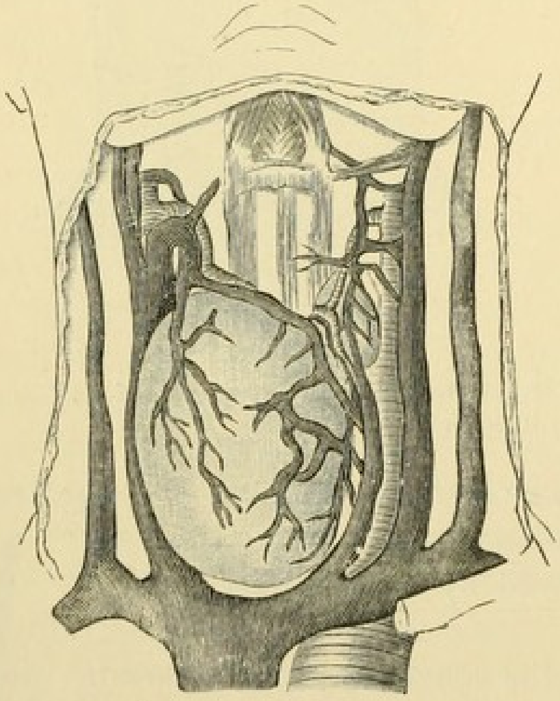


FIG. 1199. RIGHT-SIDED STRUMA, SHOWING THE RAMIFICATION OF SUPERFICIAL VEINS (Kocher)

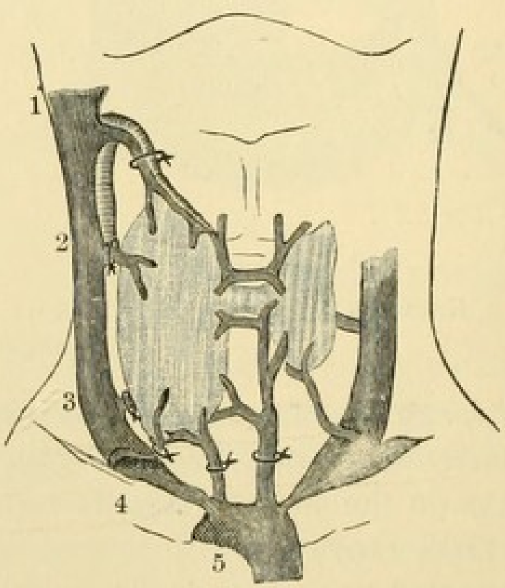


FIG. 1200. DIAGRAM SHOWING LIGATION OF LARGE VEINS NECESSARY IN EXTIRPATION OF STRUMA (Kocher)

1, *A.* and *V.* thyreoidea sup.; 2, *V.* thyroid. sup. access; 3, *V.* thyroid. inf. access; 4, *V.* thyroid. inf.; 5, *V.* thyr. ima princeps and access.

5. Entering with Kocher's director above the isthmus at the medial border of the upper horn, the surgeon, after a double ligation, divides an ascending ramus of the superior thyroid vein in the median line, and draws the upper horn forcibly upward with the fingers until the *superior thyroid vessels* become very tense. He then isolates them with the director, and ligates them; he divides the superior thyroid artery and vein.

6. On the superior and inferior borders of the isthmus, the superior and inferior communicating veins are ligated and divided; the director is slowly

inserted between the isthmus and the trachea; the isthmus is secured with two strong ligatures, and divided between them.

7. The goitre is then raised with the left hand from the trachea and its posterior margin, still adhering to the trachea, and is detached from it, care being exercised not to injure the recurrent nerve ascending at this place. Since this nerve can be injured in spite of all precaution, it is more practical, by a vertical incision made parallel to the trachea, but a little distant from it, to leave in position a portion of the posterior portion of the capsule for its protection.

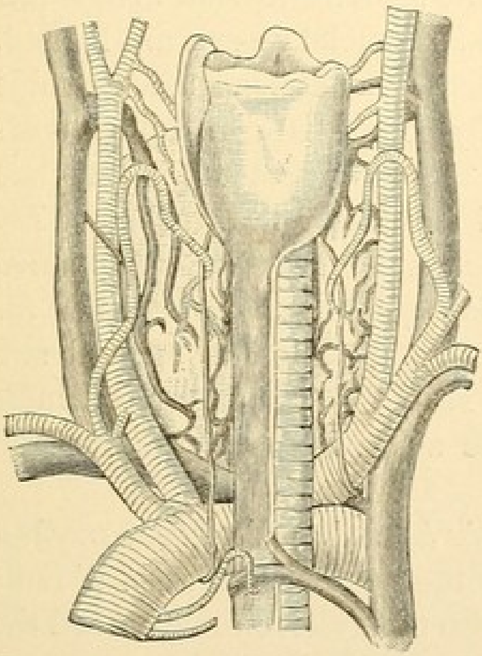


FIG. 1201. POSTERIOR VIEW OF LARYNX AND TRACHEA WITH NEIGHBORING TRUNKS OF VESSELS (Course of recurrent nerve)

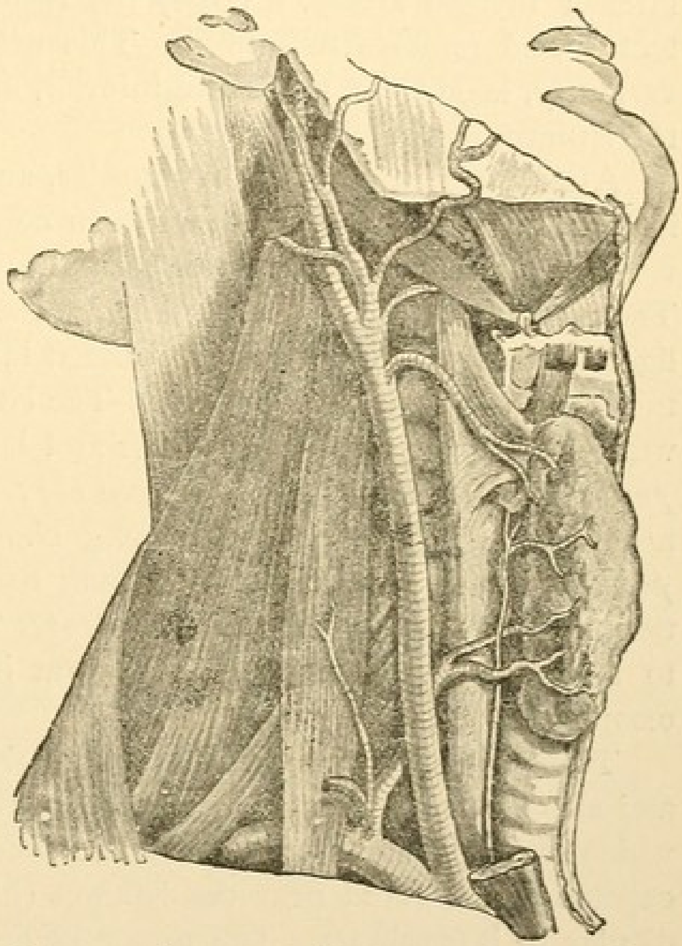


FIG. 1202. RECURRENT NERVE AND INFERIOR THYROID ARTERY (Wölfler).

The **recurrent nerve of the pneumogastric nerve**, or *inferior laryngeal nerve*, arises from the vagus, on the *right* beneath the subclavian artery, on the left beneath the arch of the aorta, *ascends* behind these vessels, in the groove between the trachea and the œsophagus behind and toward the median line from the common carotid, upward to the lower margin of the *cricopharyngeus muscle*. Below this it enters the interior of the larynx *from behind*, across the upper margin of the *lateral cricothyroid ligament*, accompanied by the inferior thyroid artery (Figs. 1201, 1202).

8. The external wound is sutured, leaving a space at the most dependent part for free drainage. Under a compressive bandage, the healing can take place in one to two weeks.

V. **Resection of Goitre** (*Miculicz*) is made in diffuse colloid degeneration on both sides, for the purpose of avoiding the serious complications produced by total extirpation (recurrent paralysis), by allowing to remain a portion of healthy glandular substance in connection with the point of entrance of the inferior thyroid artery, whereby the recurrent nerve is most securely protected, and remains uninjured. This procedure, however, can be modified variously, leaving at times the inferior, at times the superior pole, at others the isthmus of the glands.

After division of the skin, muscles, and fascia, one-half of the goitre is isolated bluntly; next, at the superior cornu, the *superior thyroid artery and vein* are ligated; at the inferior cornu only the superficial vessels are ligated. The isthmus, bluntly detached from the trachea, is divided after double ligation "en masse," while an assistant laterally compresses with his fingers the blood vessels entering into it. The lateral flap to be resected is detached with the scissors from the anterior and lateral surface of the trachea. *The portion situated at the angle between the trachea and the œsophagus is allowed to remain.* With the aid of strong clamp forceps, which *squeeze out the parenchyma*, it is ligated with strong catgut ligatures, and in several sections tied off like a pedicle by *ligatures "en masse."* The latter contracts to a nodule of the size of a chestnut in the angle between trachea and œsophagus.

To avoid the separation of the tumor *from the lateral surface of the trachea*, and also *the contusion of the recurrent nerve*, by the ligature "*en masse*," risks which are always to be apprehended, *Kocher*, with the knife, circumscribed the capsule of the gland near the isthmus (hilus) by a circular incision perpendicular to it (sagittal). The upper section of the circle, however, must lie completely above the cricoid cartilage. By this means, *injury to the recurrent nerve is excluded* almost with certainty. Finally, a small flap of the thyroid gland, similar to the normal one, is formed from the remaining stump. Next the pedicle of the detached half of the goitre is divided longitudinally in several sections with probe-pointed scissors; each part is grasped with strong clamp forceps and ligated, and then the whole tied-off mass is divided with the scissors.

VI. **Enucleation or intraglandular extirpation** (*Porta, Socin*) in cysts and in well-circumscribed adenomatous nodules and in bilateral goitres. After *cutting through the skin, fascia, capsule* (*capsula externa sive fasciosa*, deep cervical fascia), and the overlying (healthy) attenuated glandular tissue (*glandular capsule*), the several glandular nodules are enucleated *bluntly*.

Sometimes the operator can proceed still more rapidly if, by a deep incision, the adenoma is at once *divided into two equal parts*, and each half is *enucleated* with the fingers and the sharp spoon (**evacuation**, *Kocher*); often, however, a *very violent hemorrhage* ensues.

Hence it seems to be more advisable, according to *Bose*, by means of an elastic tube as thick as the little finger, to constrict the tumor behind its greatest diameter, whereby the hemorrhage is prevented; at the same time, after the division of the capsule, the glandular tissue is squeezed out of the wound. Of course, in suitable cases, the methods of resection and enucleation just described can be practically combined.

ENUCLEATION RESECTION (*Kocher*)

which is to be employed for the removal of all isolated nodules.

After the goitre has been luxated from a transverse or angular incision, as described on page 627, without ligating the large blood vessels, the isthmus is first divided after a double ligation. From this incision the internal circumference of the goitrous nodule is separated. The veil of glandular tissue is undermined in an upward and downward direction with Kocher's director, and a double ligature applied in a horizontal line. Next, from this place, the nodule is enucleated with the finger first above and below, then also at its posterior surface from the glandular substance. The latter is then vertically divided with the scissors at its posterior surface as far as the ligatures on the anterior surface between the inferior and superior cornua. The nodule is then removed, together with the tissue covering it.

VII. **Ligation of the Afferent Arteries** (*von Walther, Wölfler*). In *vascular goitre and Basedow's disease.*

(*a*) **Ligation of the superior thyroid artery.**

1. *External incision 4 centimeters long* along the internal margin of the sternocleidomastoid across the great cornu of the hyoid bone as far as the thyroid cartilage.

2. *Division of the platysma. The artery is found in front of the great cornu of the hyoid bone* in the triangle between the *omohyoid, digastric, and sternocleidomastoid muscles.*

Kocher and Rydygier searched for the artery from a transverse incision extending from the margin of the sternocleidomastoid to the body of the hyoid bone. The anterior branch of the artery is always to be felt on the median upper side of the superior cornu of the (enlarged) thyroid gland, passing downward at the side of the larynx.

(*b*) **Ligation of the inferior thyroid artery.**

Von Langenbeck made the *external incision* 6 centimeters long in the groove between *the two heads of the sternocleidomastoid muscle.*

1. Division of the *platysma,* ligation of the *transverse cervical vein, the transverse vein of the scapula, the external jugular vein.* Division of *the deep cervical fascia,* splitting the sternocleidomastoid muscle in an upward direction.

2. The tendinous part of the *omohyoid muscle* appears in the middle of the wound, and is drawn outward or divided. The *internal jugular vein,* which is now exposed, is drawn toward the median line. *The carotid, the pneumogastric nerve,* and the *anterior scalenus muscle* covered by cellular tissue and fascia can be inspected.

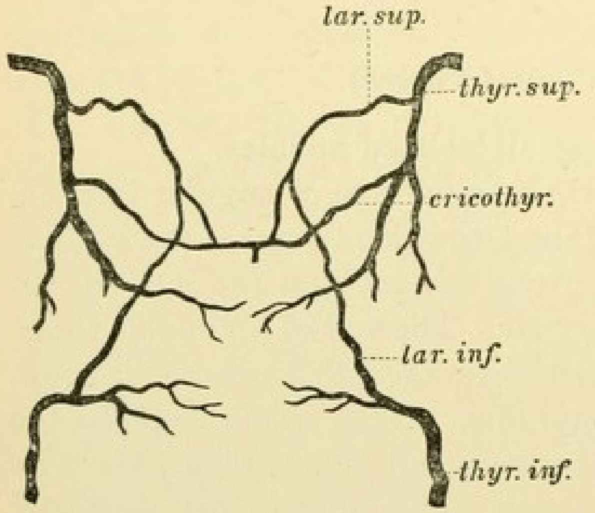


FIG. 1203. DIAGRAM OF ARTERIES SUPPLYING LARYNX AND THYROID GLAND

3. After blunt division of the latter, the *phrenic nerve* becomes visible and is pushed outward. Along the internal margin of the anterior scalenus muscle, which is drawn a little toward the outer side, the arch of the *inferior thyroid artery* (*sympathetic nerve!*) is seen. (See also Fig. 1202.)

To avoid the danger of injuring the sympathetic nerve, *Wölfler* draws the large blood vessels and the pneumogastric nerve inward. *Rydygier* in ligating this artery proceeds as follows: —

1. *The external incision* 6–7 centimeters long extends 2 centimeters *above and parallel to the clavicle,* transversely across the clavicular portion of the sternocleidomastoid muscle and the supraclavicular fossa.

2. After *incising the platysma and the superficial cervical fascia,* both forefingers penetrate in a perforating manner through the loose cellular and adipose tissue behind the sternocleidomastoid as far as the margin of the *anterior scalenus* muscle. The lymphatic glands are removed.

3. The sternocleidomastoid with the large blood vessels of the neck and the pneumogastric nerve are lifted with long blunt hooks *forward and inward,* so that the wound *gapes* widely. Then there appears on the *internal margin* of the anterior scalenus muscle the thyrocervical trunk, from which *the*

inferior thyroid artery branches off in an *inward* direction. This vessel is secured by a double ligature.

Kocher ligates the artery at a place where, *behind the carotid, it curves toward the thyroid gland inwardly.*

1. External incision transversely across the clavicle (jugulum) in a curve obliquely upward and outward across the sternocleidomastoid.

2. Platysma and sternocleidomastoid are forcibly retracted outwardly, the omohyoid and the sternohyoid muscles are drawn downward and inward; the jugular vein, the common carotid, and the pneumogastric nerve are isolated on the internal margin, and drawn outward. Then between the latter and the margin of the thyroid gland (or the sternothyroid muscle), the operator advances toward the vertebral column.

3. The thyroid gland is raised inwardly, and the convex arch of the artery is then seen lying upon the longus colli muscle beneath the recurrent nerve, which crosses it.

If the extirpation of the diseased thyroid gland appears impossible or impractical, the following **palliative operations** may be attempted:—

Jaboulay raised the goitre from its natural position and lifted it, so to say, by his **exothyreopexia**. From a median incision, the goitre is carefully separated bluntly with the fingers from its connections, and the loosened lobes are luxated outward and surrounded with sterilized gauze. After the gauze is removed on the fourth day, the skin contracts over the goitre of its own accord, while the latter gradually contracts, because the distortion of the large vessels has impaired its nutrition. Since this procedure, however, may cause thrombosis, *Wölfler* **makes a dislocation of the goitre** in a similar manner by drawing it out from its bed, where it causes functional disturbances (for instance, between trachea and sternum), and by fixating it under the skin and the sternocleidomastoid, mostly at a higher level. As a substitute for extirpation, which can no longer be performed, owing to the extent or location of the disease, he also recommends *puncturing* with the needle point of the thermo-cautery.

LIGATION OF THE ISTHMUS OF THE THYROID GLAND

was recommended by *Gipp and Jones* for the relief of *dyspnœa* and other *pressure* symptoms.

The *external incision* extends in the median line from *the thyroid cartilage downward.* The isthmus is *detached bluntly* from the trachea, constricted by ligatures "en masse" on both sides of the trachea, and divided between them (or the whole portion pressing upon the trachea is *resected*).

Asphyxia is especially to be feared *as a serious accident in operations for goitre.*

It may be caused: —

1. By *anæsthesia.*
2. By *paralysis of the recurrent laryngeal nerves.*
3. By a *complete compression* of the **scabbard-shaped** compressed trachea (when the head is turned laterally and the goitre is turned out) (Figs. 1204, 1205, 1206).

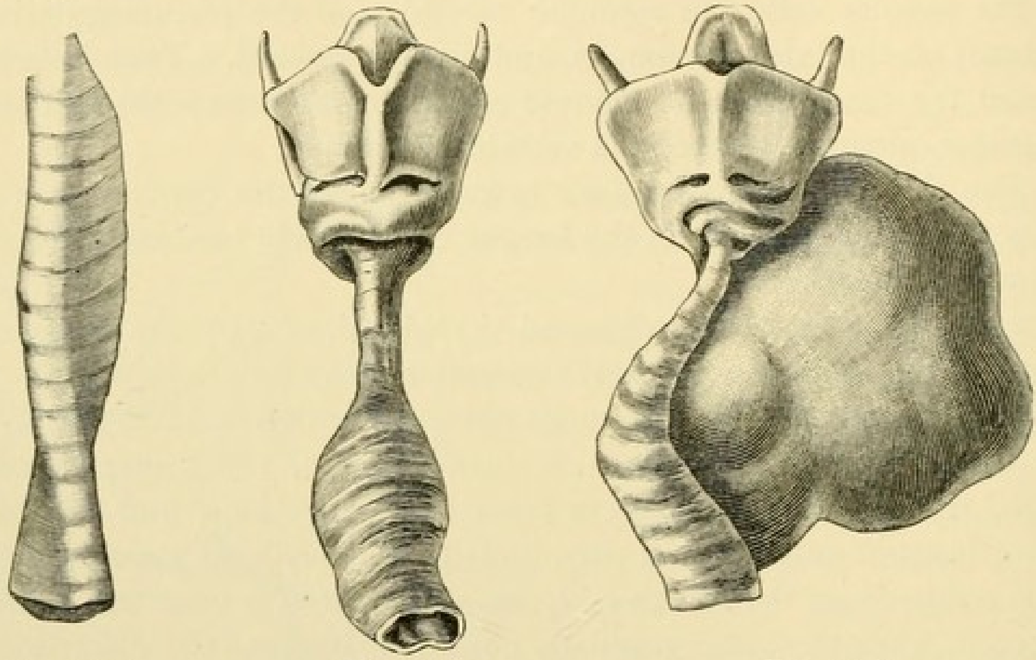


Fig. 1204 Fig. 1205 Fig. 1206

Scabbard-shaped Compressed Tracheæ (Demme)

To prevent this compression-stenosis, either *the lateral tracheal walls* may, during the operation, be *drawn apart* with sharp hooks, or the lumen of the trachea may be kept patent by *simple pressure of the finger upon the anterior wall.* For the more permanent removal of the stenosis, a strong *catgut ligature* with a curved needle is passed at two places through the lateral walls of the trachea and drawn together over the angular anterior margin in such a manner that the lateral walls are *separated* (*Kocher*).

In dyspnœa of a high degree, chloroform anæsthesia must be avoided (not ether, on account of the aspiration of profuse tracheal secretions), and a moderate morphine anæsthesia or local anæsthesia must be attempted. The latter is to be recommended also for *all* operations for goitre of short duration.

(At the present time, Kocher performs all his operations on goitres under Schleich's infiltration method.)

Tracheotomy should *be avoided as much as possible* in all these operations, since it renders asepsis almost impossible (*phlegmonous mediastinitis; aspiration*).

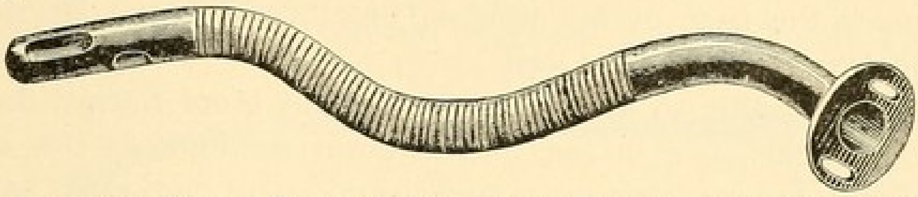


FIG. 1207. KÖNIG'S FLEXIBLE CANULA FOR TRACHEOTOMY IN STRUMA

If, in *substernal and firmly adherent goitres*, the surgeon is compelled previously to the operation to perform tracheotomy *above* the seat of compression, on account of threatening asphyxia, a long *flexible canula* must be introduced extending beyond the stenosis (*König*, Fig. 1207).

OPERATIONS ON THE ŒSOPHAGUS

The introduction of the œsophageal tube is made for relieving the stomach of any injurious contents, or for conveying food into it. For this purpose, the œsophageal tube is connected by a rubber tube with a reservoir (douche, funnel, **stomach pump**) (Fig. 1208).

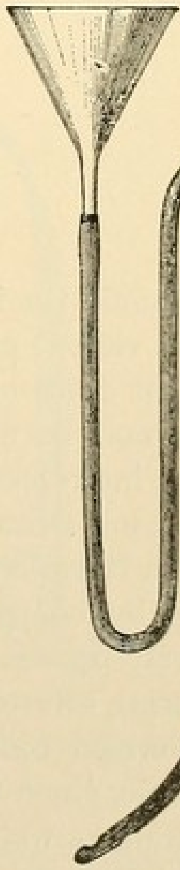


FIG. 1208. STOMACH PUMP

The reservoir is filled with fluid; the fluid flows into the stomach when the reservoir is *lifted* sufficiently; the fluid and the contents of the stomach are siphoned out, when the reservoir is *lowered* sufficiently.

If the œsophageal tube is to remain in position for some time, or if, on account of the resistance of the patient, it cannot be introduced through the mouth, it must be introduced through the lower meatus of the nose and the pharynx into the œsophagus. It can remain in position for a long time without causing any especial inconvenience.

The patient sits on a chair in front of the surgeon with his head extended, his mouth wide open, and his tongue projected. The surgeon depresses with his left forefinger the base of the tongue, and introduces the instrument held near its end with his right hand, like a penholder. Having previously lubricated the instrument well with oil, or, better, with glycerine, he introduces it carefully along the posterior pharyngeal wall into the stomach. (The cardiac orifice lies in the adult about 40 centimeters beyond the incisors.) In introducing the instrument, the surgeon, as a rule, meets with some resistance in the region of the cricoid cartilage. This resistance can be removed by drawing with the point of the left forefinger the base of the tongue, together with the larynx, forward toward the lower jaw (Fig. 1209).

It is also advisable to direct the instrument more toward the *left side.* If a stronger resistance is felt in the lower sections of the œsophagus (foreign bodies, tumors, strictures, aneurisms), great care must be taken not to use too much force. A perforation is easily caused in the surrounding tissue, which has nearly always undergone a change, lessening its resistance.

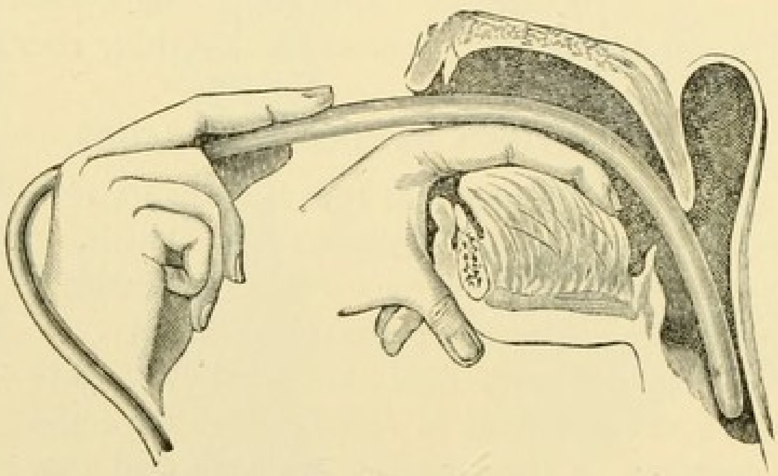


FIG. 1209. INTRODUCING ŒSOPHAGEAL TUBE

Should the instrument happen to enter the larynx instead of the œsophagus, a violent paroxysm of coughing and asphyxia at once ensues, whereas in most cases only *choking sensations* are caused by a proper introduction; these may be mitigated by deep breathing and movements of deglutition. If the instrument has passed the larynx, it can be pushed forward without producing irritation.

(In the adult the introduction of the œsophageal tube is very much facilitated by coöperation of the patient. The unpleasant gagging is often entirely prevented if the patient will manage the tube himself and advance it during efforts at swallowing.)

Foreign bodies in the œsophagus must be removed from it as soon as possible, since they provoke inflammation (and perforation) of the œsophageal wall, as well as dysphagia.

If they are firmly impacted *behind the larynx*, they may be extracted either with the forefinger, bent like a hook, or with curved dressing forceps;

if these prove of no avail, they must be exposed, if necessary, by *subhyoid pharyngotomy* (see page 608).

If they are lodged in the *upper portion of the œsophagus* itself, the surgeon may, in many cases, succeed in grasping and extracting them with

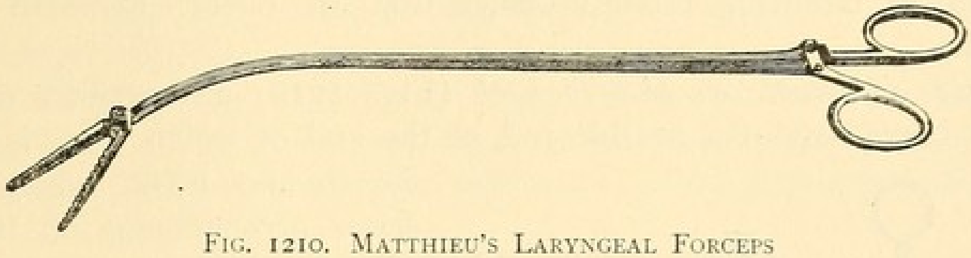


FIG. 1210. MATTHIEU'S LARYNGEAL FORCEPS

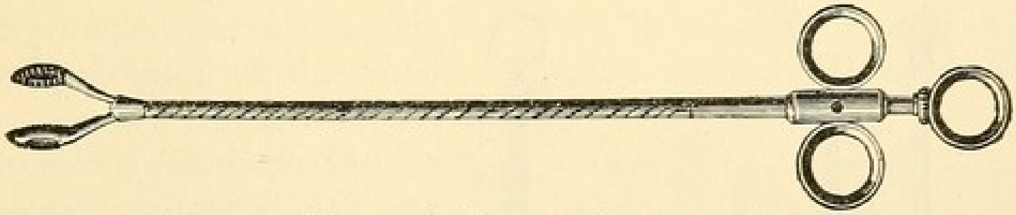


FIG. 1211. TIEMANN'S FLEXIBLE LARYNGEAL FORCEPS

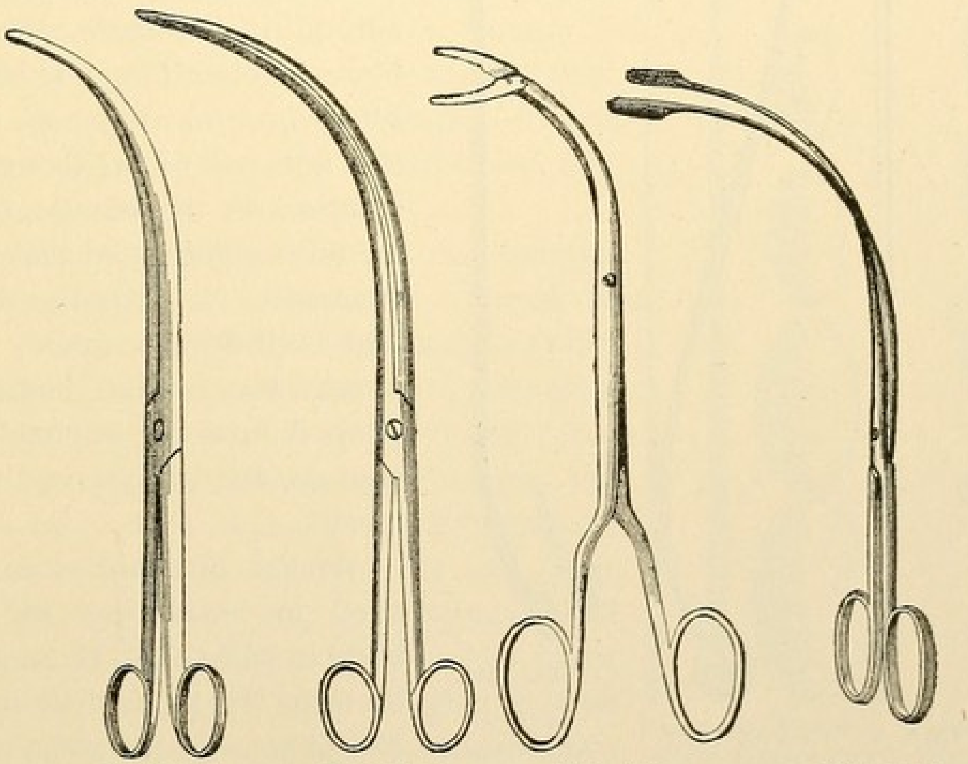


FIG. 1212 FIG. 1213 FIG. 1214 FIG. 1215
LARYNGEAL FORCEPS

curved long-billed *forceps*, which open and close in different directions; great caution, however, must be observed in order not to cause any lacerations of the mucous membrane (Figs. 1210–1215).

Flat, hard, coinlike bodies are best grasped with *Gräfe's coin-catcher* (Fig. 1217). The disklike movable blades at the end of this instrument are pushed past the body, and when the instrument is withdrawn, they catch and remove the foreign body. (Gräfe's coin-catcher is a very dangerous instrument in removing foreign bodies that are or are liable to become impacted.)

Collin's adjustable œsophagus hook (Fig. 1218) also renders excellent service. It consists of a flexible rod, at the end of which there is a small curette-like hook, which, by a screw arrangement on the handle, can be adjusted to any desirable position so that the foreign body can be grasped or *released at pleasure.*

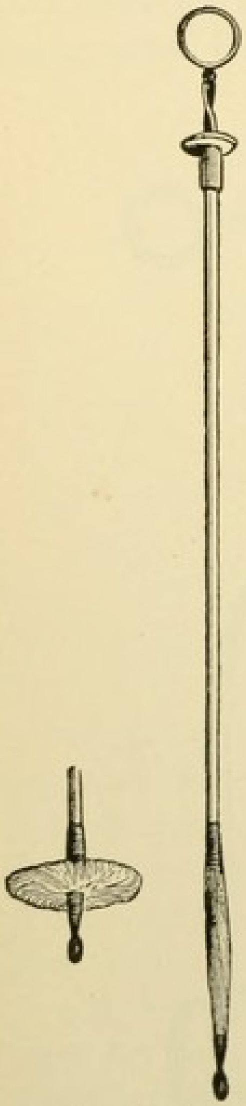


Fig. 1216
Weiss's Fish-bone Catcher

Fig. 1217
Gräfe's Coin-catcher

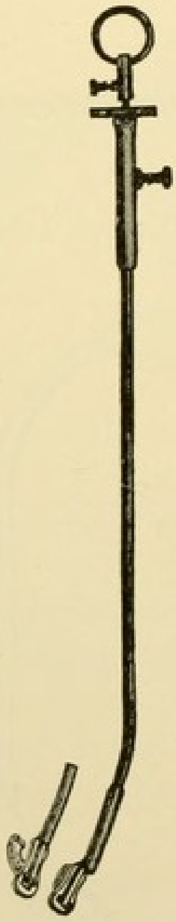


Fig. 1218
Collin's Adjustable Œsophagus Hook

Sharp-pointed bodies (needles and fish bones) are removed by *sweeping out* the œsophagus with suitable instruments. Weiss's fish-bone catcher (Fig. 1216) has at its lower end a sponge, and over it a network of bristles which, by traction on the handle, open into an umbrella-shaped disk; the instrument is introduced closed, and withdrawn open; by this means, the foreign bodies, if not pushed into the stomach by the sponge, are caught in the bristle work.

If the operator does not succeed in extracting the foreign body in spite of all these attempts, he must try to push it down *into the stomach,* best with a flexible whalebone rod, to the end of which a sponge or an ivory knob has been fastened (probang or *œsophageal bougie,* Fig. 1217). For the purpose of facilitating the passage of the foreign body through the intestinal canal as harmlessly as possible, the patient should eat potatoes, rice, and bread exclusively; these produce ample fæces to envelop the foreign body; the stools, of course, must be carefully examined. In this manner, even large bodies with sharp edges (set of teeth) may pass through the intestines without causing injury or disease. It is not advisable, however, to increase by purgatives the peristaltic action of the intestines for hastening the passage of the foreign body.

If the foreign body is so firmly impacted in the *lower section of the œsophagus* that it can neither be extracted nor pushed down into the stomach, the attempt must be made to extract it by *external œsophagotomy* (see page 223).

STRICTURES OF THE ŒSOPHAGUS

To determine more accurately *the seat of a stricture*, a *bougie of large caliber* is introduced until arrested. Next, the distance of the obstruction from the incisors is measured. By selecting bougies of decreasing diameter, the operator endeavors successively to pass the stricture with them. Whether this has been successful is ascertained from the fact that the point of the bougie is grasped on being withdrawn. In most cases, it is then possible to *pass* a bougie of the *next smaller diameter through the stricture*, and thereby to ascertain its diameter.

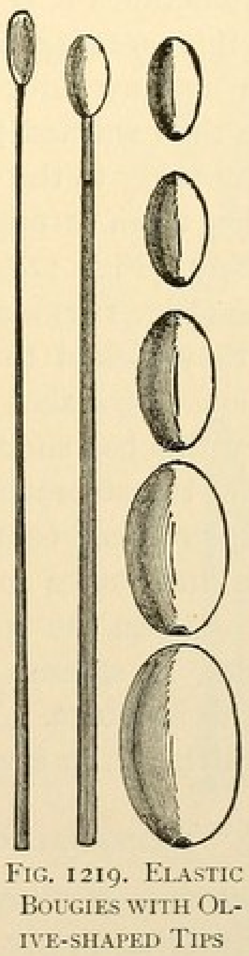


Fig. 1219. Elastic Bougies with Olive-shaped Tips

Fig. 1220 Trousseau's Probe

In attempting gradual dilation the bougie, after it has passed the stricture, is allowed to remain in position 10 to 20 minutes, producing in most cases a slight (inflammatory) softening of the surrounding tissue; on the next day, after a previous introduction of the same bougie, the next larger one can be immediately introduced; this, in turn, remains in position for the same length of time. This process is continued until the desired caliber of the lumen has been effected. The treatment with bougies is best conducted by using the *elastic bougies* with a piriform point and a thin neck; whalebone probes, provided with *ivory* olive-shaped tips of varying sizes (Fig. 1219) are in some cases also useful (more particularly in ascertaining the location and degree of the stenosis). *Trousseau's* probe (Fig. 1220) has at each end three olives of increasing size.

Leyden obtained good results by the use of *permanent tubes* — short, hard rubber tubes which remain in position in the constricted place and facilitate the introduction of food. They are introduced into the stricture by means of a probang with soft conical point (*Wolff*), and can remain in position for months. They can be easily withdrawn by means of a silk thread fastened to them previously, which hangs out of the mouth while the canula remains in position (Fig. 1221).

If the surgeon is not successful in dilating the stricture in the desired manner by treatment with bougies, he may attempt to remove the stricture at once by nicking it with instruments made for that purpose. They operate after the manner of urethrotomes and are similarly constructed (*œsophagotome*) (Figs. 1222, 1223) (*internal œsophagotomy* — *Maisonneuve*).

It is better and less dangerous, however, in such cases to perform *gastrostomy*. Sometimes it is possible subsequently to dilate (cicatricial) strictures from this *opening in the stomach* (*retrograde dilatation*). *Kraske* introduced a ligature knot from the mouth through the stricture into the stomach; he then washed the thread out from the gastric fistula by irrigation; next, by tying to the ligature ivory olives of gradually increasing size, and by passing them through the stricture, he dilated the stricture gradually and completely (Fig. 1224). *Lange* tied to such a ligature small three-edged knives (Fig. 1225), as in *Maisonneuve's* urethrotome. Drawn up by the thread, they nicked the stricture from below upward. *Socin* had the patient swallow a bird shot fastened to a ligature for dilating such constrictions. When this has succeeded and the ligature has been brought out of the opening of the stomach, the surgeon can also make *von Hacker's* **endless probings** with stretched caoutchouc threads or drainage tubes stretched tense over a probe and hence made thinner. They are introduced by means of the ligature. When the traction is discontinued, they contract and become thicker. Next, in succession, larger tubes are tied to the thinner one in position in the stricture. These, drawn through the stricture, accomplish the desired dilatation in a very short time.

EXTERNAL ŒSOPHAGOTOMY (*Goursand*, 1738),

the external opening of the cervical portion of the œsophagus, is made: —

1. For removing firmly impacted *foreign bodies*.

2. For bloody or forcible blunt dilatation of *strictures*, especially when they are situated very low down.

The operation is performed *on the left side of the neck*, because the œsophagus lies more to the left behind the trachea. The patient is placed

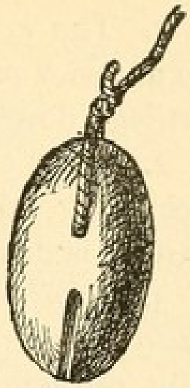


Fig. 1224
Ivory Olive according to Kraske

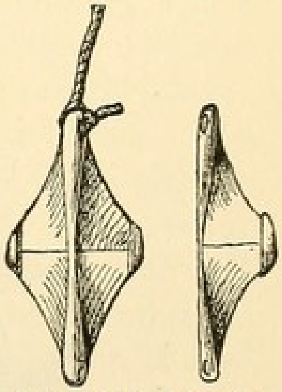


Fig. 1225. Lange's Three-edged Knives for Retrograde Dilatation

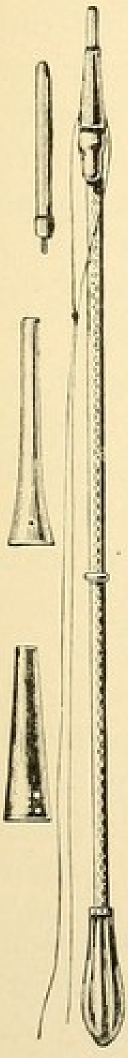
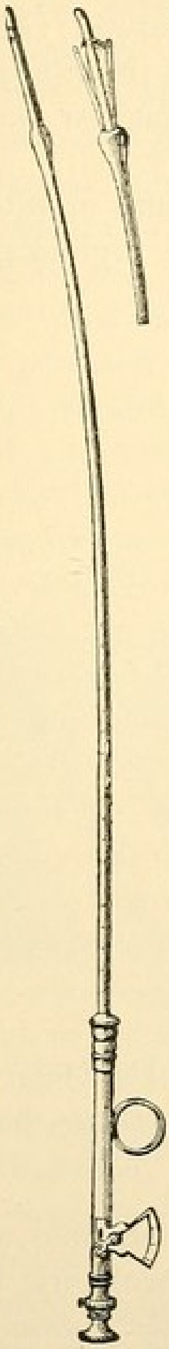


Fig. 1221
Leyden's Probe with Permanent Tube



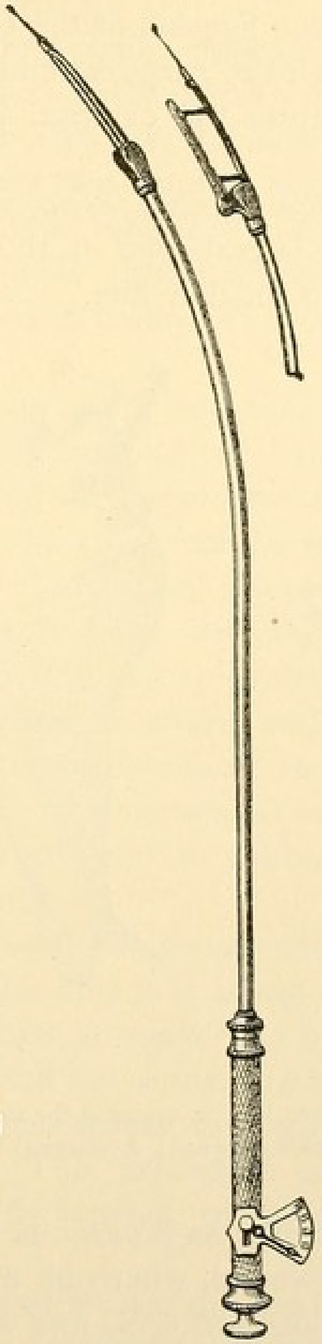


Fig. 1222. Trélat's Fig. 1223. Collin's
Œsophagotome

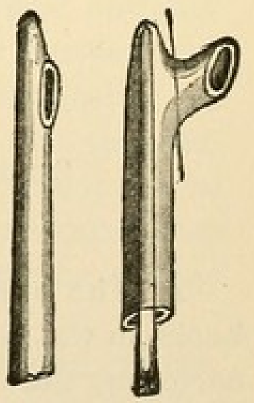


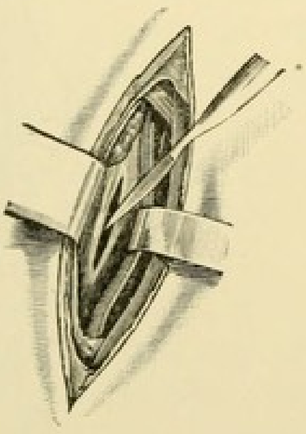
Fig. 1226. Von Hacker's Drainage Tubes stretched over a Probe and cut off laterally

in a half-sitting position, with his head turned toward the right. If possible, an œsophageal tube, as thick as possible, or a large probe (or *the* "*ectropœsophag*") is introduced into the œsophagus.

1. The *external incision*, about 5 to 7 centimeters long, extends along the anterior margin of the sternocleidomastoid from a level with the cricoid cartilage downward (as in the ligation of the carotid) (Fig. 1228).

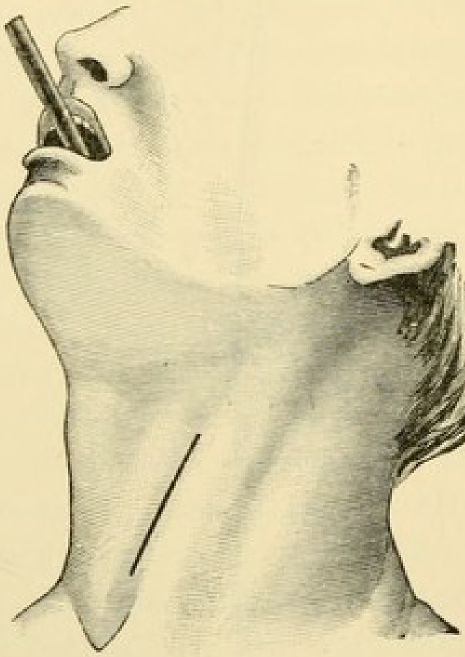
2. After cutting through the *platysma* and the *superficial cervical fascia*, care being taken not to injure the external jugular vein, the sternocleidomastoid is drawn outward.

3. *Division of the middle cervical fascia*, with or without preserving the *omohyoid muscle*; the left lateral lobe of the thyroid gland is drawn with blunt retractors toward the median line.



a

Fig. 1227



b

Fig. 1228

External Œsophagotomy. *a*, opening the œsophagus, sheath of vessel drawn outward; *b*, external incision

4. The operator penetrates as *bluntly* as possible with two strabismus hooks in the depth of the wound, where he meets first the common sheath, enclosing the *carotid, the jugular vein, and the pneumogastric nerve;* over the latter passes *the descending ramus of the hypoglossal nerve.* If the whole sheath is *drawn outward* with a broad blunt retractor, the wall of the flat roundish œsophagus, with its longitudinal fibres lying behind it, is brought into view (Fig. 1227).

5. After the introduction of an œsophageal tube, *the opening of the œsophagus* is made easily upon it. If the opening must be performed free hand, it is made best between two dissecting forceps, in which case the

strong muscular coat and the mucous membrane only, loosely connected with it, are lifted up and divided.

The height and length of the opening depend on the seat and the nature of the trouble for which the operation is performed.

6. From this wound, the *foreign body* can now be exposed and removed. In difficult cases, traction loops are applied through the margins of the wound to keep the visceral wound open (*Billroth*). In case of *cicatricial stricture*, the incision is best made closely above or below the same, and from this incision the dilatation is made; in this case, the eye can survey the operation to be performed.

The *blunt* dilatation should be made with *dilating forceps* (*Roser*), which are introduced, closed, and then opened (glove stretcher). Finally, with the probe-pointed knife, the cicatricial contraction may be *nicked* in several places, but very superficially, or the dilatation can be made with a hernia knife guided upon a *grooved director* (combined œsophagotomy — *Gussenbauer*).

7. After removal of the obstruction, an œsophageal tube is introduced from the nose into the stomach, and the several layers of œsophageal wall are closed over it by sutures. *Duplay* sutures only the mucous membrane. *Fisher* allows fluids to be swallowed *without* an œsophageal tube, a few hours after the operation. The external wound can be loosely *sutured and drained*, or, still better, *packed*, in order to prevent most effectually retentions and gravitation (mediastinitis).

If the opening of the œsophagus has been made below a tumor, obstructing the lumen of the œsophagus, and if it is not possible to extirpate the tumor from the wound, or, at least, to make the œsophagus permeable, the margins of the œsophageal wound are sutured to the external skin (**œsophagostomy**); **a lip-shaped œsophageal fistula**, through which the patient can be nourished, is thus established. This procedure can be recommended also for *very narrow strictures*, deeply located, which must probably be treated for some time (*von Hacker*).

In tumors of the œsophagus which are not too large and are well circumscribed, the **œsophagus may be resected** (*Czerny*), *i.e. transversely divided above and below the tumor;* if the removed portion is not too large, the two ends can be united by suture, else the operator attempts to bring the lower end by strong traction into approximation with the upper end; but if this does not succeed, he must suture the lower end into the wound of the skin and thus form an *artificial mouth* (lip-shaped fistula).

In tumors which are entirely inoperable, *gastrostomy* (see page 680) is indicated as a palliative operation.

can be extirpated. From an external incision extending as far as the clavicle (jugulum), the pouch is exposed, separated — in part, bluntly; in part, with the knife — from the surrounding tissues, and cut off where it is attached to the œsophageal tube. While this is being done, sutures, placed very closely together, are inserted through the mucous membrane of the œsophagus and tied after the removal of the pouch. Likewise, the connective tissue overlying this row of stitches is sutured separately. A firm tampon is applied upon the œsophageal wound. Likewise, the remaining skin wound, which is only in part sutured, is tamponed for about six days (*von Bergmann*).

Kocher obtained primary healing of the œsophageal wound by applying a double ligature at the neck of the diverticulum before amputation; he divided the pedicle with the thermo-cautery, and then cauterized the mucous membrane thoroughly. The stump of the mucous membrane was covered first by suturing the muscularis and adventitia, and finally sutured to the œsophageal wall in a longitudinal direction.

Œsophagoplasty (*von Hacker, Hochenegg*), after extensive resection, is intended to supply by skin flaps the defects which have been caused. By inverting two lateral flaps, first the posterior wall is formed; after it has healed firmly, the anterior wall is formed by a flap with the skin side turned inward; the raw surface of this flap is covered by sliding a lateral cervical flap.

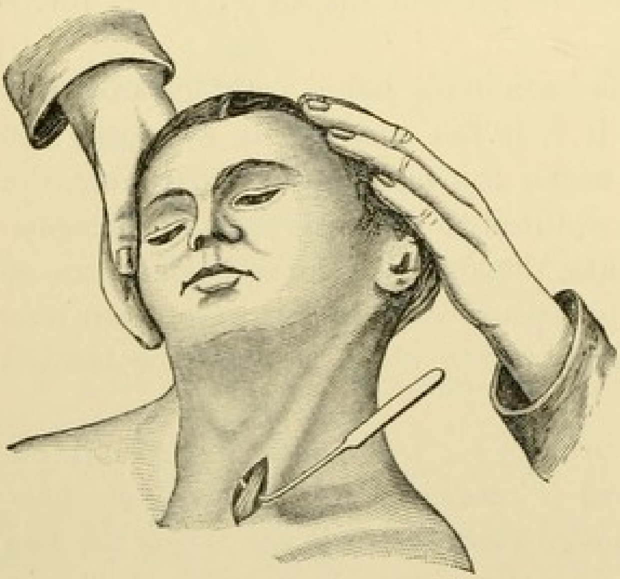


FIG. 1229. TENOTOMY OF THE STERNOCLEIDOMASTOID

TENOTOMY OF THE STERNOCLEIDOMASTOID

in congenital wryneck (torticollis, caput obstipum) under the protection of asepsis is *no longer made subcutaneously* (*Stromeyer*), but openly by *exposing* the parts which must be divided (*von Volkmann*).

The head is drawn toward the healthy side, so that the fibres of the clavicular and sternal insertions of the sternocleidomastoid are stretched forcibly.

1. *External incision*, 1 to 2 centimeters long, extending over the prominent band, about a finger's breadth above the clavicle, first, along the insertion of the *sternomastoid*, until the muscle, often degenerated to a white shining tendon, appears to view. After it has been grasped with a tenaculum (Fig. 1229), it is lifted out and divided upon the instrument (*external jugular vein!*).

2. If the *cleidomastoid* causes tension, it is divided in the same manner, if possible, through the same skin wound.

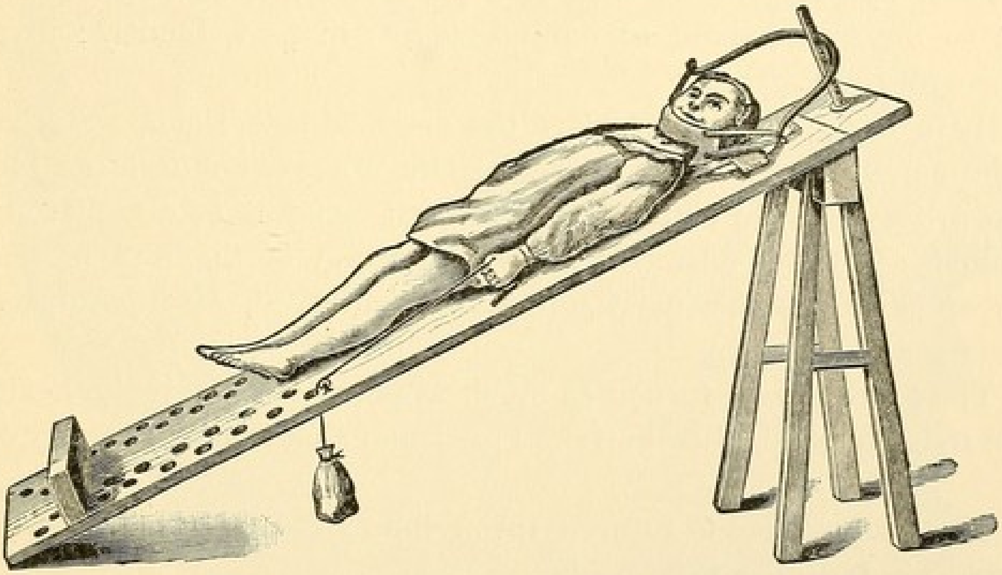


FIG. 1230. STROMEYER'S OBLIQUE BED

3. The little wound is sutured completely. After the operation, the patient is placed upon an extension bed; his head is drawn upward by a weight, fastened by means of a support to the chin and the neck (Glisson's sling), while the weight of the body itself makes the necessary counter extension, the bed being placed in an inclined position. Afterward, the patient is placed upon *this oblique bed* for the greater part of the day (*Stromeyer*, Fig. 1230); his head is kept in position by *Glisson's* sling, and is turned toward the diseased side by an oblique position of the curved crop piece. The extension of the muscle may be still further increased by having the arm of the diseased side extended by means of a weight and pulley.

Since the cicatrix lying between the muscular ends and the connective tissue surrounding the muscle always tend to retract, *Miculicz* in serious cases made the

EXTIRPATION OF THE STERNOCLEIDOMASTOID (*Miculicz*, 1891)

1. External incision, 3 to 4 centimeters long, between the two heads of the muscle; division of the platysma.

2. By retraction of the margins of the wound, both tendons are separated, one after the other, undermined, and cut off upon an elevator (internal jugular vein) immediately above their origin, from the clavicle and the sternum.

3. Each end is grasped with forceps, forcibly drawn upward, and enucleated as far as its point of conjunction, — in part, bluntly; in part, by pushing with the knife.

4. By inclining the head toward the diseased side, the operator succeeds, from the small skin wound, in freeing the diseased muscle as far as the mastoid process, and in cutting it off with the scissors as closely to the same as possible. But the posterior superior portion of the muscle, perforated by the spinal accessory nerve, must be preserved, else paralysis of the trapezius muscle ensues.

5. The head is then turned as much as possible toward the healthy side, and the tense fibres of the shortened muscular sheath are carefully dissected out.

6. The little wound is sutured throughout; the mal-position of the head is temporarily but little improved.

This operation is followed by a marked disfiguration in the external form of the neck, because the prominence given on that side by the sternocleidomastoid has been removed; but the time of treatment is shorter and the correction of the deviation permanent.

OPERATION FOR CERVICAL TUMORS

Encysted tumors of the neck (deep *atheromatous cysts*) lying upon the vascular sheath, as a rule, require no extirpation, since they can nearly always be obliterated by *puncturing with subsequent injections of iodine;* it is necessary, however, to irrigate the sac of the cyst with boracic solutions through the canula of the trocar, until the irrigating fluid flows out clear; not until then should the injection of *Lugol's* solution be made (see hydrocele testis).

(The removal of diseased cysts by enucleation is a comparatively easy and safe operation, and can always be relied upon in effecting a permanent cure.)

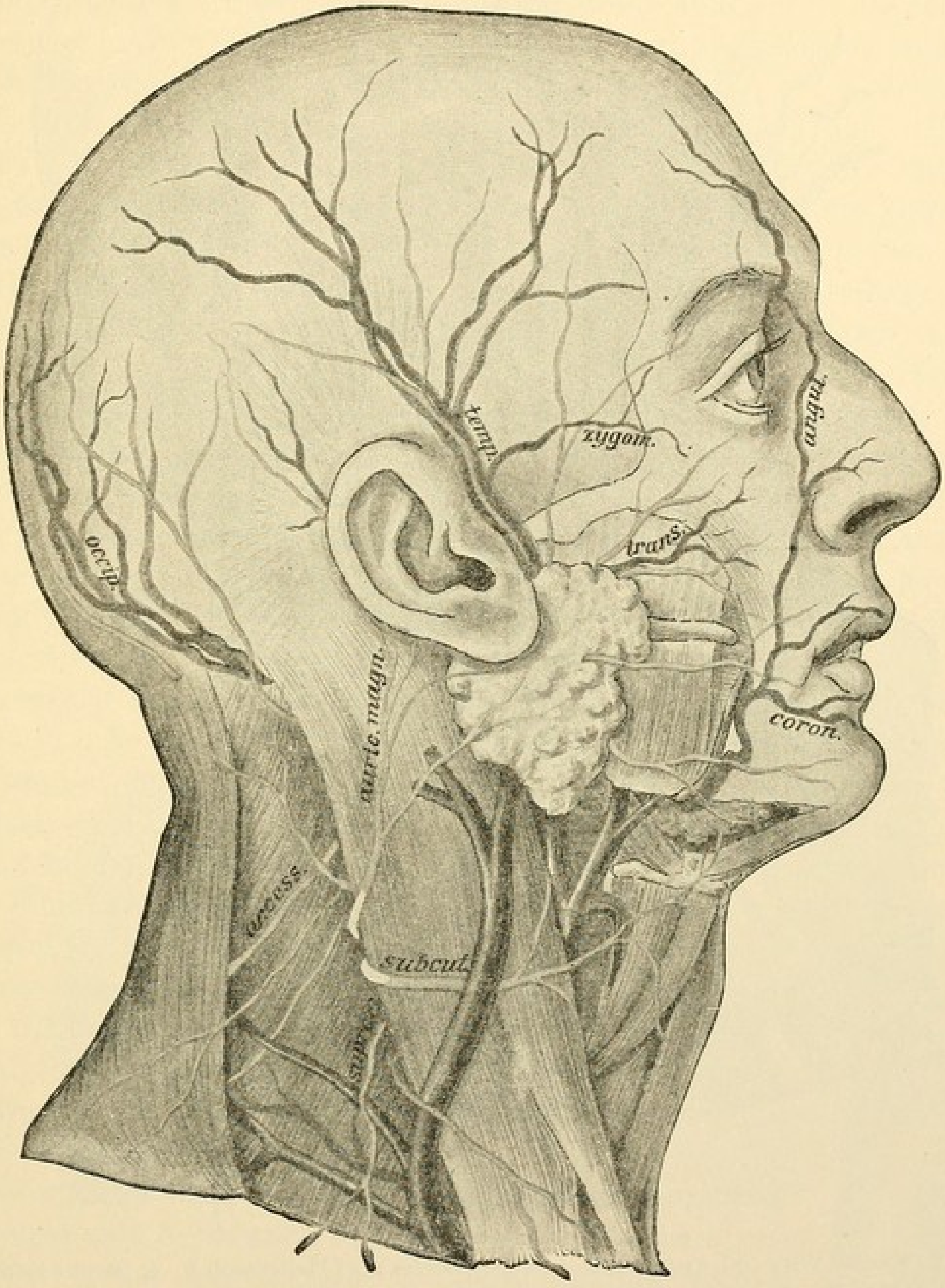


FIG. 1231. TOPOGRAPHY OF THE REGION OF THE HEAD AND NECK (Superficial Layer). *temp.* A. and V. temporalis with N. auriculotempor; *zygom.* A. zygomatica; *trans.* A. transversa faciei; *coron.* A. coronaria from A. maxillaris ext.; *angul.* A. angularis; *occip.* A. and V. occipitalis major; *access.* N. accessorius Willisii; at its side supraclavicular nerves; N. auricularis magnus; N. subcutaneus colli med.

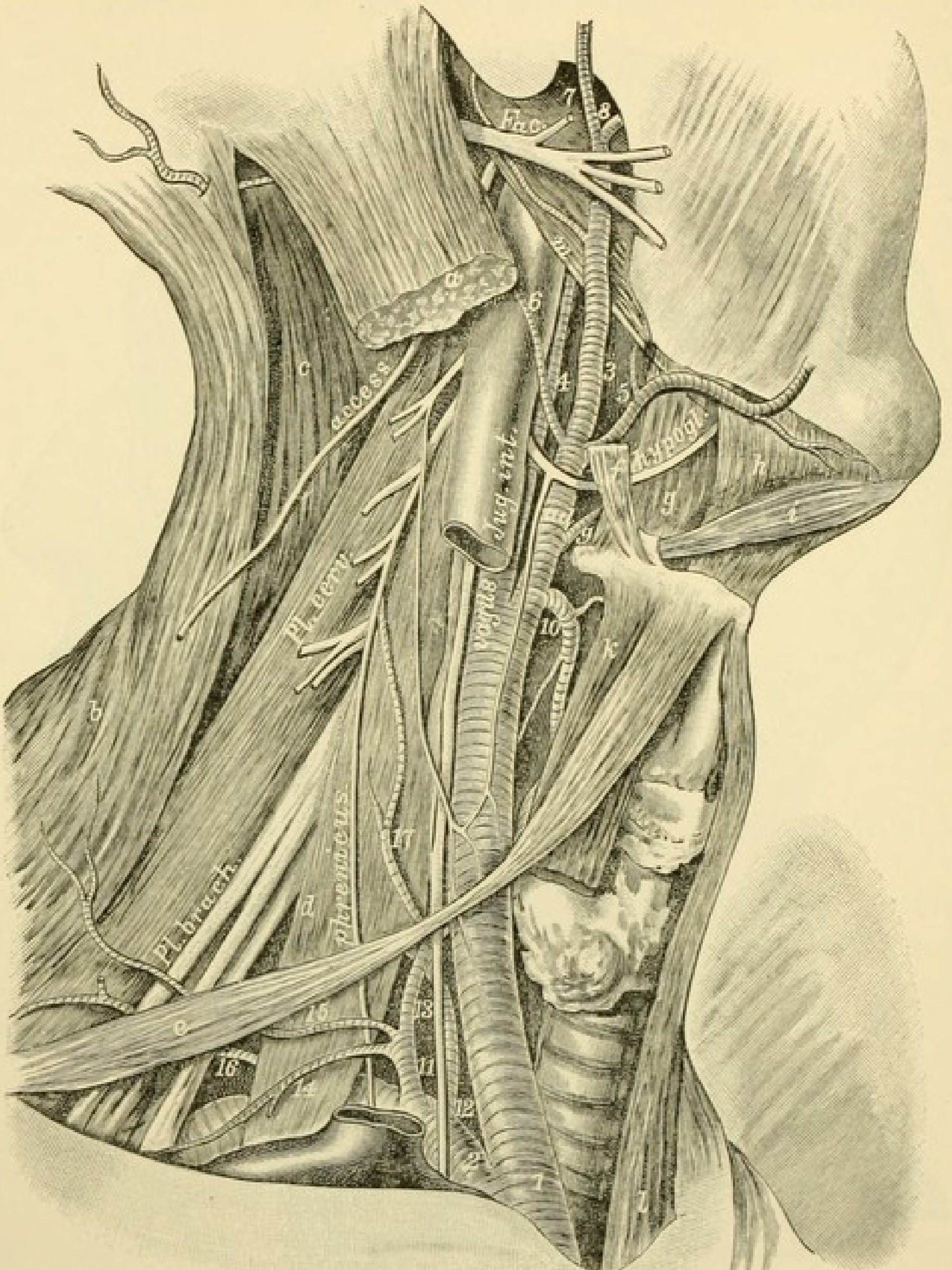


FIG. 1232. TOPOGRAPHY OF THE NECK (Deeper Layer). (Heitzmann.) 1, carotis communis; 2, art. subclavia; 3, carotis externa; 4, carotis interna; 5, A. maxillaris ext.; 6, art. occipitalis; 7, A. temporalis; 8, A. maxillaris interna; 9, A. lingualis; 10, A. thyreoidea sup.; 11, truncus thyreo-cervic; 12, A. vertebralis; 13, A. thyreoidea inf.; 14, A. transversa scapulæ; 15, A. cervicalis superfic.; 16, A. transversa colli; 17, A. cervicalis ascend.; *ad*, Ram. descend. nervi hypoglossi; *a*, M. sternocleiodomasteus; *b*, M. cucullaris; *c*, M. splenius capitis; *d*, M. scalenus ant.; *e*, M. omohyoideus; *f*, M. stylohyoideus; *g*, M. hyoglossus; *h*, M. mylohyoideus; *i*, M. biventer; *k*, M. sternothyreoideus; *l*, M. sternohyoideus; *m*, M. stylopharyngeus

Extirpation of solid tumors is an operation not attended by any special difficulties, if they are *well encysted* and *not firmly* attached to the surrounding tissues. After the capsule has been exposed, they can be enucleated with the fingers or blunt instruments (*Kocher's director, or Cooper's scissors closed*) with ease, and without any considerable hemorrhage. But the operation may become *extremely difficult* when the tumors are intimately connected with the surrounding tissues, more especially with the large blood vessels (jugular vein and carotid artery). *Injury to the veins* is then always the principal danger, partly on account of the violent hemorrhage, partly on account of the possibility *of air entering the veins*, an accident that may cause instant death by air embolism and cardiac insufficiency. Often an accidental nicking of the veins cannot be avoided, for, unless a vein is filled with blood, it cannot with certainty be distinguished from a band of cellular tissue; hence, *the incisions should always be directed toward the tumor*, and when the edge of the knife is in the neighborhood of the larger blood vessels (the relative position of which in large tumors may have been materially changed), it is advisable frequently to discontinue the pressure and traction upon the tumor and to allow the veins to become filled with blood, which makes them discernible. In spite of all precautionary measures, sometimes a large vein is injured; the operator, believing that he is dividing a band of cellular tissue, may in reality cut off a portion of the jugular vein itself, or a lateral branch inosculating with the same, and make a round opening in the wall of the vessel. In such a case, the wound suddenly becomes inundated with a flood of dark blood; if air enters the vessel (in case the patient is in the act of inspiring), a *hissing noise* is heard, and with the next expiration, the blood, rushing from the central part of the vein, is frothy.

Only the *immediate application of the finger* upon the vein wound or upon the vein on the proximal side of the wound can avert the threatened danger.

The attempt must be made to grasp the injured wall of the vein with hemostatic forceps, and to close the opening, if it is not too large, by a lateral ligature with a fine, strong, silk ligature (*lateral ligature*, Fig. 1233); otherwise, if the opening is too large, the vein is separated entirely from its surrounding tissue and ligated above and below the place of injury.

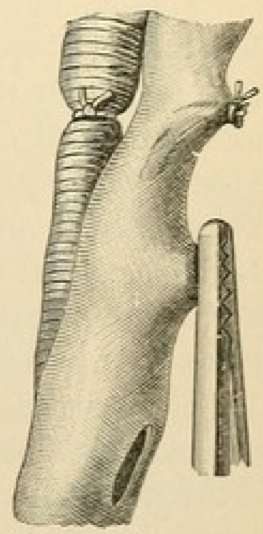


Fig. 1233. Lateral Ligature of Vein

(Such wounds of a vein have occasionally been closed successfully with the continuous suture.)

The accidental nicking of the artery can be avoided more easily on account of its thicker walls. If, however, the carotid passes through the tumor, or is firmly adherent to it, the portion of the artery involved must be included in a double ligature and resected with the tumor. Injury and ligature of the *pneumogastric nerve*, which lies behind and between the artery and the vein, must be carefully avoided as far as possible. (Figures 1231 and 1232 may serve to illustrate the topography of the region of the neck.)

Suppurating lymphomata softened by caseous degeneration can be cleanly enucleated from the surrounding tissues only in rare cases, because any injury to their capsule (which is often very thin) causes the contents to flow out and the tumor to collapse and lose its tension. In such a case the surgeon should incise them and scoop them out thoroughly with the sharp spoon. The pockets thus produced are dilated with dilating forceps, and smoothed. In the *technique of making the incisions*, the following rules may be observed: In dissecting out, the edge of the knife *should always be directed toward the tumor*, and the incisions should be made almost perpendicularly upon the capsule. Each vessel, as it becomes visible, is ligated doubly before its division. By traction on the portion to be removed, wherever it is possible, the operator should try to create *an emphysema of the cellular tissue*, which makes the limit of the healthy and the diseased tissue most easily discernible. In this case the surgeon can advance more rapidly with the handle than with the edge of the knife.

Finally, never dissect "in the dark." If the tissues are flooded with blood, the blood must be removed by quick *sponging* before the surgeon proceeds with the operation. If the enucleation does not succeed well in one place and causes difficulties, the surgeon should try some other place. Hence, *never persist too long in one certain place*, but proceeding first in one place, then in another, as occasion demands, detach the tumor from its base. If muscles that cannot be drawn aside are in the way, they may be divided and subsequently reunited by sutures; diseased portions of the same must be excised unhesitatingly.

The wound, which is sometimes very extensive, can, as a rule, be completely closed *by suturing* after all the tumors have been thoroughly extirpated. In the most dependent part of the wound cavity a drainage tube is inserted. If suppuration existed, the cavity of the wound *is tamponed* and subsequently closed by secondary sutures.

(In cases in which the glands of the neck are extensively involved, the S-shaped external incision recommended by the editor a number of years ago exposes the field of operation most satisfactorily, and leaves the slightest disfiguration from the resulting scar.)

Since the cicatrices resulting from extensive extirpations of the glands swell more and more in the course of time, and cause a very great disfiguration, *Dollinger*, for cosmetic reasons, makes **subcutaneous extirpation** by a skin incision extending from a level with the external auditory meatus along the limit of the hairy scalp, and 1 centimeter distant from it to the occiput. From here he succeeds in lifting out bluntly, not only the gland situated behind the superior portion of the sternocleidomastoid and behind the maxillary angle, after the skin has been undermined and elevated with the fingers, but also in enucleating in the same manner the glands lying on the vascular sheath and on the clavicle. After the wound of the skin has been sutured, nothing of the extensive radical operation is noticeable on the neck.

OPERATIONS ON THE BREAST

LIGATION OF THE INNOMINATE ARTERY (*Mott*, 1818)

The *trunk of the innominate artery*, 2 centimeters long, lies behind the manubrium sterni in front of the trachea between *the right innominate vein and the left common carotid artery*, close upon the right pleural dome. It is covered by the *left innominate vein* lying transversely over it. Behind the right sternoclavicular articulation it divides into *the subclavian and the right common carotid arteries* (Fig. 1234).

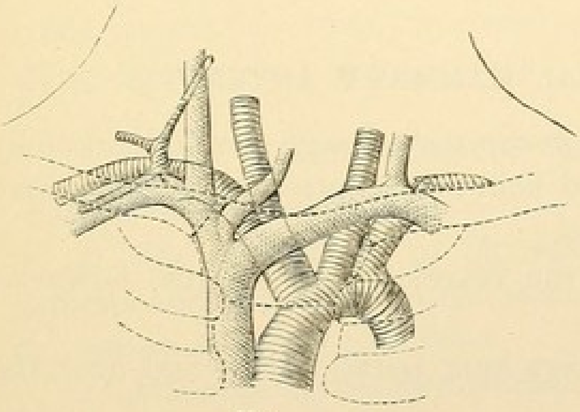


FIG. 1234. RAMIFICATION OF THE LARGE BLOOD VESSELS BEHIND THE STERNUM

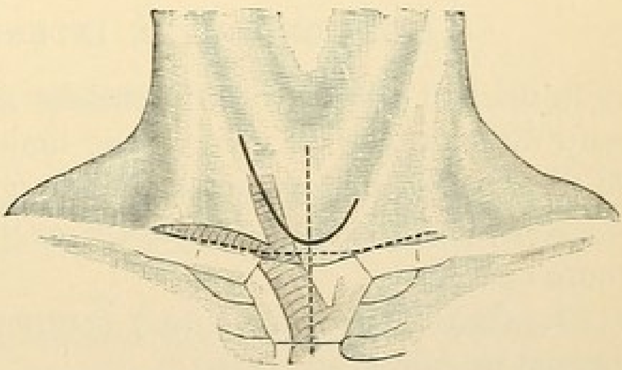


FIG. 1235. EXTERNAL INCISIONS FOR LIGATING INNOMINATE ARTERY
—— Von Langenbeck ---- Bardenheuer

The head is well extended and turned a little *to the left* over the edge of the operating table or a pillow for the neck.

1. Curved *external incision* beginning above the left sternoclavicular articulation and ascending transversely across the upper margin of the

manubrium sterni, along the inner margin of the right sternocleidomastoid (*von Langenbeck*) (Fig. 1235).

2. After division of the *platysma and the superficial cervical fascia*, if necessary, the *right sternohyoid and the sternothyroid muscles* are divided, and the sternal portion of the right sternocleidomastoid muscle is detached from the sternum.

3. Division of *the deep cervical fascia;* the bulbus of the internal jugular vein, with the pneumogastric nerve and the common carotid, are then exposed to light.

4. Whilst the vein and the nerve are carefully drawn *outwardly* with blunt retractors, the carotid is followed centrally as far as the subclavian, and the latter is likewise followed, carefully avoiding the pneumogastric nerve, the recurrent nerve, and the phrenic nerve, as far as the trunk of *the innominate artery*.

5. With the artery hook a strong ligature is passed from below upward (injury to the pleura is thus avoided) around the artery as high as possible (toward the aorta). The ligature is tightened very gradually.

Since access to the innominate artery is very difficult from above, and since, on account of the depth of the wound, the surgeon cannot obtain a sufficient survey, the sternal end of the clavicle can be resected (*von Bergmann*) if it seems necessary, or, according to *Bardenheuer*, the artery may be exposed by **the resection of the manubrium sterni** (see page 653).

LIGATION OF THE INTERNAL MAMMARY ARTERY

in injuries of the same *from gunshot or punctured wounds* can be made only with difficulty, on account of the limited field of operation after the wound in the *intercostal space* has been enlarged.

Resection of a costal cartilage over the vessel wound affords, however, more space.

1. *External incision* 5 to 7 centimeters long parallel with and near the sternal margin (Fig. 1236).

2. After division of the *superficial fascia*, the fibres of the *pectoralis major muscle*, and *the perichondrium* of the exposed rib, a piece about 2 centimeters long is excised from the latter with the knife (or costal scissors) (see also page 655).

3. Perpendicular division of the *external intercostal muscle* (ligamentum coruscans), aponeurotic at this place, and of the fibres of the *internal intercostal muscle* in the two intercostal spaces.

4. Closely below the muscular layer, about 1 centimeter distant from the sternal margin, the artery is found *accompanied by two veins* separated from the pleura by the muscular fasciculi of the *triangularis sterni* muscle (Fig. 1237). It is ligated at its central and its peripheral end (anastomosis with the inferior epigastric artery).

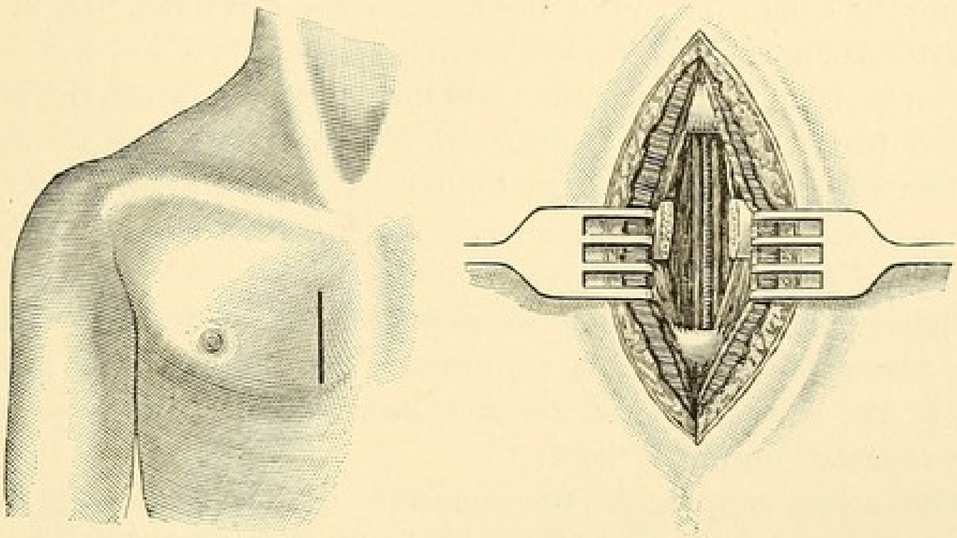


Fig. 1236 Fig. 1237

Ligation of Internal Mammary Artery

a, external incision *b*, wound

Ligation of the artery in its *continuity* in the next upper and lower intercostal space (*Goyrand*) by *transverse incisions* affords less space than the direct ligation and is not so safe.

RESECTION OF THE MANUBRIUM STERNI

may become necessary :—

1. For *the ligation of the innominate artery or vein* (see page 651) in injuries and aneurisms of the same or their nearest branches when the same are firmly adherent to tumors.

2. For *opening the retrosternal space* in order to extirpate tumors of this region (sarcomata, chondromata, struma) and to perform tracheotomy in inoperable retrosternal goitres, or to open abscesses.

3. For *removing the diseased thoracic wall* (tumors, caries).

The size of the portion to be removed must be governed by the cause for which the operation is made; as far as possible, the periosteum should be preserved; in diseases of the thoracic wall itself, it must always be removed with the same.

Bardenheuer makes the resection of the uppermost portion of the sternum in the following manner: —

The head of the patient is forcibly extended and turned to the left.

1. *Crucial incision;* upon a *median incision* about 8 to 10 centimeters long across the jugulum and the manubrium sterni *a transverse incision* is made along the upper margin of the manubrium, the inner half of the right and the articular portion of the left clavicle (Fig. 1235 - - - -).

2. After division of the platysma and the superficial fascia, the periosteum is detached from the anterior surface of the manubrium, beginning at the median line and extending toward both sides. Separation of *the insertion of the sternocleidomastoid*, of the anterior layer of the *deep cervical fascia, of the sternohyoid and the sternothyroid muscles.*

3. Division and *detachment of the periosteum* from *the right clavicle;* the latter *is sawed through* 3 to 4 centimeters from the sternal articulation; likewise, at the same distance, *the first and the second rib;* the same procedure is repeated on *the left side.*

4. With strong bone hooks, the stumps of the clavicle and of the ribs are drawn forward, and from their *posterior surface* the periosteum is detached. Then the hook is inserted into the right margin of the sternum. The latter is strongly drawn forward, and the periosteum is freed *from the posterior surface* of the manubrium.

5. Upon a plate (of zinc) placed under it, *a portion of the manubrium about* 4 *centimeters high is chiselled off transversely* (or divided with a strong pair of costal scissors), and the loose portion of the bone is removed.

6. Cutting through the periosteum and the *deep cervical fascia exactly* in the median line. *The internal jugular vein* is now exposed and is pushed outward with the *pneumogastric nerve* until *the common carotid artery and the subclavian artery* become visible. By protecting the phrenic nerve, the pneumogastric and the recurrent nerves, and by advancing along the subclavian artery as far as its conjunction with the common carotid, the operator reaches the *innominate artery.* In exposing it, the left innominate vein and the middle and left thyroid veins are held to the left; the right innominate vein, to the right; and the two pleural layers, in a downward direction; thereupon the sheath of the artery is dissected free and opened.

This operation can be made also after a preliminary osteoplastic resection; viz., by chiselling through the sternum subcutaneously at the lower extremity of the vertical skin incision and by leaving it *in connection* with the skin covering it; next, the chiselled-off portion of bone is turned in a downward direction. The large wound is tamponed, and subsequently, when the danger of *mediastinitis* has passed (after about eight days), the portion of bone is replaced into its original position.

RESECTION OF THE RIBS

— *the excision of a portion from one or several ribs on account of disease* of the same (caries, necrosis, neoplasms) or for sufficiently *opening the thoracic cavity* — is made in the following manner: —

1. An *incision*, made parallel to the costal axis about 5 to 6 centimeters long and *over the middle of the rib*, divides the skin and the muscles down to the periosteum.

2. With sharp hooks, the divided soft parts are drawn apart. The *periosteum* is incised 2 to 3 centimeters in length in the direction of the skin in-

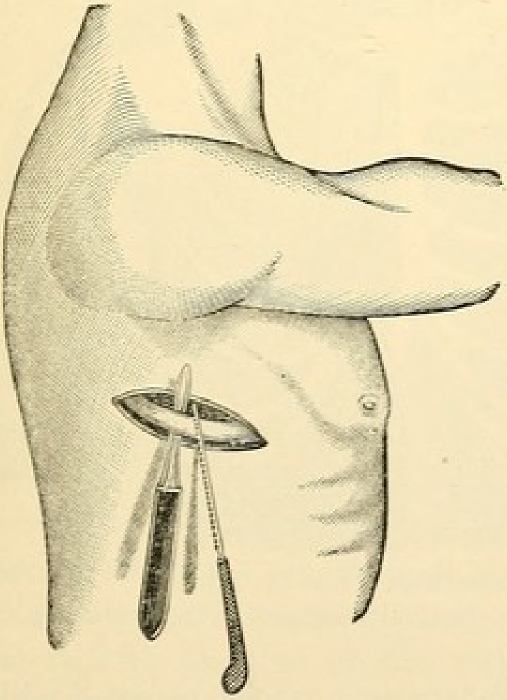


FIG. 1238. RESECTION OF A RIB WITH THE METACARPAL SAW

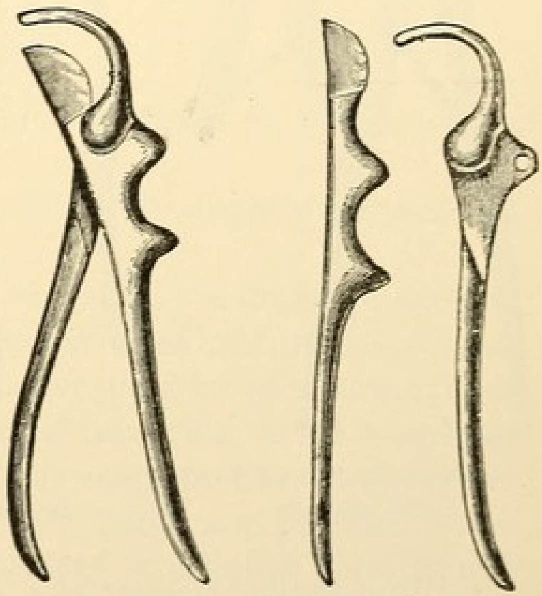


FIG. 1239. GLUCK'S COSTAL SCISSORS (Costotome)

cision. At each end of *the periosteal* incision, a transverse incision (|——|) is made; from one costal margin to the other and then with the raspatory, the periosteum is detached from the external surface of the rib *in two flaps* in an upward and downward direction.

3. Next, with a pointed and curved elevator, from *the lower costal margin* (avoid the *intercostal artery* in the costal groove) the periosteum is likewise carefully detached from the *posterior* costal surface until the point of the

instrument can be forced out at the upper intercostal space between the periosteum and the rib.

4. The periosteum is protected, and a sufficient portion of the rib is resected with a *metacarpal saw* (Fig. 1238), the *costal scissors* (Fig. 1239), or the *American pruning shears* (Fig. 1240).

5. If it is desirable to open the pleural cavity, the posterior wall of the periosteal cylinder, which is now exposed in the depth of the wound, together with the *pleura costalis* attached to it, is *incised* so far that one or two very thick drainage tubes can be inserted into the thoracic cavity (see page 661).

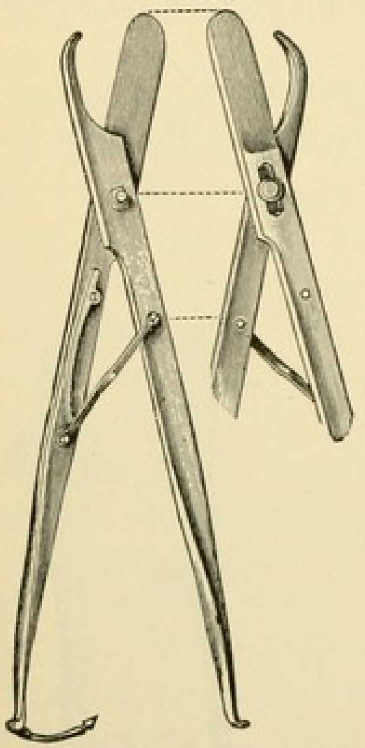


FIG. 1240. AMERICAN PRUNING SHEARS

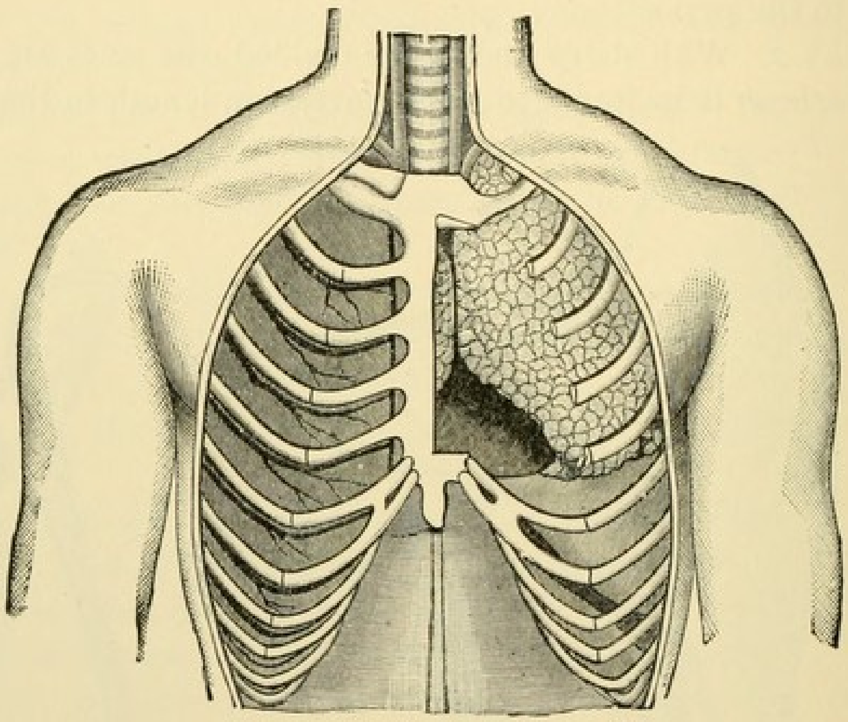


FIG. 1241. ANTERIOR VIEW OF THORAX
Intercostal Artery and Internal Mammary Artery are visible

6. In a similar manner also, *portions of the sternum* can be resected with *Lüer's gouge forceps*, if it seems required for the free drainage of the pleural contents; but the operator must not forget that the *internal mammary artery* lies on both sides of the sternum about 1 centimeter from its margin behind the costal cartilages (Fig. 1241).

If, on account of *disease of the ribs themselves* (tumors, caries), portions of the same must be removed, the operation should not be made *subperiosteally*, as just described, but, according to the extent of the disease, the soft parts surrounding the bone, periosteum, muscles, skin, and even, under some circumstances, portions of the lungs should be removed.

OPENING OF THE THORACIC CAVITY

is made in *exudations of the pleura*, especially when, owing to their *extent* (compression of the lungs and the heart) or their *nature*, they endanger the life of the patient.

First of all, accurate evidence concerning the *extent* of the exudation must be obtained by a careful *physical examination* (dulness or diminished resonance, weakened vocal fremitus, absence of respiratory murmur) and by *exploratory puncture* with a sterilized *Pravaz's* syringe.

In case the operator finds only *serum or blood*, the exudation is evacuated by *simple puncture;* if, however, the fluid drawn off by the exploratory puncture is *purulent*, puncture alone is not sufficient; a *permanent drainage* for the escape of pus must be established (see page 661).

THORACOCENTESIS,

the opening of the thoracic cavity by puncture, is made in the following manner: —

The patient lies on the edge of the bed, with thorax slightly elevated and inclined toward the healthy side.

If the exudation were punctured at *its lowest place*, the drainage opening would become obstructed in a short time by the movements of the diaphragm. Hence, it is advisable to select a somewhat higher place for puncturing, most frequently **the fifth intercostal space in the line of the axilla, or the intercostal space between the seventh and eighth ribs in the scapular line** on the back. To reach the intercostal space safely, the soft parts are pressed firmly into it with the tips of two fingers, and a trocar is inserted between the fingers, but not too deeply, in order to avoid injury to the lungs. The puncture should be made close to the *upper* margin of the lower rib, in order not to strike the intercostal artery.

The puncture of the thoracic cavity with a *single* trocar is a technical error; for, even if in the beginning a continuous drainage is effected by positive intrathoracic pressure caused by the exudation, nevertheless, after equalization of the unbalanced pressure in the pleural cavity, air would be aspirated with every deep inspiration (cough) (*hydropneumothorax*).

Hence, *this suction of air* must be prevented by suitable measures.

The simplest procedure is the formation of *a valvelike closure* of the external opening of the canula by using a thin flaccid membrane, which at each inspiration closes the canula, but which does not prevent the escape of fluid during expiration. *Billroth* used a piece of thin intestine of a calf; *Reybard* and others recommended pushing the trocar through a thin membrane of caoutchouc (condom) and fastening this to the shield of the canula so that it lies like a curtain in front of the opening, and with each inspiration is firmly pressed against it. The procedure is simple and reliable (Fig. 1244).

The puncture can also be made with a *trocar* supplied *with a stop-cock* (Figs. 1242, 1243).

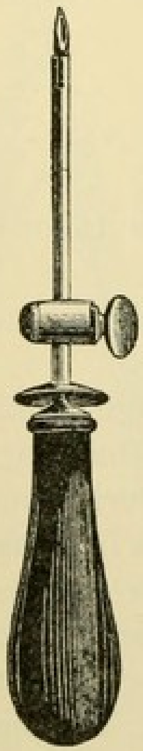


FIG. 1242
KUSSMAUL'S TROCAR

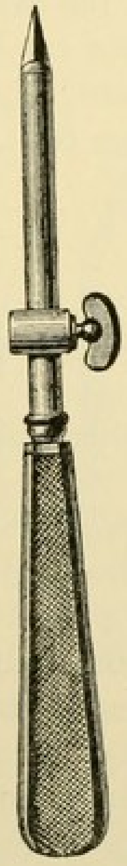


FIG. 1243
WITH STOP-COCK

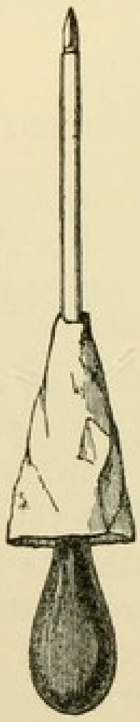


FIG. 1244
REYBARD'S TROCAR

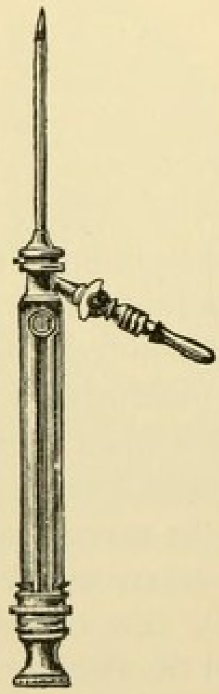


FIG. 1245
FRÄNTZEL'S TROCAR

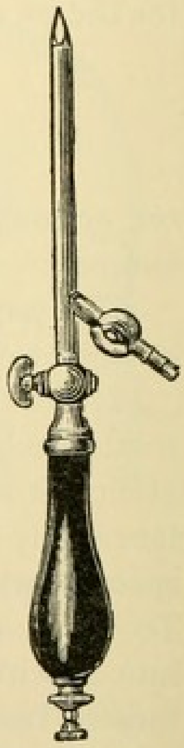


FIG. 1246. BILLROTH'S TROCAR

After insertion of the trocar, the stylet is withdrawn behind the stop-cock; the latter is then closed; the stylet is removed, and over the end of the canula is attached a short rubber tube which extends to a vessel on the floor, filled with antiseptic solution (*Biermer*). When the stop-cock is opened, the fluid drains off until the difference of pressure has been equalized; if negative pressure is produced through coughing, etc., a part of the fluid already drained is aspirated again, because the end of the tube is in the fluid.

PUNCTURE WITH ASPIRATION

Since in simple puncture only so much is drained off as the pressure, existing in the pleural cavity, permits (which is sometimes very slight), it is advisable to connect with the canula a *siphon or an aspirator*, by which as much of the fluid is evacuated as is deemed desirable. In this procedure, it is to be borne in mind that congestion of the lungs and of the pleura, cough, and even fainting easily occur from a too free aspiration and the consequent fluctuation of pressure in the thoracic cavity.

Hence, it is advisable *never to evacuate the fluid completely at one sitting*, but to interrupt the flow for a time. If the fluid shows a bloody tinge, the operation should be discontinued at once. For after the evacuation of even a small quantity, a resorption of the remainder of the serous transudation sometimes takes place. *Fräntzel* advises removing, even in very large transudations, *not more than* 1500 *cubic centimeters* at one sitting.

For *puncture with aspiration*, various kinds of apparatus have been invented. The operation is performed in a most satisfactory manner with *Fräntzel's trocar* (Fig. 1245) and *Potain's* or *Dieulafoy's aspirator* (Figs. 1247, 1248).

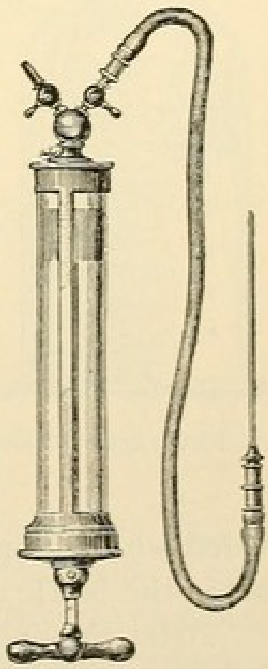


Fig. 1247. Dieulafoy's Aspirator

The *stylet of Fräntzel's trocar* (Fig. 1245) can be withdrawn in an *air-tight* manner by means of a button attached to the handle, while the fluid is drained off through the canula attached laterally and provided with a stop-cock. If an obstruction of the canula occurs from fibrinous masses during aspiration, a simple insertion of the stylet suffices to remove mechanically this otherwise very annoying occurrence. The little canula attached laterally is connected with the aspiration bottle by a rubber tube. In the latter, the air can be rarefied by the exhausting pump; by this means, the fluid is aspirated into the bottle after opening the stop-cock in the canula.

If the simpler *aspiration needles* (Figs. 1247, 1248), similar to the needle canulas of a *Pravaz* syringe, are used instead of this trocar, the flow may be suddenly stopped by obstruction from a small particle of fibrin; in such a case, nothing else can be done than to withdraw the needle and to insert it in another place, — a procedure that is perfectly justifiable on account of the trifling operation, however unpleasant it may be for the surgeon and his assistants.

Fürbinger simplified the various kinds of aspiration apparatus by using for aspiration of the fluid a simple bottle, closed air-tight with a cork. Two glass tubes pass through the cork, one reaching through the antiseptic fluid at the bottom, the other ending just below the cork (syringe-bottle). The longer glass tube is connected by a rubber tube with the instrument for puncture. By means of a second tube fastened to the shorter tube and pro-

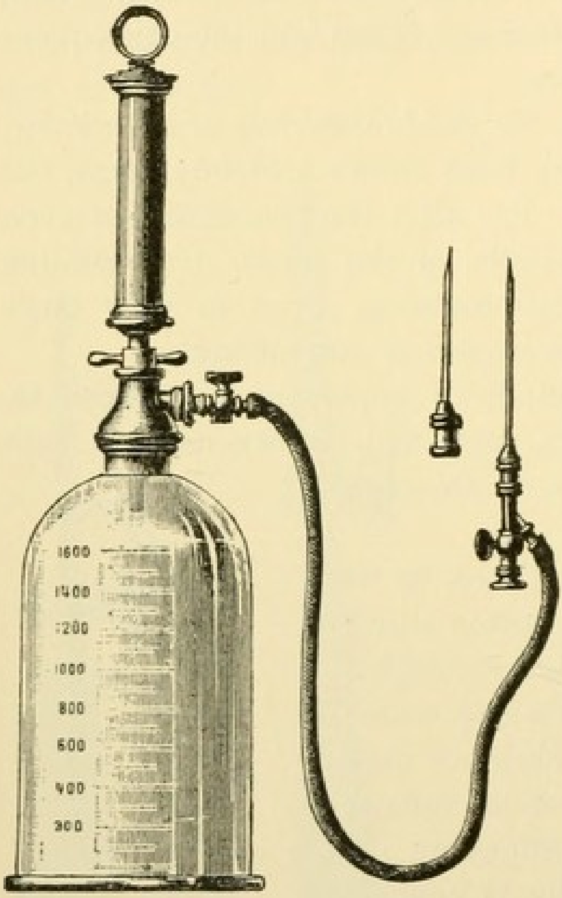


FIG. 1248. POTAIN'S ASPIRATOR

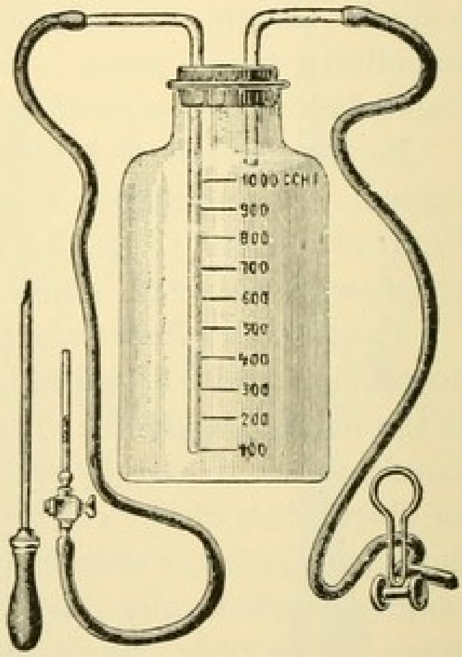


FIG. 1249. FÜRBINGER'S ASPIRATOR

vided with a stop-cock (so that it can be opened and closed at pleasure), the air in the bottle can be rarefied by aspiration with the mouth.

After the operation has been completed, the little puncture is sealed with iodoform collodion, and a light compressive bandage is applied.

PUNCTURE WITH PERMANENT ASPIRATION (*Quincke, Bülau*)

is used with very good success, especially in the young, in many forms of *empyema* (Fig. 1250).

A strong trocar (*a*) is inserted, preferably in the axillary line (if possible, at the lowest point of the empyema). The stylet is withdrawn, and a tight-fitting rubber tube (*b*) (Nélaton catheter) is inserted through the lumen of the canula; over this the canula is then withdrawn so that the rubber tube alone remains in position in the thoracic wall. It is securely fastened to the thoracic wall with collodion, and connected by means of a short glass tube (*c*), provided with a longer thin rubber tube (*d*), the end of which extends into a bottle (*e*) filled with antiseptic fluid. The degree of aspiration of this siphon apparatus can be controlled at pleasure by lowering or elevating the bottle; the flow of pus may be observed through the interposed glass tube. If the aspiration bottle is full, the rubber tube is compressed, while the bottle is cleansed or changed. In this manner, the evacuation of an empyema is made very slowly, while at the same time the lung, relieved from its pressure, can expand gradually. Under some circumstances, the patient may walk about, carrying the bottle in his pocket.

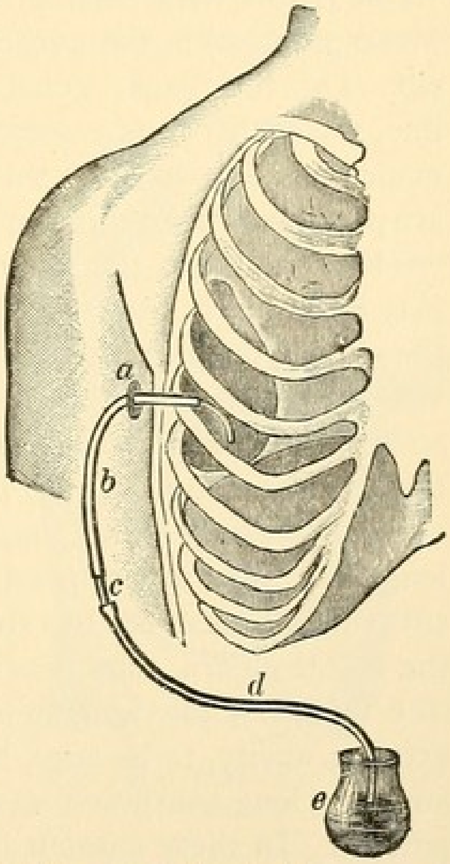


FIG. 1250. BÜLAU'S PERMANENT ASPIRATOR

THORACOTOMY

The opening of the thoracic cavity by incision must be made in all *purulent or septic exudations* to establish a permanent and sufficient drainage for the free escape of pus.

Empyema is treated in the same manner as any other abscess; viz., *by free incision and drainage*. Since the operation is concerned with a suppurating cavity whose walls are in some places rigid, in others have essentially lost their elasticity, it is necessary to preserve the drainage opening until a visible decrease of the empyema by contraction or adhesion of its walls (pleura costalis et pulmonalis) has taken place.

The patient, during this operation, is placed in a half-sitting position, inclined *slightly* toward the healthy side; with a complete lateral position on the healthy side, sudden death may occur during the operation (*Paget*).

The **simple incision** *of the thoracic wall* in an *intercostal space* in most cases is not sufficient, since the wound closes up sooner than the empyema heals; in consequence of this, there remains an obstinate *empyema fistula*. Even *Hippocrates* tried to establish a better drainage by *trephining a rib*. More practical is the *subperiosteal* **resection** of about a finger's length **of a rib**. On the back, generally the seventh to ninth rib, in the axillary line, the fifth rib, is resected (see page 655). Into the wide opening thus made one or two very thick rubber drainage tubes are introduced; these are prevented from slipping into the cavity by safety pins, placed transversely.

For enlarging the opening, from the same incision the next higher rib may be similarly resected by making forcible traction; the pleura is opened; the soft parts lying between the two longitudinal incisions, and also the blood vessels, can be ligated with two ligatures passed with the aneurism needle; and the pleural incisions can be connected by a perpendicular incision; the opening then gapes in the form of ⌶.

The *healing* of an empyemic cavity drained in this manner varies in length of time, and depends on the fact whether the compressed lung has still enough elasticity to expand and to approximate the pulmonary pleura to the costal pleura, thus producing adhesion. If the disease lasts a long time (for months), the lung generally loses this capacity almost entirely; the existing cavity, to be sure, has a drainage; but it does not decrease in size, and the long-continued dyscrasia consumes the strength and life of the patient. In these cases it is important to make the rigid thoracic wall sufficiently elastic ("to mobilize it surgically") that it can approach more easily the surface of the lung and resume its normal function. *Simon* attempted to obtain this result by resecting *several ribs* over the empyema over a large surface. Subsequently, *Esthlander* (*Homén*) devised his **thoracoplasty** on the same principle; he *diminished* the resistance of the diseased portion of the thorax wall *by resecting* in the axillary line (where the overlying soft parts are thinnest) *five to seven ribs to an extent of* 3 *to* 12 *centimeters, thus making an oval excision lengthwise in the solid framework of the thorax*. For this purpose, a *large vertical incision* is made over the affected side of the chest; the soft parts are dissected back from the ribs, and the latter are resected *subperiosteally*. After making a free incision of the pleura, a sufficient survey concerning the extent of the empyema and the condition of the lung is obtained. During the healing process the ends of the ribs approach each other, and at the same time are drawn in the direction of the abscess cavity.

In cases of very long-standing empyema, *Schede* proceeded boldly and with the best success *by applying the thoracic wall, deprived of the unyielding* *parts*, and thus rendered flaccid, *directly upon the collapsed lung*, and thus effected healing of the same. From the thoracic wall he formed *a large flap with an upper base* (Fig. 1251). The incision begins above the anterior margin of the pectoralis major on a level with the axilla, descends in form of a curve as far as the inferior limit of the pleura, and ascends on the back between the vertebral column and the scapula as far as the second rib. The flap, containing all the soft parts, together with the scapula, is dissected back in an upward direction. Next, *all the ribs* from the second downward *are resected from their epiphysis to the tubercle of the ribs*. *A wide incision of the costal pleura* in the whole extent of the wound affords *a free inspection of the cavity of the pleura*. The entire remaining portion of the thoracic wall (intercostal muscles, thickened pleura) is removed with a pair of strong scissors and bone-cutting forceps; the costal arteries, previously compressed by two fingers, are divided and ligated. After the pulmonary pleura has been cleansed, and all granulations and fibrinous deposits have been removed with a *large sharp spoon*, the skin flap is placed in position over the lungs, and fastened in this position by a compressive bandage. *The healing* of the large wound in most cases takes place by primary intention; the remittent fever previously present ceases at once.

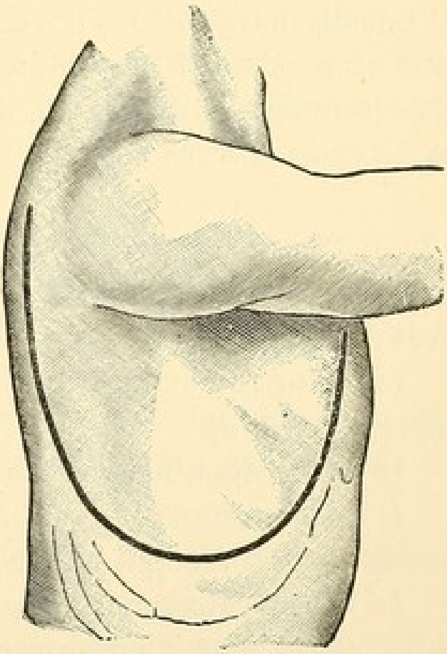


FIG. 1251. SCHEDE'S THORACOPLASTY

In the after treatment of empyema, it was formerly the custom to cleanse the cavity daily by thorough irrigations, etc. *Roser* even rolled the patient like a barrel to and fro in order to bring all parts of the cavity in contact with the antiseptic fluid.

By these frequent irrigations, however, the healing (adhesion between the two pleural layers) is at least *delayed*, because the recent delicate tender adhesions are mechanically torn apart. Even sudden death has occurred during the irrigations. Hence, it is better to leave the interior of the cavity undisturbed, and *to irrigate it only once* (during the operation), but *thoroughly*, with a non-toxic antiseptic solution.

Afterward, it is sufficient to renew the saturated dressings, to take out the drainage tubes, and to cleanse them from stagnant coagula; otherwise, the cavity of the wound is left alone (unless some additional putrefactive process demands a renewed disinfection).

(In ordinary empyema, operated upon by the radical method, a primary disinfection does more harm than good except in cases of fœtid empyema. Irrigation with non-toxic antiseptic solution becomes necessary if the amount of pus discharged does not decrease. Thiersch's solution and a saturated solution of acetate of aluminum are best adapted to this purpose. The cavity should never be distended, and the fluid used should be at least heated to blood temperature.)

PNEUMOTOMY,

incision of the lung, has been practised in modern times, frequently with the best success : —

(*a*) For removing tumors, cysts (echinococci), or a tubercular focus (very rarely possible).

(*b*) For opening *abscesses* and larger (sac-shaped) *bronchiectases*.

(*c*) For removing *gangrene*, caused by necrosed tissue (after injuries) or firmly lodged foreign bodies.

(*d*) For causing *tubercular cavities* to heal or to contract — provided the tubercular focus is circumscribed — in a lung otherwise healthy, or nearly so.

Pneumotomy is performed with the thermo-cautery ; an essential condition for the operation is *to secure previous adhesion of the two pleural surfaces* over the place of operation.

After the seat of the disease has been carefully located by a physical examination, and by an exploratory puncture with a *Pravaz* syringe or a capillary trocar, an incision is made over this place in the thoracic wall, and a sufficiently large portion of one or several ribs is resected (see page 239). On account of the uncertainty of the diagnosis, it is often necessary to do this from a large flap incision. Whether adhesions of the pleura exist can never be determined with accuracy ; hence, it is best to suture the pleural layers directly in the opening ; or, after the costal pleura has been successfully exposed, the operator tries to inform himself about the condition of the lung by *extrapleural palpation* (*Tuffier*), or, according to *Quincke*, he operates in two stages by first securing pleural adhesions by cauterization with *paste of zinc chloride*, applied to the floor of the wound which has been made. The operator then penetrates with the red-hot knife point of the thermo-cautery, without any considerable hemorrhage, deep into the pulmonary tissue, until he reaches the focus of the disease ; the abscess cavity is drained through the external wound. Whether a drainage tube is to be inserted, or the wound to be tamponed, depends on the location of the cavity and the character of the secretion. The artificial fistulous canal, after some time, closes of itself, while the patient's expectoration and general condition improve considerably.

In *tubercular cavities*, the walls of which are surrounded by firm indurated tissues, and are hence less liable to contract than simple pulmonary abscesses, it is above all important, aside from cauterization with zinc chloride, to perform rib resection *including the periosteum* in such a manner that the wound can heal by the formation of a yielding and retracted cicatrix (*Quincke*).

Since these cavities most frequently occur in the *apices of the lungs*, and since, in most cases, also firm pleuritic adhesions exist as far as the second intercostal space, they are usually opened *through the first intercostal space*.

Sonnenburg proceeded as follows: —

1. The *external incision* extends at a distance of a thumb's breadth beneath the clavicle from the manubrium sterni to about 4 centimeters in front of the coracoid process.

2. After cutting through *the deep thoracic fascia*, the pectoralis minor muscle becomes visible.

3. After the intercostal space has been exposed *bluntly* with the fingers, the short costal arch of *the first rib* projecting from under the clavicle is resected with the costal scissors; the *intercostal muscles and the pleura* are divided, and the exposed pulmonary tissue *is perforated* with the knife point of the thermo-cautery down to the cavity.

Tubercular cavities seldom offer indications for operative interference (*Sonnenburg*).

In a similar manner, *larger portions of the lung* (tumors) can be removed; whether the resection of *a lobe of the lung* (**resection of the lungs**) or even of *a whole lung* at the hilus is permissible (**extirpation of the lung**) cannot be decided with safety judging from present experience.

Puncture of the pericardium *in the treatment of serous and bloody extravasation* into the pericardium, if respiration and the cardiac function are considerably impaired by its size (*Rose's* heart-tamponade), is made in the same manner as puncture of the pleural cavity, *but only with the aspiration apparatus*.

The trocar is best inserted perpendicularly *in the fourth or the fifth intercostal space*, about 2 centimeters distant from the left sternal margin. The evacuation should be made very *slowly* (syncope!).

(*Dr. J. B. Roberts* of this country has done much to introduce pericardial puncture and aspiration into more general use, and the therapeutic value of these procedures in well-selected cases can no longer be questioned.)

PERICARDIOTOMY

is, however, safer.

The opening of the pericardium by incision in *purulent extravasation* is made by a *transverse incision in the fourth or the fifth intercostal space*, advancing layer by layer. *The internal mammary artery* must be ligated during this operation. For exposing the pericardium to a greater extent, resection of the costal cartilage is advisable, which is performed in the same manner as in the ligation of the internal mammary artery (see page 652). From a similar incision, *Rehn* has successfully sutured a wound of the heart.

OPERATIONS ON THE MAMMARY GLAND

(INCISIO MAMMÆ)

The incision of the mammary gland in abscesses after mastitis sometimes resembles the simple incision of a superficial abscess.

If the pus is seated more deeply, the operation may become more difficult and require anæsthesia.

1. *External incision* must extend in a *radiate direction* from the periphery of the gland toward the region of the nipple, for the purpose of injuring as few of the lacteal ducts as possible, which radiate in a similar manner.

2. After division of the adipose tissue which envelops the gland, — and which in most cases is well developed, — the abscess is opened by inserting the knife; and while the contents escape, the finger is introduced and palpates the inner surface of the cavity, which is often very sinuous; the bands and threads of connective tissue are torn; thus smaller lateral cavities are opened, and all the pockets are reached and widely opened; scraping with the sharp spoon may sometimes be required, and may induce a more rapid healing.

3. After a short time, the *hemorrhage* is arrested by compression; the cavity of the wound is loosely tamponed; if the abscess cavity is large, and in retromammary abscesses, it is advisable, in addition, to make *a counter opening* in the most dependent part of the abscess for more efficient drainage.

EXTIRPATION OF THE MAMMARY GLAND

Benign neoplasms, if not too large, may be excised — that is, *extirpated* — from the mammary gland; but if they have invaded the glandular tissue to a large extent, or if they lie scattered in several places in it, it is better to *remove the whole gland* (**ablatio mammæ**).

The skin is divided by two oblique curved incisions extending from above outward to below and inward, with the nipple between them. First the *lower incision is made*, and the margin of the pectoralis major is exposed; next, the *upper incision* is made, and the skin is detached as far as the upper limit of the gland. The organ, circumscribed with the knife on all sides, is then grasped with the hand, and detached as bluntly as possible from its base (muscular fascia) by traction and by using the handle of the knife; thereby the hemorrhage is rendered less severe than by using the knife too freely.

Breasts which are much hypertrophied or which are infiltrated by a number of benign tumors are reduced in size or can be made to disappear by **a temporary detachment**. They are circumscribed with the knife along the border of half their circumference, and detached from underlying tissues. If they are turned back into their former position after the hemorrhage has been arrested, the cicatricial tissue which forms and the thrombosis of the blood vessels induced result in a diminution of the blood supply.

If, however, from the appearance and the course of the disease, there is a suspicion that the tumor is malignant, not only the whole mamma must be *excised*, but also *the axilla must be cleared out*, **even in the event that no diseased glands can be detected by palpation through the intact skin**.

AMPUTATION OF THE BREAST WITH CLEARING OUT OF THE AXILLA

for *malignant disease* (carcinoma, sarcoma) is made in the following manner: —

1. The skin is incised as described above (page 666) by two curved incisions, leaving between them, not only the nipple, but also any portion of the tumor adhering to the skin. *The lower elliptical incision* is made first; it penetrates at once down to the pectoralis major muscle.

2. From this incision, the operator *enucleates* the gland from below, (*without* distorting or contusing it), **together with the muscular fascia**, *from the pectoralis major muscle* as far as its upper limit by incisions parallel with the muscular fibres.

3. Then the *superior curved incision* is made through the skin, and likewise extended down to the muscle; the mammary gland, then detached, adheres only to the adipose tissue (or to *the lobuli aberrantes* extending into the axilla) in the upper and outer angle of the wound, and is **not** detached

at this place. The *hemorrhage*, which is rarely very profuse in amputation of the mammary gland, takes place from branches of the *long thoracic artery, the external and internal mammary arteries, and the intercostal arteries.* It is temporarily arrested by compression with a large sponge or by sterilized gauze tampons.

The pectoralis major muscle is very carefully palpated for any diseased portions; if even the slightest suspicion is aroused, the portion is excised by carrying the incisions through healthy tissue, and the diseased fibres are extirpated in their entire length; if necessary, the whole muscle is removed — viz., from its insertion to its origin; likewise, the pectoralis minor muscle must sometimes be transversely divided or entirely removed to facilitate the extirpation of diseased glands (*Halsted, Meyer*).

(*Haidenhein*, from his investigations, has shown the necessity of liberal excision in all radical operations for carcinoma of the breast, as well as the channels through which infection is most likely to take place. *Halsted* has applied his teachings in practice, and does not hesitate in extirpating both pectoral muscles in attempts to reach beyond the limits of the disease.)

4. *From the upper angle of the wound, the skin incision is made in a slight curve* between the margins of the pectoralis major and the latissimus dorsi muscles *into the axilla* (Fig. 1252).

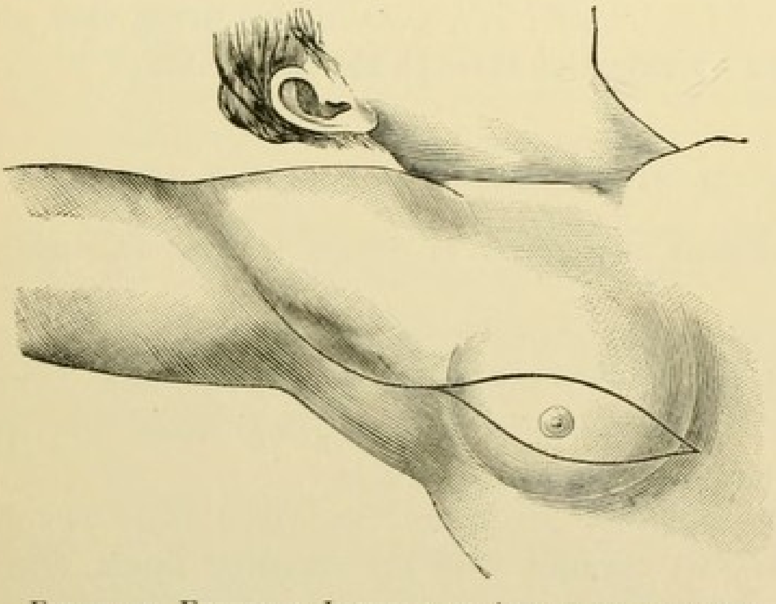


FIG. 1252. EXTERNAL INCISION IN AMPUTATION OF THE BREAST AND CLEARING OUT THE AXILLA

(*Dr. E. J. Senn* has devised an incision above the border of the pectoralis major muscle through which the axillary space can be easily reached, and which offers decided advantages in the prevention of wound infections, as it is made outside of the axillary space, a region very difficult to disinfect.)

5. After division of the axillary fascia and exposure of the margins of the two muscles, the operator advances along the lateral thoracic wall upon the serratus magnus muscle toward the axilla. **All adipose and connective tissue, together with the lymphatic**

glands and lymphatic vessels contained therein, *are removed in a connected piece, partly in a blunt manner, partly with the knife.* Special precaution is required when the operator approaches the external wall of the axilla, formed by the head of the humerus and the large vessels passing over it. The axillary artery lies behind the large nerve trunks, which furnish a certain degree of protection. *The large axillary vein*, which is most superficial of all the important axillary contents, is most frequently injured; very often the surrounding cellular tissue and the embedded glands are *adherent* to its walls. With forceps and grooved director, the vein wall

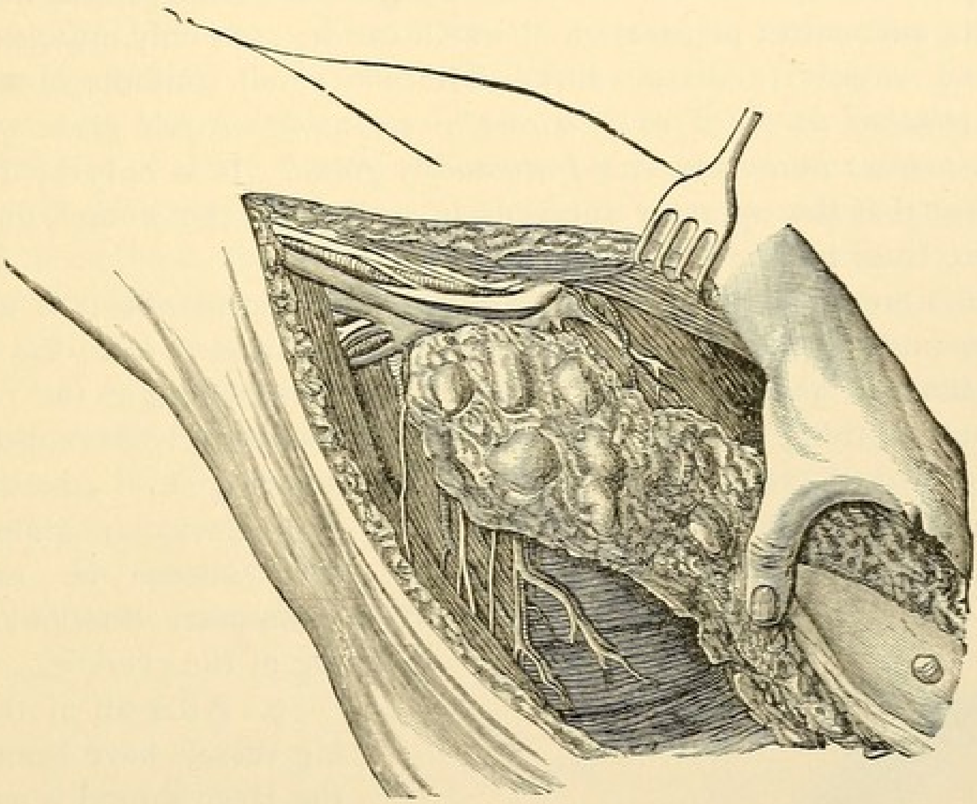


FIG. 1253. CLEARING OUT THE AXILLA

is carefully separated in preference by blunt dissection; should it be nicked, a *lateral ligature* is applied. If diseased portions must be excised from its wall, the opening caused by it is sutured longitudinally with the continuous suture. The pectoralis major must be forcibly drawn upward with blunt retractors; the arm must not be raised too much, but must be kept rather in a horizontal position to the trunk, for lessening tension of the muscles. Likewise, care must be taken not to render the vein bloodless by too forcible traction on the tissue to be removed, else it cannot be distinguished from the bands of cellular tissue.

6. As soon as the outer axillary wall has been exposed, and as soon as, *at the posterior wall*, the subscapular bundle of blood vessels lying deep upon *the subscapularis muscle*, and *the subscapular nerve* lying toward the median line, appear to view, the operator dissects bluntly along the latter in a downward direction, and thus reaches the nerve of *the latissimus dorsi muscle.* If possible, these nerves are all preserved (*Küster*). Not until then should the clearing out of the space be completed; *the intercostohumeral nerve,* coursing from the thoracic wall to the axilla, is divided from the second intercostal nerve passing to the internal cutaneous nerve of the arm (Fig. 1253).

7. After the operation is completed, **the axilla should present the appearance of an anatomical preparation** in which can be seen only muscles, nerves, and blood vessels (axillary vein). The extirpated contents of the axilla *remain attached in the form of a continuous wedge-shaped mass of adipose connective tissue to the enucleated mammary gland.* It is only by following this course that the operator succeeds in protecting the wound, during the operation, from traumatic cancerous infection.

8. In a more extensive disease of the lymphatic glands, it is necessary to expose and remove the glands extending like a rosary from the axilla to *the subclavicular space* and into the same, by drawing either the pectoralis major muscle strongly upward, or by dividing it transversely and subsequently suturing it. Likewise, the supraclavicular glands must then always be extirpated (temporary division by sawing of the clavicle).

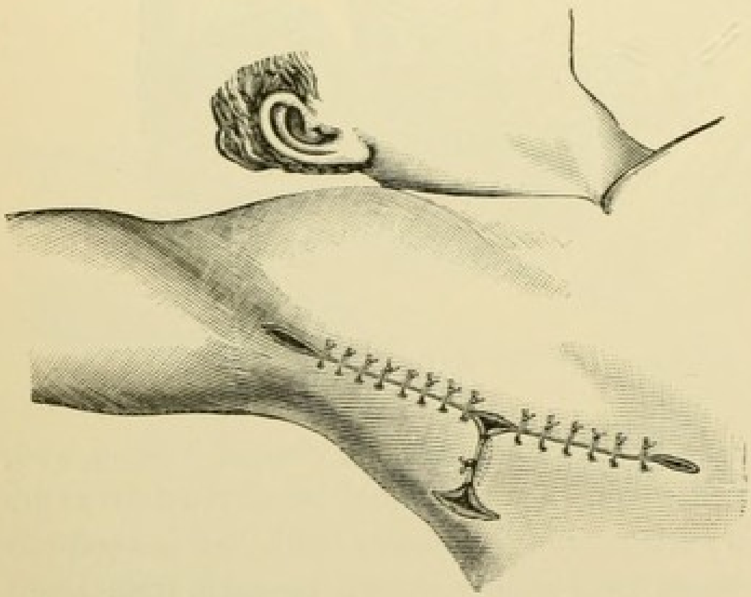


FIG. 1254. SUTURE AND DRAINAGE AFTER AMPUTATION OF THE BREAST AND CLEARING OUT THE AXILLA

9. After all of the bleeding vessels have been ligated, the large wound is sutured in its entire extent. A drainage tube is inserted into the axilla, or, still better, the skin is incised at the most dependent part of the wound (the patient being in the dorsal position); over a pair of introduced dressing forceps, a strong catgut thread is introduced through the opening; and, by tying the thread over the line of suturing the opening is made to gape so that the wound secretions can escape through it with facility (*Maass-Hoffa*) (Fig. 1254).

More beneficial, it seems, is the introduction of a thick drainage tube into this opening. A silk thread is fastened to the drainage tube; and, on the second or third day, it is removed under the dressing by making traction on the thread.

By a *cushion dressing* the surfaces of the wound are gently pressed against each other; a ball-like compress presses the skin into the axilla; the whole arm of the diseased side is fastened to the thoracic wall in an immovable position.

After the healing, which in most cases ensues rapidly, œdema of the arm sometimes occurs from cicatricial contraction in the axilla, and the patient is unable to raise the arm. *Küster* has attempted to remedy the latter inconvenience by saving the nerves mentioned above. *Rydygier* prevents cicatrization over the nerve-trunks by making the external incision in the axilla in the form of a flap toward the margin of the latissimus dorsi muscle.

If it has been impossible to preserve enough skin to enable suturing of the wound throughout, the margins of the wound are mobilized and rendered more elastic by detaching them extensively from the underlying tissues; or the defect is closed by a plastic operation or skin grafting; or the wound is allowed to heal *by granulation;* in this case, any recurrence that may take place is more easily recognized and removed.

(The late *S. W. Gross* taught the surgeons an important lesson in advocating extensive removal of skin. He relied on healing of the wound by granulation. In extensive skin defects resulting from the operation it is always advisable to cover the wound at once by a plastic operation.)

OPERATIONS ON THE ABDOMEN

(PUNCTIO ABDOMINIS)

The opening of the abdominal cavity by puncture is made in *far advanced dropsy* (*hydrops ascites*) in the following manner: —

The patient is placed in a semi-recumbent position at the edge of the bed; a towel or broad bandage is so placed around his abdomen that the ends cross each other in the region of the umbilicus. The bladder must be previously evacuated, if necessary, with a catheter.

1. After the surgeon has once more ascertained by percussion the limit of the dull and the resonant region (the intestines *float* upon the fluid), a medium-sized trocar (on the canula of this trocar, the depth to which it is to be inserted is fixed by the forefinger of the hand which directs the trocar) is inserted perpendicularly into the abdominal cavity **in the linea alba** *about midway between the umbilicus and the symphysis pubis* (Fig. 1255). Sometimes the puncture can be made *laterally* in a line drawn from the umbilicus to the anterior spine of the ilium (injury of the inferior epigastric artery may occur!).

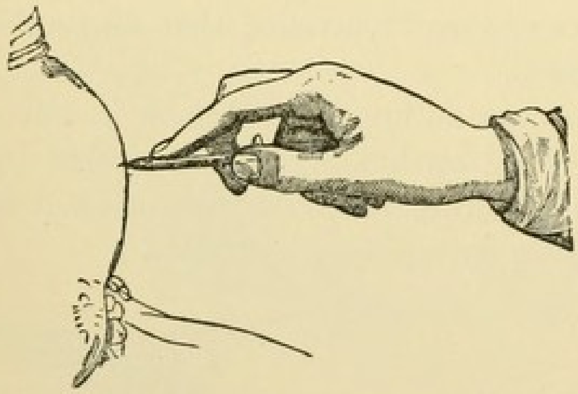


FIG. 1255. OPENING THE ABDOMINAL CAVITY BY PUNCTURE

2. When the stylet of the trocar is withdrawn, the fluid issues from the canula in a stream. To the end of the canula, a suitable rubber tube is fastened and placed into a receptacle placed below. If the pressure during the flow decreases, it may be somewhat increased by making traction on the bandage or towel; by this means, at the same time, the pressure fluctuation in the abdominal organs, caused by puncture and its consequences (cough, syncope), is prevented.

3. When the flow ceases, the canula is removed, and the little puncture is covered with adhesive plaster or sealed with iodoform collodion. A light compressive bandage is applied around the abdomen to prevent as much as

possible the pressure relief and its consequences (hyperemia) and the recurrence of the transudation.

In very thick abdominal walls, it is advisable to incise the skin with the knife at the place of puncture; under local anæsthesia, the trocar then penetrates more easily.

Very feeble patients should be given some cognac or wine during the evacuation of the fluid. If syncope occurs, the flow is interrupted by compressing the rubber tube. If fibrinous flakes — or an intestinal loop — obstruct the flow, they can be removed from the end of the canula by stripping the rubber tube with jerking movements; else, they must be carefully dislodged by a blunt instrument (probe, Nélaton catheter) inserted into the canula. *Exploratory punctures* with a *Pravaz* syringe can be made at any place.

LAPAROTOMY (CŒLIOTOMY)

The abdominal cavity is opened by incision: —

(*a*) For making surgical operations on the abdominal viscera.

(*b*) For diagnostic purposes.

Preparations: Several days previously, if the disease permits, care must be taken *to evacuate the intestinal canal* thoroughly by purgatives and intestinal irrigations. Shortly before the operation, the patient must take a full bath and must have his *bladder evacuated*. Irrigation of the stomach is likewise always advantageous.

The operation must be made as *rapidly* as possible, *in a warm room* (77° F.), the air of which has been *previously* charged with steam. To prevent the withdrawal of too much bodily heat, the patient is placed upon a warm *water bed*, and his extremities are covered with cotton or flannel. Since an infected peritoneum can never be disinfected completely, the *strictest asepsis* must be observed during the operation. See chapter on *Asepsis*.

After the abdominal cavity has been opened, *irrigations with disinfecting solutions are generally not made;* the blood is wiped off with an aseptic sponge of absorbent gauze or cotton, made practically dry by forcibly squeezing out the absorbed fluid. Intestines that have been drawn forward are wrapped in *warm* sterilized gauze compresses until they can be replaced into the abdominal cavity.

Irrigations of the abdominal cavity with salt water (0.6%), *Tavel's* solution (Na. Carbon. Calcin. 2.5; Na. Chlorat. pur. 7.5; Aq. Dest. 1000), or non-toxic disinfecting solutions (boric, salicylic, *Rotterin*), should be made only in cases in which an *infection* (pus, fæces) has occurred. In this case, however, the careful sponging with sterilized moist gauze pads is better.

1. **The external incision** is made as long as seems necessary for the operation, preferably *in the linea alba;* if the incision extends above the umbilical region, the umbilicus is circumscribed on *the left* side. According to the organ which the operator desires to reach, incisions can also be made *laterally* from the linea alba along the *external margin* of the *rectus abdominis muscle*, or through its fibres. Under some circumstances, *oblique or transverse incisions* may become necessary.

By making *the incision in the median line* after division of the skin and the underlying adipose layer, *the white shining linea alba* is first reached. If fibres of the rectus abdominis are reached, in case the incision has not been made exactly in the median line, the margin of the sheath of the muscle is sought by the use of a probe; by this means, the linea alba is located.

2. *After its division*, the layer of *subperitoneal adipose tissue*, more or less thick, in most cases is exposed; then the delicate, almost transparent *peritoneum.*

3. After all hemorrhage has been carefully arrested, a fold of the peritoneum is raised between two dissecting forceps and incised with knife or scissors; at once, a broad, flat, grooved director is introduced, and upon it the incision is enlarged far enough for the operator to penetrate into the abdominal cavity with two fingers of the left hand; while these protect the intestines, *the peritoneum between them is incised to the extent of the external incision.*

4. *The margins of the peritoneum are stitched* to the external skin by interrupted sutures placed at a distance of about 5 centimeters from each other; their ends remain long.

The hand can then be introduced into the abdominal cavity, and the necessary operations can be performed.

The **reunion of the wound** must be made very carefully. If it is necessary to finish the operation rapidly, first several deep *sutures* are inserted embracing all of the tissues of the margins of the wound, and the skin between these sutures is united by several *superficial catgut sutures.* But, for the purpose of securing a firm and lasting union, the "*étage*" *or buried suture* is made use of; first, the serous surfaces of the peritoneum, next, the overlying parts, fascia or muscle, are united by interrupted or continuous sutures with catgut (or silver wire, *Schede*), and, finally, the margins of the skin are closed by sutures applied alternately with catgut and silk. (The best suturing materials are: for the peritoneum, fine catgut sutures suffice, the deep interrupted sutures, including all other tissues except the peritoneum, are used, the fascia of the recti muscles is united with catgut, and the skin with horsehair sutures.) *Drainage* in the form of rubber or glass tubes or iodoform wick is established only when an infection of the abdominal cavity has occurred. In such cases, it is even advisable not to suture the wound at all, in order to relieve the abdominal cavity from pressure and to secure the escape of the exudates. *Israel*, in diffuse, purulent peritonitis, made an extensive crucial incision through the abdominal wall, and left it open; an apron of sterilized muslin is inserted in front of the intestines. After some time, they retract into the abdominal cavity of their own accord.

If, during the operation (for instance, after the removal of very large tumors), a "*dead space*" has been created in the abdominal cavity, from the walls of which a secondary hemorrhage might easily ensue, *it is tamponed*, according to *Miculicz*, by packing it with a large piece of iodoform gauze. This gauze bag is then filled with sterilized gauze, the ends of which are brought out from an angle of the laparotomy wound, sutured except at this angle. This gauze is gradually drawn from the cavity, which is thereby slowly decreased in size and closed.

The **dressing** can be applied either with iodoform collodion or with iodoform gauze, cotton, or strips of adhesive plaster. *Moderate compression* of the abdomen by a broad bandage and compression by sand bags placed upon it are advantageous.

If *violent vomiting* occurs after the operation, caffeine injected or tincture of opium or ice pellets administered are *sometimes* very effective. If vomiting is very violent, irrigations of the stomach by siphonage may be advantageous.

In the after-treatment, the nourishment is of the greatest importance, since after operations on the stomach and intestine, only such nourishment must be given as is easily absorbed and does not cause irritation. Sometimes, for the first days, nourishment must be administered "per rectum." The modern food preparations make it possible temporarily to supply a sufficient quantity of nourishment to the system by the stomach. For milder cases, the following simple bill of fare may be sufficient: —

On *the day of the operation:* The mouth is washed out with cold water.

First day: Half a liter of cold milk (one spoonful every hour).

Second day: In addition, a biscuit ("zwieback") in the morning and another in the afternoon.

Third day: In addition, a soft-boiled egg.

Fourth day: In addition, wine soup at noon.

Fifth day: In addition, boiled pigeon or scraped meat lightly roasted, with mashed potatoes or boiled rice.

Sixth day: From now on, daily, somewhat better and lighter food can be given — in addition, from the beginning, wine (champagne) may be taken.

The dressings are generally removed on the tenth or twelfth day; the patient *is dismissed* during the third week after the operation.

(In all abdominal operations the editor makes it an inflexible rule to confine patients to bed for at least four weeks.)

Every patient that has had laparotomy performed must wear an *abdominal supporter* in order to avoid a retraction of the margins of the wound (abdominal hernia, Fig. 1256).

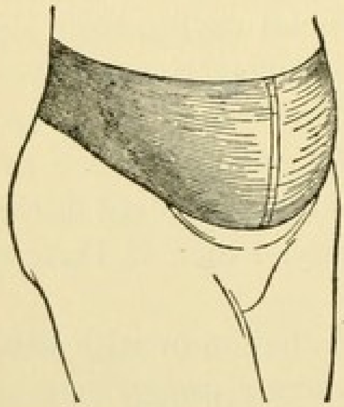


FIG. 1256. ABDOMINAL SUPPORTER AFTER LAPAROTOMY

For examining the abdominal organs, *Bardenheuer* recommended **the extraperitoneal explorative incision,** *without invading the peritoneal cavity,* in order to palpate the intestines through the thin parietal peritoneum (*diaperitoneal*). For this purpose, he makes very large incisions down to the peritoneum, from which he detaches to a wide extent the abdominal wall in the form of a door (leaves of a door). Starting from a *sacrolumbar incision* along the anterior margin of the iliocostalis, he makes transverse incisions either above on the costal arch or below along the crest of the ilium (*lumbar, costal, iliac, door incision*). To reach the organs of the small pelvis, he detaches the abdominal wall by a transverse incision at a varying distance from the anterior superior margin of the pelvis (*suprasymphysis incision*).

LAPAROTOMY FOR ILEUS

In *ileus caused by mechanical intestinal obstruction* (foreign bodies, neoplasms, cicatricial stricture, invaginations, intussusceptions, volvulus, retention by bands, etc.), if internal remedies have not yielded any relief, laparotomy is indicated; if, however, *septic intestinal paralysis* has already set in, — that is, if no single floating intestinal loops can be any longer distinguished in the barrel-like swollen abdomen, — and if the patient is almost exhausted, it is important, *first of all, to secure an evacuation* for the accumulated putrefied intestinal contents (*enterostomy*, see page 697). For this purpose, a place is selected as *nearly above* the obstruction as possible. By this *preliminary* operation, the obstruction itself is sometimes removed permanently; else the radical operation may be performed subsequently, when the patient has regained his strength.

If the operator is sure of the exact location of the seat of the obstruction, he should make the incision for laparotomy preferably *above the obstruction*. If, however, the same is unknown, the incision is made *in the linea alba*.

The seat of the obstruction must then be sought; the hand, introduced into the abdominal cavity, seeks to ascertain the seat and the cause of the obstruction by palpating the intestines as far as possible. If this is not successful, *the intestine must be exventrated and examined*. An assistant seizes any of the markedly inflated loops of intestine lying in the abdominal wound, and holds it securely all the time; proceeding from the same, the operator continues to exventrate other loops, which the assistant returns directly into the abdominal cavity. If, from the decrease of the inflammation and the inflation of the intestinal loops, the operator is satisfied he is receding from the seat of strangulation, then, on the other side of the intestinal loop, firmly held by the assistant, the operator proceeds in the same manner until the obstruction is reached (*Hulke, Miculicz*). The obstruction is *most promptly* found, however, when the operator, "a priori," makes a very long external incision. The intestines are received and placed in a hot compress (*Kümmell*). On account of the rapid cooling of the intestines, the greatest speed is imperative in adopting this procedure.

If the operator finds an invagination, or if an intestinal loop has passed through an opening in the mesentery, the attempt should be made to liberate the same by traction; bands are divided after previous double ligation. If he finds neoplasms, the intestinal portion involved must be resected, or anastomosis must be established. If he finds a volvulus caused by elongation of the mesentery, the intestine must be replaced into its normal position, and the mesentery must be shortened by forming a fold running parallel to the intestine (*Senn*); the sigmoid flexure, reduced into its normal position, is sutured to the left abdominal wall (*von Nussbaum*).

After *removal of the obstruction*, the intestines must be returned into the abdomen as rapidly as possible, — a procedure that may become extremely difficult, on account of the distention of the intestines.

By returning them slowly into the abdominal cavity and by gradually diminishing the external wound by suturing, this procedure can be accomplished; but it is not advisable to employ too much force, because, as a rule, the *fatal collapse* sets in rapidly, and, notwithstanding the removal of the obstruction, the paralyzed intestine cannot transport its decomposed contents.

If the intestine is not yet paralyzed, the peristaltic movements of its musculature often facilitate its reduction; also, by irrigating the stomach with an open abdominal cavity (*Rehn*), more space can be created, and the return can be facilitated. In case of greatest necessity, the distended exposed intestinal loops must be incised at one place by a longitudinal incision, and the contents must be stripped out with the fingers, or are allowed to flow out gradually through a drainage tube fastened into it (*Miculicz*). If the reduction is successful after this, the visceral wound can be closed by enterorrhaphy; but if the intestines are paralyzed, it is better to fasten the loop in the external wound, and thus establish an *artificial anus* (see page 289).

OPERATIONS ON THE STOMACH AND THE INTESTINES

GASTROTOMY

The scientific opening of the stomach is made for removing *foreign bodies which have been swallowed* and which, on account of their shape and quality, cannot be expected to pass spontaneously. By incising the stomach, as early as 1635, Daniel Schwab successfully removed a knife that had been swallowed. If abscesses or adhesions with the abdominal walls are present, *a simple incision* suffices; otherwise, the method is as follows:—

1. *External incision* either from the tip of the ensiform cartilage obliquely to the left, a thumb's breadth below and along the left costal arch; or beginning in the median line, in the linea alba, a thumb's breadth below the ensiform process. Incision and stitching of the *peritoneum* to the skin (see page 675).

2. *The stomach is drawn forward* with the two fingers; the anterior wall, if necessary, is held by two ligature loops passed *only through the serous and the muscular coats.*

3. The stomach is then opened, preferably, by a *vertical* incision, for the purpose of avoiding large blood vessels (gastric artery), either directly over the foreign body, if it can be felt, or in the free space between the ligature loops.

4. If the opening is sufficiently large, the foreign body is extracted with the fingers or forceps, and the opening is closed by *gastrorrhaphy*, in which the ligature loops can be used. In recent times, gastrotomy has also been made for *gastrorrhagia* and *gastric ulcers.* After the stomach has been opened, the bleeding vessel can be sought for, and *ligated;* ulcers are *excised,* and the fresh wound surfaces are united by suture (*Rydygier*).

(In the surgical treatment of gastric ulcers, *W. Andrews* of Chicago raises a cone on the inside of the stomach with the ulcer as its apex, applies a ligature at its back, and amputates the tissues on the gastric side of the point of ligation.)

GASTRORRHAPHY

is indicated: —

(*a*) In wounds of the stomach.

(*b*) In *gastric fistulas* caused by ulcers or injuries. (From punctured or incised wounds, the stomach in most cases prolapses, so that nothing of its contents reaches the abdominal cavity; if this is the case, fatal peritonitis rapidly ensues.)

According to *Lembert's method* (Fig. 1310), the suture passes only through the serous and the muscular coats; *the margins of the wound are inverted* either by interrupted sutures or by rectangular continuous suture (see page 703).

Contused portions of the margins of the wound are vivified, if necessary; in gastric fistulas, the fistulous margins must be excised and their cicatricial surroundings must be removed prior to the insertion and tying of the sutures.

Gastropexy is an operation which has for its object the stitching of the stomach to the opened anterior abdominal wall by sutures passing through its serous and muscular coats.

Poncet makes it directly after stenoses of the œsophagus, that he may subsequently be able to open the stomach in case of necessity more easily at the place where it has become adherent to the abdominal wall. It can also be resorted to in elevating the stomach dislocated downward (*gastroptosis*). *Bircher*, *Weir*, *Brandt*, and others have, by **gastroplication**, successfully diminished the size of the stomach, when greatly dilated and when this condition resisted the usual treatment. The exposed anterior wall of the stomach is folded inwardly in the direction of the long axis of the organ with a probe, and the wall of the stomach is sutured over it, the sutures passing only through the serous coat. With several rows of buried sutures, a fold as broad as the hand and extending into the interior of the stomach can be formed and permanently retained. In the same way, several longitudinal folds can be made on the anterior and the posterior side. Similar is *Tricomi's gastrostenoplasty*. *Von Hacker* designates the operation of separation of adhesions and bands that often cause violent gastralgias, **gastrolysis**.

GASTROSTOMY (*Sédillot*, 1849)

an operation for establishing a *fistulous opening into the stomach through the abdominal walls*, is made: —

(*a*) On account of *stricture* or obstruction *of the œsophagus* from ulcers or cicatrices situated so deeply that they cannot be reached from a wound in the œsophagus.

(*b*) On account of *large diverticula* of the œsophagus.

(*c*) For the removal of *foreign bodies* firmly impacted in the same.

If, on percussion, the stomach is found to be very much contracted, — as it is in most cases, — it is advisable, if at all possible, to inflate it by some *effervescent* mixture shortly before the operation.

1. *External incision* 7 to 8 centimeters long from the median line and the ensiform process *obliquely* to the left downward, parallel to and 2 centimeters below the left costal arch as far as the eighth costal cartilage (*Fenger*), *or vertically* 2 to 3 centimeters to the left from the linea alba through *the fibres of the rectus abdominis muscle* (which, after healing, forms a sphincter-like closure) (*von Hacker*).

2. *Having incised the peritoneum* and stitched its margins to the skin, the stomach is sought for, which, contracted in most cases, lies deeply behind. From the course of the gastro-epiploic artery and vein, the wall of the stomach is discernible, and can be distinguished from the transverse colon, which, moreover, is covered by the omentum.

3. A fold of the anterior wall of the stomach is drawn forward and *stitched* with about fifteen to twenty medium-sized silk sutures (which do not pass through the entire wall of the stomach, but only grasp *the serous and the muscular coats*, extending about 1 centimeter in the latter) all around to the margins of the skin wound, covered with the peritoneum, so that an oval portion (about 4 centimeters long and 3 centimeters wide) of the wall of the stomach forms the floor of the wound. The long ends of the sutures are spread all around (in the form of a star), and the wound is covered with an antiseptic dressing (Fig. 1257).

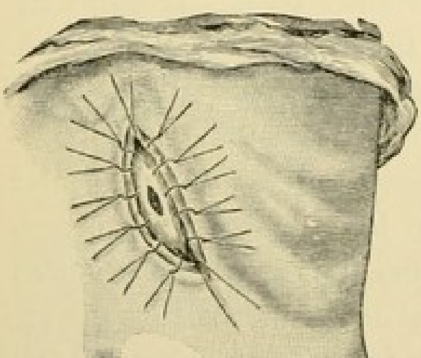


FIG. 1257. GASTROSTOMY (Suturing wall of the stomach)

During the first days, the patient is nourished with nutrient rectal enemata (*Leube's* meat solution, tropone, somatose, etc.). *F. Fischer* at once administers nourishment by inserting a very fine canula obliquely into the stomach, and by injecting milk through the same; by making the insertion of the needle obliquely for some time repeated every day, always at the same place, he establishes an oblique, well-retaining fistula.

But when the danger of starvation is not very great, then, after three to five days after the peritoneal surfaces have become adherent with one another and have intimately united the anterior wall of the stomach to the abdominal wall, —

4. The *opening of the stomach is made.* After the dressings have been removed, the surface of the wound, not clearly distinguishable on account of the granulations, is lifted somewhat with dissecting forceps or with fine hooks between the outspread ligature ends, and now a simple or crucial incision is made with the knife or with the thermo-cautery (*Hagedorn*), just large enough to admit with some difficulty a rubber tube having a lumen of $\frac{3}{4}$ centimeter to 1 centimeter.

If the strength of the patient has been brought to a low ebb (from inanition), it is often impossible to wait for peritoneal adhesions and to perform the *operation in two stages;* in such a case the stomach is opened *immediately* after its wall is stitched, and a tube, through which nourishment can be at once administered, is introduced.

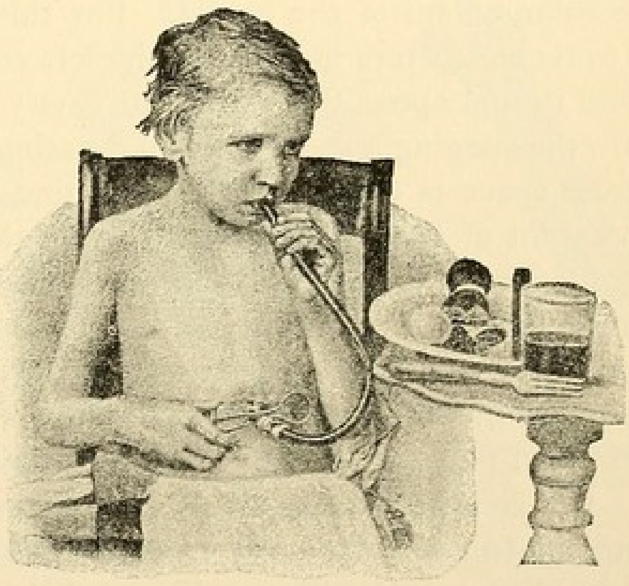


FIG. 1258. MODE OF CONVEYING FOOD TO THE STOMACH OF A PATIENT WHO HAD GASTROSTOMY PERFORMED

Through this tube the patient takes nourishment, at first cautiously (eggs, scraped meat, peptones, etc.). Later on, the patient's *taste and relish* for food may be gratified, and at the same time the necessary insalivation and the reflex secretory function of the stomach may be utilized, by masticating the food and then conveying it through a tube into the stomach (*Trendelenburg*, Fig. 1258).

Between meals the tube is closed by a wooden plug; later on a hard rubber canula with suitable closure may be employed. If the opening in the stomach *has not been made too large,* the canula may be removed entirely in the interval. By the contraction of the margins of the wound a sufficient closure of the fistula is then effected, especially if, according to *von Hacker*, the opening has been made in the rectus muscle, whereby a kind of sphincter is formed.

The latter object is obtained still more satisfactorily by *Girard's method.* He makes a vertical incision 15 centimeters long across the middle of the upper portion of the left rectus muscle, sutures to the middle of this incision the prolapsed wall of the stomach, detaches at both sides of the opening a bundle of muscular fibres from the rectus of about a finger's breadth from the deeper portion of the muscle, and places these two muscular bridges crosswise one over the other in such a manner as to grasp the sutured cone of the stomach between them like a sphincter. They are fastened in this position by sutures.

E. Hahn stitches the stomach in *the eighth intercostal space* in order to use the *elastic costal cartilages* like a *compression stop-cock*, and also to prevent an enlargement of the fistula. For this purpose he first makes an incision 5 to 6 centimeters long along the left costal arch, about 1 centimeter distant from it, and opens the peritoneal cavity to the same extent. He introduces into the opening a pair of curved dressing forceps, with which the eighth intercostal space is perforated from behind upward. Next he cuts down upon the point of the forceps from the outside. Then, with the thumb and the forefinger, he draws from the lower wound a portion of the stomach as near as possible to the cardiac extremity (fundus), grasps it with dressing forceps, and draws it through the tunnel made in the intercostal space, where it is fastened by sutures. (Injury to the pleura and the diaphragm need not be feared in perforating the eighth intercostal space.)

If a cicatricial stricture has contracted the œsophagus, the operator may attempt to dilate the same from the gastric fistula, first with catgut strings, and subsequently with a rubber tube passed over a fine whalebone bougie (*von Hacker*) and with the common bougies. After the stricture has been sufficiently dilated (see also page 641), the gastric fistula can be closed.

But in case of a malignant stenosis that cannot be removed, the patient is considerably relieved *by establishing an oblique fistula according to Witzel or Frank.*

Witzel sutures the wall of the stomach over a little rubber tube, so that it forms *two longitudinal folds.* This procedure forms a *canal*, the course of which resembles the lower extremity of the ureter in the wall of the bladder.

1. External incision a finger's breadth below the left costal arch and along the same as far as the sheath of the rectus.

2. The sheath is opened by a longitudinal incision; the fibres of the rectus are divided bluntly and longitudinally in the middle.

3. With the knife and the tip of the finger, the operator passes through the transversalis abdominis obliquely from the right to the left, down to the peritoneum.

4. The peritoneum is opened; next, by a quiet, steady, somewhat prolonged traction, a sufficiently large portion of the anterior wall of the stomach is drawn forward, and on it are raised two oblique folds extending from the left to the right upward to a distance of $1\frac{1}{2}$ to 2 centimeters.

5. At the lower extremity of this groove a small opening is made, and a rubber tube as thick as a pencil is inserted (Fig. 1259).

6. Over this tube, directed upward, the raised folds of the stomach are sutured to form a canal about 4 centimeters in length by four or five *Lembert's* sutures. A few fine superficial sutures secure the complete closure of the groove (Fig. 1260).

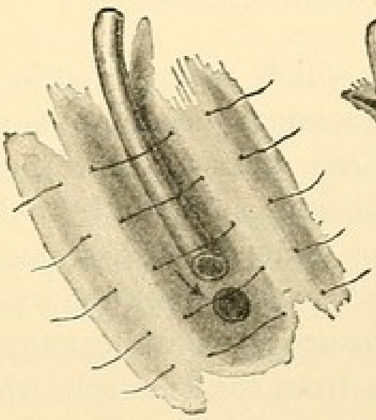


FIG. 1259. GASTROSTOMY

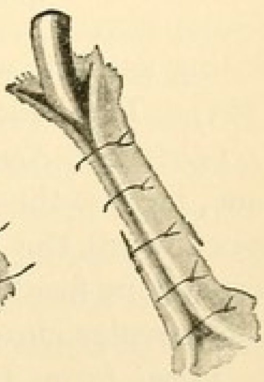


FIG. 1260. OBLIQUE FISTULA (according to Witzel)

7. Next follows the stitching of the stomach to the abdominal wound, as described on page 681. Through the fibres of the rectus and transversalis muscles the rubber tube, carried outward, is grasped as if by a cross-clamp.

8. The little tube can remain in position for weeks without escape of the stomach contents. Subsequently it can be removed, and is introduced only for the administration of food. The fistula is covered with a gauze pad.

Marwedel modified this method by forming the oblique fistula *intraparietal* between the mucous and the muscular coats. (This operation should be accredited to Professor *E. Andrews* of Chicago, who first described it in the medical press.) After a fold as broad as the thumb has been formed of the anterior wall of the stomach, its serous and muscular coats are incised for about 4 to 5 centimeters; at the lower angle of the wound the mucous coat is punctured, a thin drainage tube is inserted into the stomach and fastened with a catgut suture; next, the margins of the serous and muscular coats are united over the tube. The tube can be removed after 5 to 6 days, and is reinserted only for the introduction of food.

The oblique course of the fistula becomes perpendicular after some time, but the good closure is nevertheless maintained by means of serous surfaces hugging closely the rubber tube, the strong fold of the mucous membrane, and the muscular functions of the fibres of the rectus. Hence *Kader* formed from the beginning *a serous funnel, perpendicular* to the wall of the stomach. After the introduction of the tube he stitched the wall of the stomach in several folds over it by deep (Fig. 1261) and superficial sutures (Fig. 1262), closing sutures, which are covered in a third layer by fixation sutures (Fig. 1263). The abdominal incision is closed by deep and buried sutures.

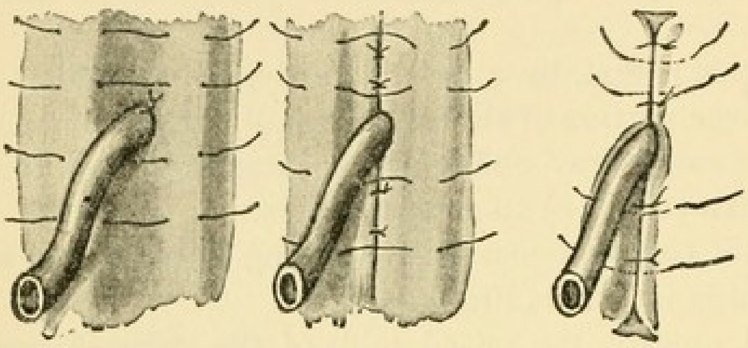


FIG. 1261 FIG. 1262 FIG. 1263

KADER'S GASTROSTOMY

(*Dr. E. J. Senn* raises the anterior wall of the stomach in the form of a cone, incises the apex sufficiently to insert a small rubber tube, inverts the apex toward the lumen of the stomach, and sutures the margin of the inverted cone firmly around the tube with a purse-string and superficial sutures. The valvular closure prevents leakage.)

Frank forms from the stomach, which has been drawn forward, a kind of small subcutaneous œsophagus in the following manner: —

1. From the common external incision a portion of the anterior wall of the stomach 3 to 4 centimeters in length is drawn forward, the apex of the cone thus formed is provided with a ligature loop, the base of which is closely stitched to the parietal peritoneum and the deep fascia (*Kocher*, Fig. 1264).

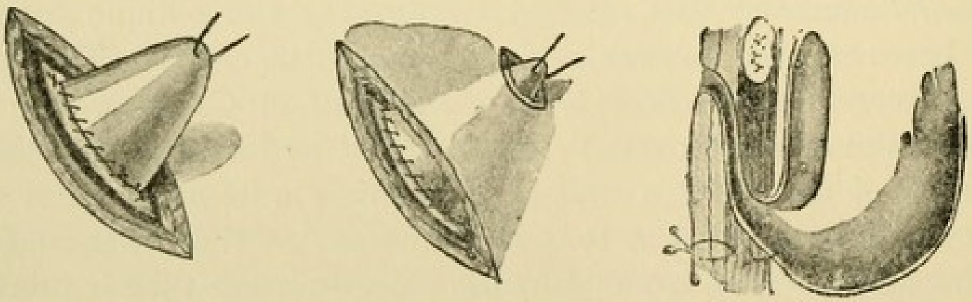


FIG. 1264 FIG. 1265 FIG. 1266

FRANK'S GASTROSTOMY

2. A small skin incision $1\frac{1}{2}$ centimeters long is made *above* the costal arch, about 3 centimeters above the first incision; the bridge of skin formed

between the two incisions is bluntly undermined, and the sutured part of the stomach is drawn beneath the bridge by the ligature loop into the upper opening (Fig. 1265).

3. The tip of this segment of the stomach is opened and fastened with a few sutures to the wound edges of the little buttonhole.

4. The first incision is sutured in its whole extent. The little canal can be very well used for the introduction of food; owing to its curved course around the costal arch and the contraction of the rectus muscle (Fig. 1266), leakage is prevented.

RESECTION OF THE PYLORUS (*Billroth*, 1881)

Excision of the pylorus is made in stricture of the same from *tumors* (*carcinoma*) and extensive *cicatrization*, provided *adhesions* with the surrounding parts do not exist at all, or at least not to any considerable degree, and provided the strength of the patient has not been too much reduced.

Preparations: after approximate information concerning the seat and the extent of the disease has been obtained by frequent preliminary examinations (under anæsthesia), and after the intestinal canal has been thoroughly evacuated by laxatives and enemata shortly before the operation, the stomach is irrigated several times with weak antiseptic solutions (boro-salicylic); then the patient receives an enema of ten to twenty drops of tincture of opium.

(Saline rectal enemata administered for 24 hours before the operation at intervals of 6 hours and strychnine hypodermatically before the anæsthetic is given are potent prophylactic measures against shock.)

. For preventing collapse during the long operation, it is advisable to avoid anæsthesia as much as possible and to operate, according to *Schleich*, as long as possible under local anæsthesia. As an analeptic, a warm mixture of good claret and water (1 to 3) can be kept ready; at intervals, this is injected into the rectum (*Lange*). Just as effective is an enema of a spoonful of cognac to half a liter of water (for the rest, see page 674).

1. **External incision** in the linea alba from the ensiform process to the umbilicus (*Rydygier*), or an *oblique incision* across the diseased portion, transversely through the recti muscles (*Wölfler*, *Billroth*).

2. After the peritoneum has been opened and a portion of the pylorus has been drawn forward, the operator ascertains by palpating the surrounding parts whether a resection is at all possible, and especially whether adhesions with the transverse colon, the pancreas, and the liver are present. In case of necessity, by a slit made in the *gastrohepatic ligament* or in the gas-

trohepatic omentum, the posterior surface of the pylorus can be palpated with the finger. If it appears that the operation cannot be successfully performed, either the abdominal wound is closed again (*diagnostic laparotomy*), or *gastro-enterostomy* is made.

If, however, resection has been determined upon, then

3. The **pylorus** and the parts to be removed are **isolated** and detached from their surrounding parts; detachment of the *gastrocolic omentum* from the greater curvature after a careful double ligation of all blood vessels between two hemostatic forceps or with the thermo-cautery (*Wölfler*). The separation must *not be made any farther* than the line of the intended resection, else gangrene of the colon may ensue (*Lauenstein*); likewise, the detachment of the *gastrohepatic ligament* from the lesser curvature and that of the *hepatoduodenal ligament* are made in the same manner; ligations at this place are sometimes very difficult; likewise, after any slight adhesions of the posterior side to the pancreas have been carefully divided or ligated, the now completely detached portion of the stomach is drawn forward entirely from the abdominal wound; a sterilized compress of gauze (or a flat sponge) is placed under it and warm compresses over it; everything else is returned into the abdominal cavity.

4. **Excision of the pylorus**: before the incisions are made, *the lumen of the stomach and of the duodenum must be closed* to prevent the intestinal contents and putrid material of the carcinoma from escaping.

This is best done by *the fingers* of an assistant; or the stomach and the duodenum are encircled with a thin *rubber ligature* or *a silk thread* (*Schede*), *or strips of gauze* (*Billroth*); special *compression instruments* (*compressoria*) are also recommended for this purpose.

Rydygier's intestinal clamps (Fig. 1269) consist of two delicate steel rods covered by thin drainage tubes; they are applied around the intestine, and are compressed at their ends by being tied together with a rubber band. Of similar construction is *Wehr-Heineke's compressorium* (Fig. 1270), a steel clamp with a rubber tube stretched over it for compressing the intestines.

Billroth's intestinal clamps (Fig. 1267), *Hahn's* (Fig. 1268), *Gussenbauer's parallel forceps* (Fig. 1271), *Küster's* (Fig. 1272), *Lücke's*, and others can be employed.

These instruments are applied in such a manner that the portion of the pylorus can be excised at least 2 centimeters distant from the margins of the disease. The duodenum is compressed by *one* clamp; the stomach by two clamps from above and from below. If the clamp cannot be well applied on the duodenum, on account of firm adhesions, two ligature loops are drawn through the intestinal wall and the mesenteric insertion; by means of these, the intestine is somewhat drawn forward and flexed. On

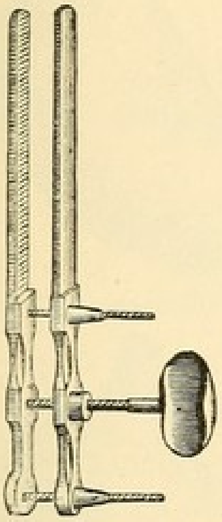


Fig. 1267. Billroth's

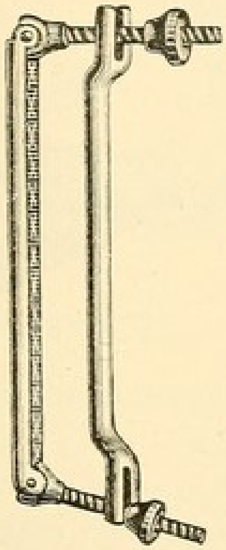


Fig. 1268. Hahn's

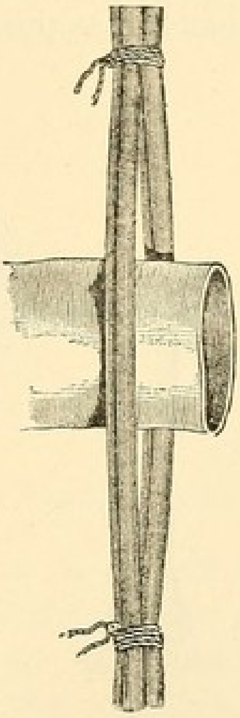


Fig. 1269. Rydygier's

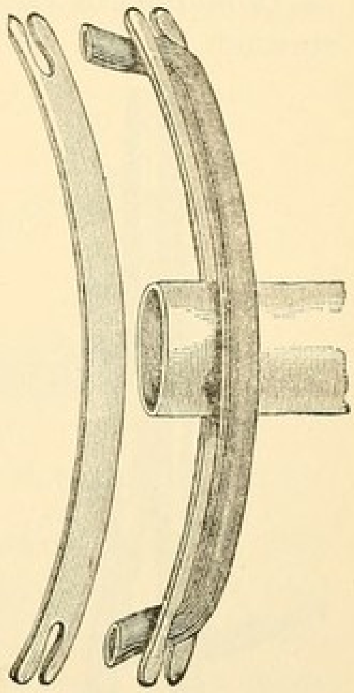


Fig. 1270. Wehr and Heineke's

Intestinal Clamps

the other side of these clamps, the healthy part of the stomach is closed by the fingers of the assistant; on the duodenum, however, a second clamp is applied.

5. The tumor is grasped with broad *Muzeux's* forceps, and the *stomach is cut through* with a pair of straight scissors mostly in an oblique direction (Fig. 1273).

The incision begins at the lesser curvature above on the left, and extends downward to the right; each visible blood vessel is ligated after each sweep with the scissors; when the lumen of the stomach has been opened, its contents are at once absorbed by a sponge, introduced into the stomach, and it is wiped antiseptically with a second sponge. At the greater curvature, the stomach is still left in connection with the pylorus corresponding about to the size of the circumference of the duodenum.

6. The wound of the stomach, commencing at the lesser curvature, is at once sutured *by a double row of sutures according to Czerny-Lembert* (**occlusion suture**, Fig. 1274, *a*). After that, the incision of the stomach at the greater curvature is completed.

7. Parallel to the incision of the stomach, the operator then *divides the duodenum obliquely between the two clamps*, advancing step by step and carefully arresting the hemorrhage.

(Obliquity of visceral incision at the expense of the convex border of the stomach.)

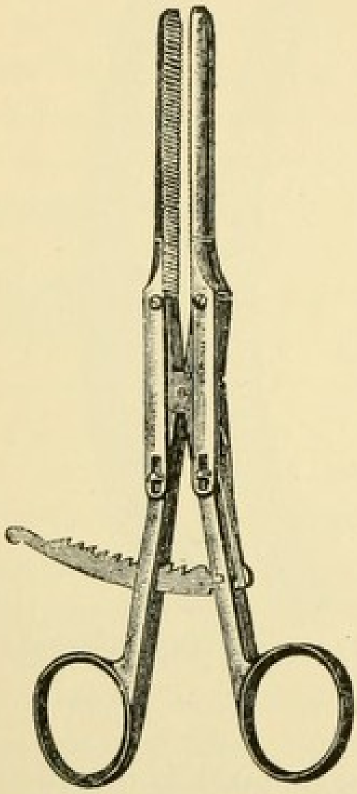


FIG. 1271. Gussenbauer's

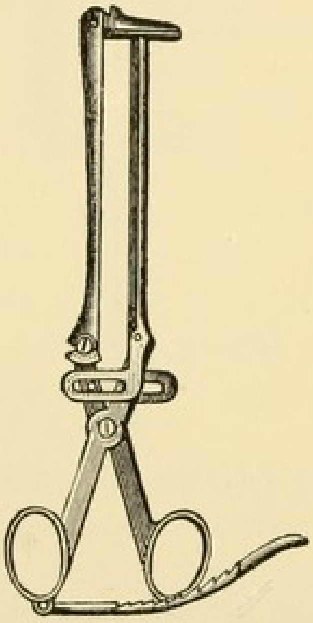


FIG. 1272. Küster's

PARALLEL FORCEPS

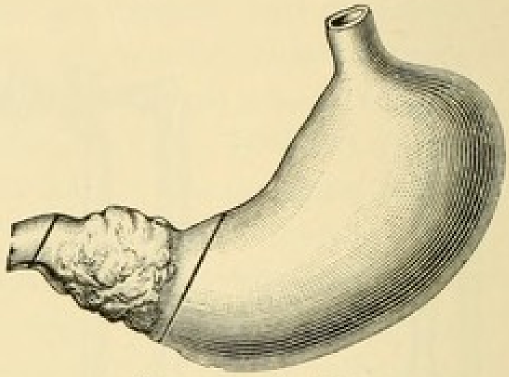


FIG. 1273. Incisions

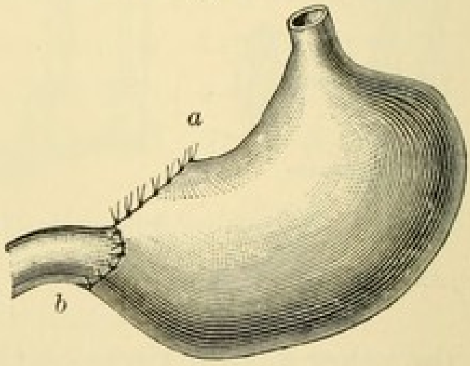


FIG. 1274. *a*, occlusion suture; *b*, circular suture

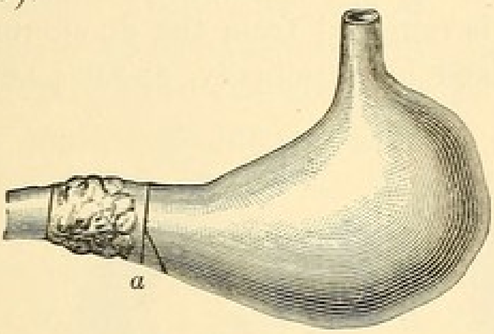
BILLROTH-WÖLFLER'S RESECTION OF THE PYLORUS

8. He then stitches the duodenum to the decreased wound of the stomach (**circular suture**) according to the rules of *circular enterorrhaphy* (see page 704). Commencing at the lesser curvature, he first applies the *inner mucous membrane sutures* as far as practical, and next over these *a second row of sutures according to Lembert* (seromuscular). Whether he employs the interrupted suture or the continuous suture makes no difference; a continuous suture with silk is applied more rapidly, and closes the wound very well.

9. After the rows of sutures have been once more *carefully examined* and after such parts as appear weak have been strengthened by interrupted sutures placed between them, the surface is sponged with antiseptic solution; the compress placed beneath it is removed, and the stomach is

returned into the abdominal cavity. *The sutures of the external incision* are applied as described on page 675.

The patient is *nourished* during the first three or four days exclusively by nutrient enemata; after that time, liquid nourishment is administered (see page 676).



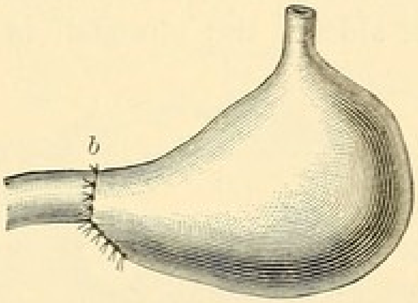


FIG. 1275 FIG. 1276

RYDYGIER'S RESECTION OF THE PYLORUS. *a*, incisions; *b*, suture

The stitching of the duodenum *to the greater curvature* (*Rydygier, Billroth, Wölfler*) creates a more useful channel for the passage of the food than its insertion *at the lesser curvature*, — as was done first. The stomach, distended in most cases, becomes by the occlusion suture more like a cul de sac (Fig. 1276).

For avoiding such saclike formation in case the lumina to be united differ too much in size, the operator must try to equalize these irregularities by making the incision through the stomach near the great curvature oblique (Fig. 1275, *a*). Implantation of the duodenum *into the middle* of the wound of the stomach offers no advantage.

In some cases in which the neoplasm has become so extensive that the reunion of the resected parts would be impossible without very great tension, *Billroth* first made gastro-enterostomy, extirpated the tumor, and closed the opening in the stomach and the duodenum by suture (Fig. 1276).

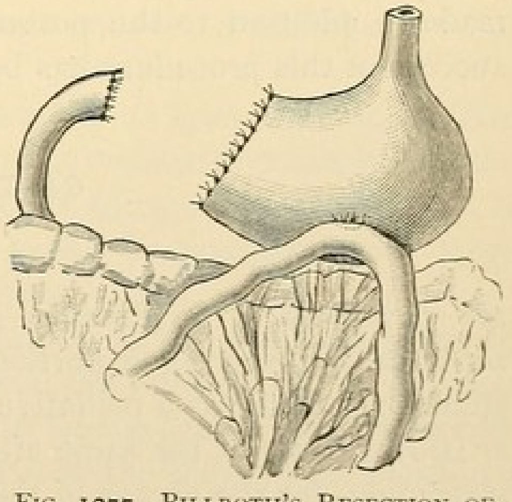


FIG. 1277. BILLROTH'S RESECTION OF PYLORUS AND GASTRO-ENTEROSTOMY

Kocher obtains very good success with pylorus resection and **gastroduodenostomy**. He divides first the duodenum between the two clamps; next, the stomach along the clamps; and closes the latter *completely* by continuous silk sutures extending through all layers (Fig. 1278). A row of *Lembert's* sutures is applied over this row of sutures. The assistant then turns the posterior wall of the stomach anteriorly, pressing it at the same time toward the right margin of the external wound to the duodenum, which has been drawn forward, and which thereby becomes occluded. The posterior margin of the duodenum is then sutured by serous sutures to the posterior wall of the stomach, and the clamp is removed from the duodenum. The posterior side of the stomach is incised longitudinally, about ½ centimeter

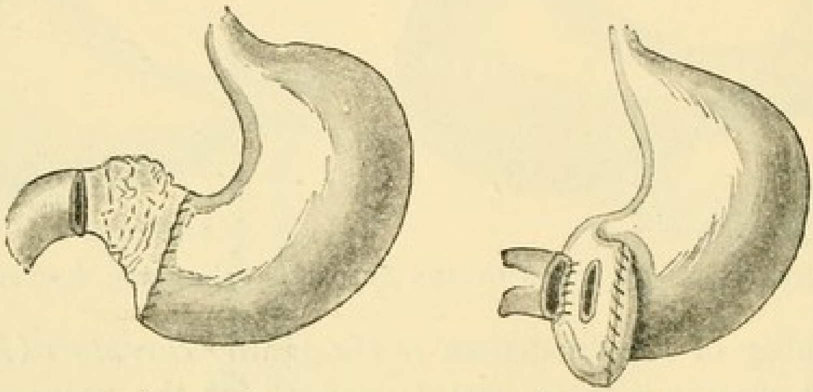


FIG. 1278 FIG. 1279

KOCHER'S RESECTION OF PYLORUS AND GASTRODUODENOSTOMY

from this sutured place corresponding to the breadth of the duodenum, and after ligation of all bleeding vessels, first the posterior (Fig. 1279), and, in connection with it, the circular, sutures are applied, extending through the whole thickness of the intestinal wall, the serous coat, the muscular coat, and the mucous membrane. Over this, the serous suturing of the anterior part is made in addition to the posterior serous sutures previously applied. The success of this procedure has been very good up to the present time.

GASTRO-ENTEROSTOMY

(*Wölfler*, 1881),

the formation of a fistulous opening between the stomach and the small intestine by suturing a portion of the small intestine to the wall of the stomach, is made as a palliative measure in *inoperable cancer of the pylorus or in recurrence* of the same after previous resection, and in *strictures of the duodenum*, for the escape of the contents of the stomach into the intestine.

1. *Longitudinal incision in the linea alba* from the ensiform process to the umbilicus; the peritoneum is divided and stitched with a few sutures to the external skin.

2. *The transverse colon and the omentum* are brought out with the fingers and placed in an upward direction to the right. The *duodenojejunal fold* of the peritoneum, from which the small intestine emerges, is now seen; its mesentery always becomes longer to the left; and at a distance of 40 to 50 centimeters it is so long that the intestine can be applied to the stomach across the colon (Fig. 1280).

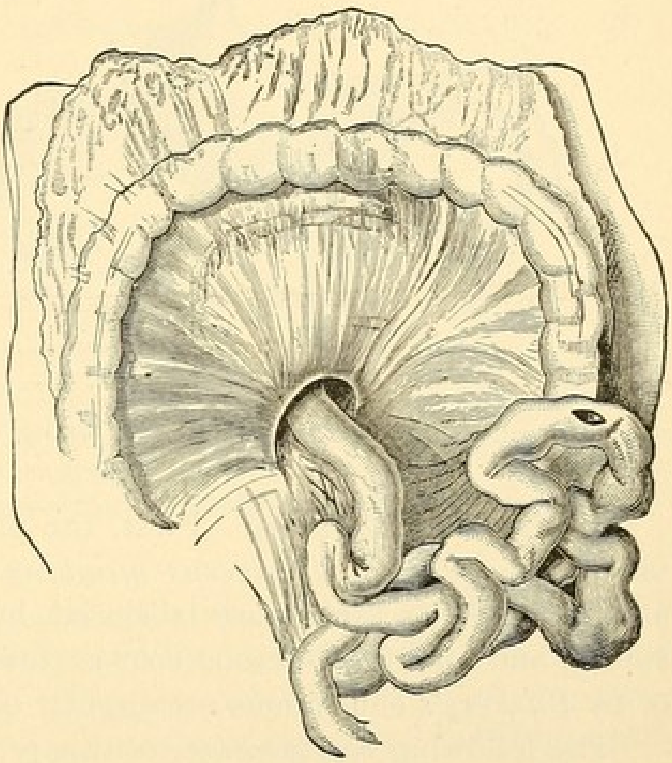


Fig. 1280. Duodenojejunal Fold, Transverse Colon and Omentum placed in an Upward Direction

3. This portion of the small intestine is drawn from the abdominal wound; a portion about 10 centimeters long is stripped empty with the fingers, and clamped on both sides with rubber bands, with thick silk ligatures, or with Rydygier's clamps, which are passed through small slits made in the mesentery with forceps ("Schiebern"). Except the two parts which are to be incised, viz. the portion of the small intestine and the wall of the stomach, everything is returned into the abdominal cavity, and the whole abdominal wound is covered with sterilized warm compresses.

4. The clamped-off *loop of the small intestine is opened* by an *incision* 3 centimeters long at the side opposite to the mesenteric insertion; the hemorrhage is arrested, and the inner surface is sponged antiseptically. It is advantageous to make the incision as small as possible, since large incisions promote subsequent "spur" formation.

5. The *anterior wall of the stomach* is grasped by the assistant, lifted up near the fundus, or even in the middle between the fundus and the pylorus; it is securely clamped off with his fingers, with *Gussenbauer's* clamps, or with *Bruns's* clamp-forceps; and then opened between the same by an incision 3 to 5 centimeters long at a place about 4 centimeters above the large curvature (where the coronary artery branches off into smaller ramifications).

The hemorrhage is arrested, the inner surface of the stomach is irrigated with a weak antiseptic solution. The incisions in the wall of the stomach and the portion of the small intestine may be made either longitudinally (*Wölfler,* Fig. 1281) or *transversely* (*Socin,* Fig. 1282).

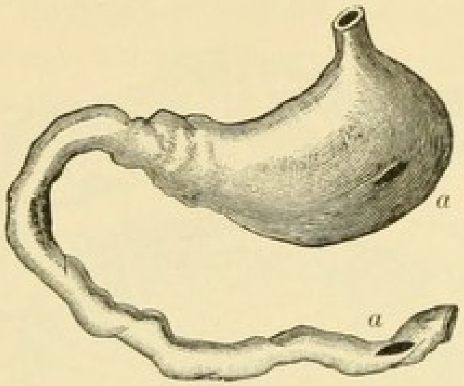


Fig. 1281. Wölfler's

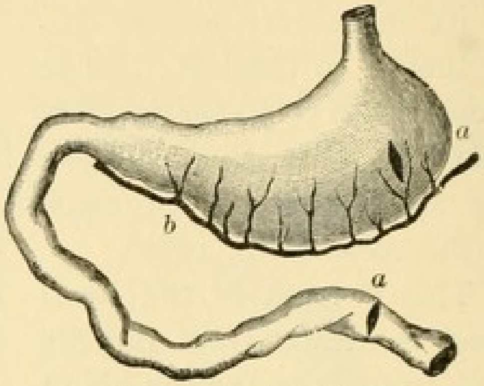


Fig. 1282. Socin's

Gastro-enterostomy. *a*, making incisions; *b*, coronary artery

6. *Applying the suture.* First, the posterior margins of the wound are united by *the internal mucous membrane suture* (*Wölfler,* Fig. 1312) as far as possible; the remainder is closed by an external mucous membrane suture, and finally the serous coat is closed all around by *Lembert's* suture or by *Cushing's* continuous rectangular quilt suture (see page 704).

The following *modifications* of this procedure must be mentioned: —

Von Hacker (*and Courvoisier*) recommends stitching the loop of the small intestine *to the posterior wall of the stomach* in order to prevent strangulation of the transverse colon by the loop of the small intestine laid over it. For this purpose, after the colon and the omentum have been turned up, he makes posteriorly in a blunt manner a *slit* in a non-vascular portion of the *mesocolon,* stitches its gaping margins to the posterior wall of the stomach; next, he sutures the loop of the small intestine in this opening to the posterior wall of the stomach (Fig. 1283). This can become very difficult; the transverse colon with the great omentum remains *in its normal position in front of* the loop of the small intestine. Even now, many surgeons recommend this as the best operation.

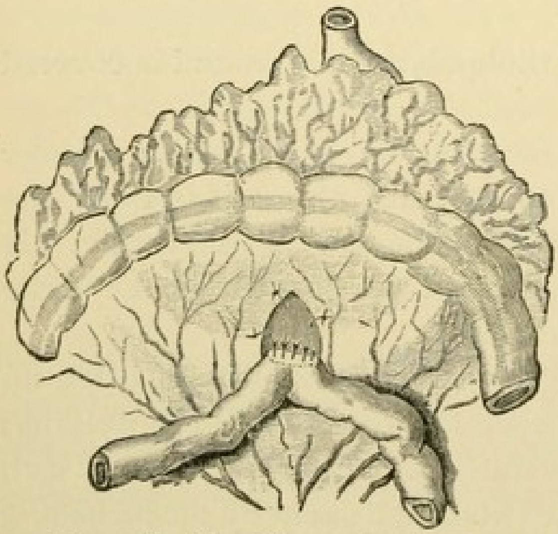


Fig. 1283. Von Hacker's Gastro-enterostomy

Wölfler, to prevent vomiting caused by the bile flowing into the stomach and thence with the gastric contents into the *proximal* part of the intestine, formed a *valve* over the proximal crus of the small intestine by suturing the right half of the intestinal opening to the intact wall of the stomach, and only the left portion to the margin of the opening of the stomach (Fig. 1287).

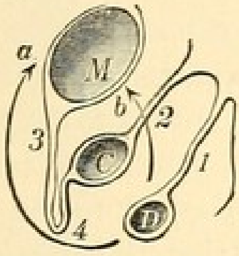


FIG. 1284

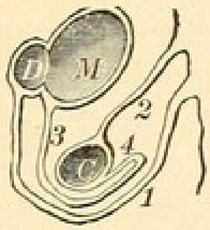


FIG. 1285

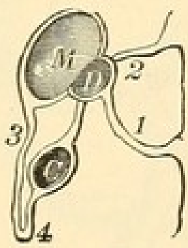


FIG. 1286

DIAGRAM OF GASTRO-ENTEROSTOMY

Fig. 1284: *M*, stomach; *C*, colon and small intestine in normal position; 1, mesentery; 2, mesocolon; 3, gastrocolic ligament; 4, great omentum; ⌒↘*a*, Wölfler's procedure; ⌒↘*b*, von Hacker's procedure. Fig. 1285: Wölfler's antecolic gastro-enterostomy. Fig. 1286: Von Hacker's retrocolic gastro-enterostomy

According to his suggestion, the same end can be attained by *completely dividing* the loop of the small intestine and by implanting the inferior *distal end into the wound of the stomach*, while the superior *proximal end*, somewhat contracted by the suture, *is implanted into the distal end* (Fig. 1288). *Von Hacker* narrowed the proximal intestinal portion by a serous tobacco-pouch suture.

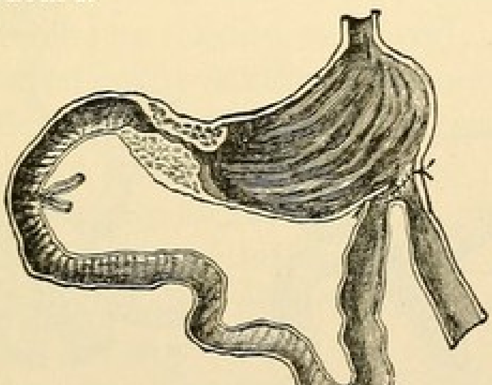


FIG. 1287

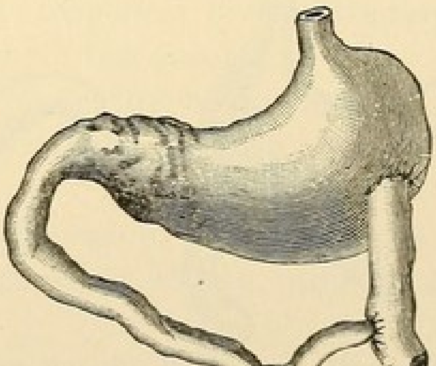


FIG. 1288

Lücke takes *any loop* of the small intestine lying nearest to the wound and having a sufficiently long mesentery, and sutures it to the stomach in such a manner that the distal end comes to lie to the right, but the proximal to the left, so that the *peristaltic motion* of the stomach and the intestine takes place *in the same direction from left to right.* He tries to ascertain the direction of the peristaltic movement by touching it with a crystal of sodium chloride, which, according to *Nothnagel's* experiments, produces an *antiperistaltic motion* on the intestine of rabbits. But, unfortunately, the success of this experiment is not perfectly sure in man. *Kocher* proceeded in a similar manner by making the incisions in the stomach and the small intestine and the application of the suture as seen in Figs. 1290 and 1291. Subsequently he operated so as to stitch the intestinal loop, after a transverse opening, to the anterior wall of the stomach, so that the proximal segment came to lie *under* the distal segment (Fig. 1292). In this case, the distal segment can close the proximal segment; but not *vice versa*.

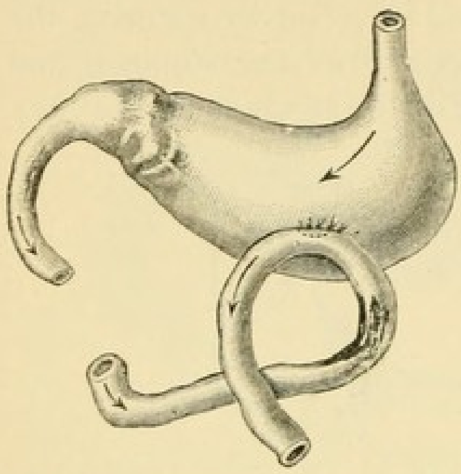
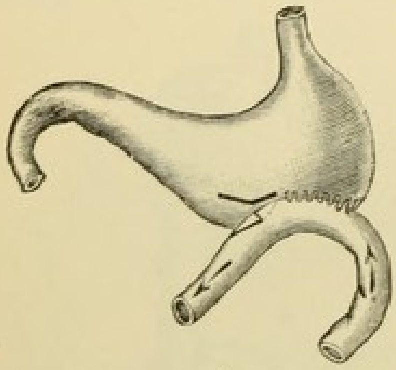


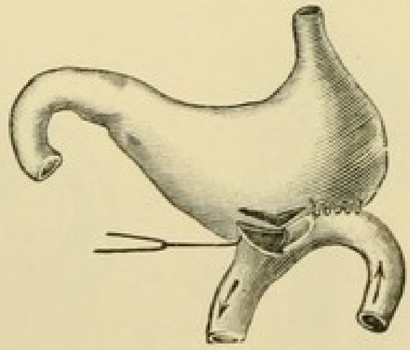
FIG. 1289. LÜCKE'S GASTRO-ENTEROSTOMY

Doyen formed a longitudinal valve on the proximal intestinal segment. He perforated the gastrocolic omentum; through the opening he placed the entire great omentum into the lesser sac of the peritoneum (to guard against the subsequent compression of the loop by the transverse colon), and stitched the colon to the greater curvature of the stomach. Only then did he suture the intestinal loop to the greater curvature to an extent of 10 to 12 centimeters; in the middle of this suture, he made a fistulous opening



a

FIG. 1290



b

FIG. 1291

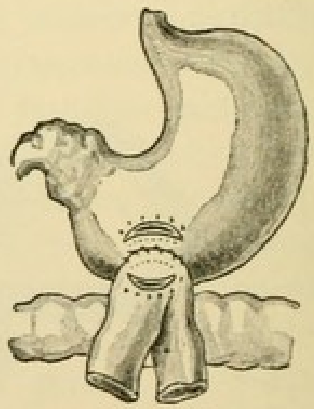


FIG. 1292

KOCHER'S GASTRO-ENTEROSTOMY. *a*, incisions; *b*, suture

3 to 4 centimeters long. The proximal intestinal segment received thereby a higher position (Fig. 1294), and also a valve extending in longitudinal axis by means of a few *Lembert* sutures.

If the operation must be made as rapidly as possible, on account of the weak condition of the patient, it is advisable to open the abdomen under local anæsthesia, and to form the fistula according to the simplest method (*Wölfler* or *von Hacker*) by employing the *Murphy* button (see page 705).

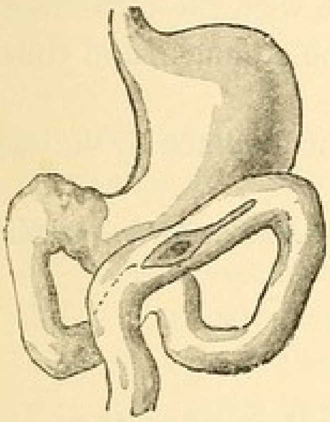


FIG. 1293

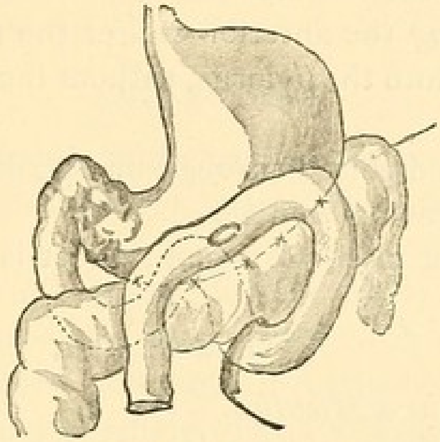


FIG. 1294

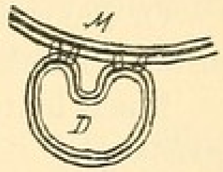


FIG. 1295

DOYEN'S GASTRO-ENTEROSTOMY

Finally, in cases in which even gastro-enterostomy is impossible, and in which the necessary absolute rest of the intestinal canal for several days might endanger the life of the very much exhausted (starved) patient, it is preferable to make **duodenostomy** instead of this operation (*Maydl*), or, still better, **jejunostomy** (*Albert*), which is easier and less dangerous: —

1. The abdominal wall is incised transversely at the pit of the stomach.

2. Fifteen to 20 centimeters from the duodenojejunal fold, the small intestine is drawn forward sufficiently, and completely divided transversely; the peritoneal cavity is closed temporarily by a few sutures.

3. The distal intestinal end is incised 10 centimeters below its margin at the convex side for a distance of 3 centimeters, and the proximal end is implanted laterally by suturing.

4. The peripheral intestinal end is fastened in the left angle of the abdominal wound with four interrupted sutures, so that it projects 2 centimeters over the skin.

The introduction of food through this fistula is easy. The digestive juices from the liver and the pancreas are preserved for the patient as in Fig. 1288. *Albert* modified jejunostomy by forming an anastomosis at the base of a prolapsed loop (see page 708). He drew forward the apex of the intestine through a second skin-incision above the first, as in *Frank's* gastrostomy (see Fig. 1265), and incised it a few days subsequently with the thermo-cautery. The anastomosis lies directly behind the wound of the abdominal wall in the abdominal cavity.

If *the stricture of the pylorus* has been produced by *scar contraction*, and if, at least at the anterior wall, no considerable adhesions with the surrounding parts are present, the attempt has been made to dilate the stricture with the finger, by *indenting* the anterior wall of the stomach with the tip of the finger and pushing it into the pylorus, without incising the stomach, and thus *dilating* the pylorus.

Or the stricture is divulsed through an opening in the stomach by digital or instrumental dilatations (*Loreta*).

Much better and of more permanent effect is the *plastic dilatation of the pylorus*.

PYLOROPLASTY,

according to *Heineke and Miculicz*.

A longitudinal incision, not too long (5–8 centimeters), is made through the entire cicatricial portion, and is united again in a *transverse* direction, so

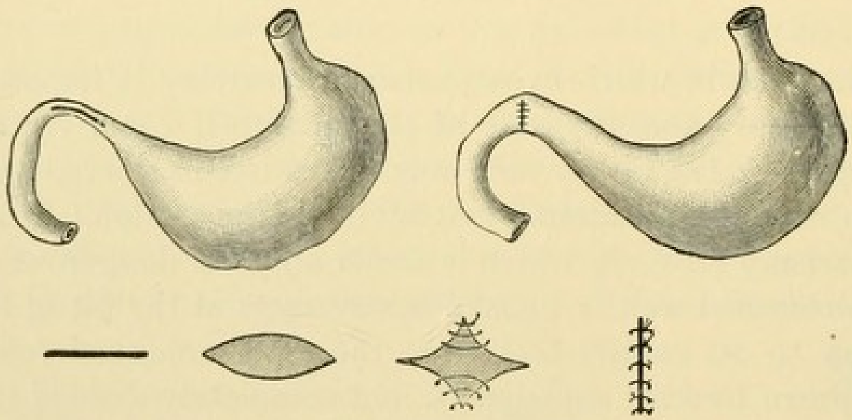


Fig. 1296 Fig. 1297
Von Heineke's Pyloroplasty. Diagram of Suture

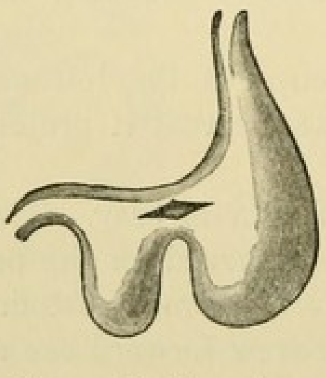


Fig. 1298. Gastroplasty

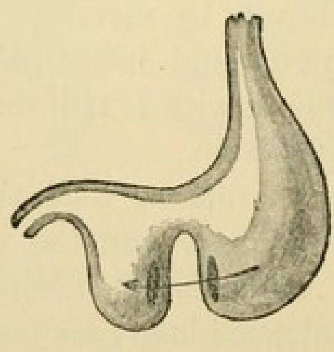


Fig. 1299. Gastroanastomosis

In Hour-glass Contraction of the Stomach

that the duodenal angle of the incision is in apposition to the angle of the stomach (Figs. 1296, 1297).

In the *hour-glass contraction of the stomach*, for dilating the constriction, this operation is made in a similar manner (Fig. 1298), or a *gastro-anastomosis*, according to *Wölfler*, is made at the most dependent part of the two sacs.

ENTEROTOMY

The opening of the intestine by an incision becomes necessary when it is desirable to remove *foreign bodies or pedunculated tumors* (lipomata, adenomata, sarcomata, etc.).

For the extraction of an impacted foreign body, the *incision* is made as long as required, parallel to the longitudinal axis of the intestine on the side *opposite to* the mesenteric insertion. (A transverse incision on the convex side of the bowel furnishes ample room for the extraction of the foreign body, and, after suturing, is not as liable to constrict the lumen of the bowel as when made in an opposite direction.) Pedunculated tumors are cut off after a needle has been passed through the pedicle and the same has been ligated on both sides. Next, the wound in the intestine is closed by enterorrhaphy (see page 702).

ENTEROSTOMY,

the formation of a fistulous opening in the intestine and the abdominal wall, is made either for a *temporary* or *permanent* evacuation of the intestinal contents above a place through which their passage is obstructed (*acute and chronic intestinal stenosis* from invagination, volvulus, adhesions, strangulation by bands, reposition of hernias, with the strangulated neck of the hernial sac, — reposition " en bloc," — from cicatrization following ulceration, and neoplasms that cannot be removed by extirpation).

According to the part of the intestine to be opened, we distinguish **ileostomy** and **colostomy**.

A **temporary enterostomy** is made in cases of intestinal obstruction, in which the manner and seat of the obstruction cannot be determined with certainty, and in which the distention of the intestine from gaseous or fæcal matter (septic intestinal paralysis) has gone so far that there is danger of the patient's not surviving an operation of the magnitude involved in the removal of the obstruction.

The intestine is opened at a point *lying as nearly above the supposed seat of the stenosis as possible*, in order to prevent intestinal exclusion to such an extent as would impair nutrition. With a perfectly certain diagnosis of the seat of the obstruction, the abdomen is opened at the place where this portion of the intestine is located; if the diagnosis cannot be made with certainty, the operator selects for the incision places where certain sections of the intestine (colon) can be found with some degree of certainty; *the right inguinal region,* in which the *cæcum* is found, and the *left inguinal region,* where the lower extremity of the descending colon, the *sigmoid flexure,* lies (**inguinal colostomy**), *or the anterior abdominal region* between the umbilicus and the sternum, where the *transverse colon* takes its course (**colostomia media**). If, in existing meteorism or tympanites of high degree, *instead of the colon,* a greatly distended *loop of the small intestine* presents itself in the wound, the latter is opened, if it is desirable only to create at some place a temporary outlet for the intestinal contents.

Colostomy in the inguinal region is made in the following manner: —

1. *External incision,* 5 to 6 centimeters long, a finger's breadth above, and parallel to, the external half of *Poupart's* ligament, obliquely upward to the anterior superior spine of the ilium (Fig. 1300).

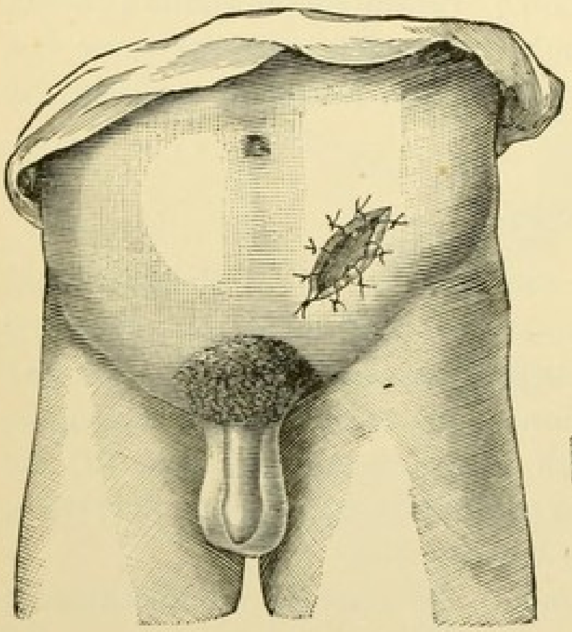


FIG. 1300. Suturing intestine

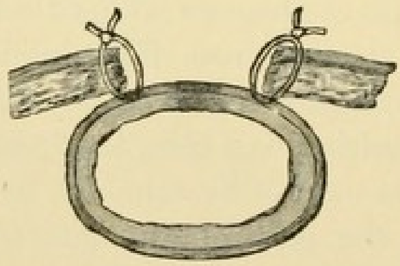


FIG. 1301. Applying suture

INGUINAL COLOSTOMY

2. Division of the aponeurosis of the *external oblique muscle,* blunt division of the fibres of the *internal oblique muscle* and of *the transversalis muscle,* until the peritoneum is exposed.

3. *Incision of the peritoneum.* Stitching of the visceral peritoneum to the margins of the external wound.

4. *Bringing the large intestine into the wound.* The large intestine is often surrounded with loops of the small intestine, but it can be distinguished from the latter by its paler color, its sacculated appearance (haustra), and its longitudinal bands (tæniæ). In order to determine which is the proximal and which is the distal part, the operator palpates along the intestine until he reaches the obstruction; or, if possible, he injects water from the anus, and follows the course of the distention. (Insufflation with air is better as a diagnostic aid.)

5. The serous coat of the intestine is then *sutured* to the parietal peri-

toneum in the wound with silk sutures, extending only through the serous and the muscular coats of the intestine on one side, and the peritoneum on the other (Fig. 1301); the sutures are applied as closely as possible; the sutures remain long, and are spread in a radiating manner around the wound. The closure becomes still denser if a continuous suture is applied after the application of four interrupted sutures at the angles of the wound and at the middle portion of the wound edges. If it is necessary to relieve the patient as rapidly as possible, the operation is made *at one sitting;* then follows: —

6. *The opening of the intestine* longitudinally with the knife or the cutting thermo-cautery; for the purpose of guarding against the entrance of fæcal matter into the peritoneal cavity between the sutures, it is advisable to cover the whole line of sutures with a thick layer of salicylic vaseline, to powder it with iodoform, or to cover it closely with strips of gauze. If, however, the condition of the patient permits, the operation *should be made in two stages,* and the intestine should be opened only after 2 to 4 days, when the adhesions between the peritoneal surfaces have taken place in the meantime, furnishing adequate protection against peritoneal infection from the fæcal discharges.

The intestine is then irrigated, and into the proximal segment a drainage tube as long as possible is introduced; this projects beyond the skin, and protects it as much as possible from contamination (eczema). If the original obstruction has been removed, this *temporary* intestinal fistula can be easily closed by vivifying its margins and suturing, or by resection and circular enterorrhaphy.

FORMATION OF AN ARTIFICIAL ANUS,

from which the *total* intestinal contents *can be evacuated permanently,* is indicated in *obstruction of the rectum by tumors* that cannot be reached and removed from the anus, and by old obstinate *ulcers* (syphilis) of the same.

The descending colon is opened as low down as possible. According to the older methods, the colon was opened either from behind and extraperitoneally, or from the front through the abdominal cavity. It is advisable, however, to search for and open the *sigmoid flexure* in the left inguinal region. Only in exceptional cases does the surgeon still perform: —

1. *Extraperitoneal lumbar colostomy according to Callisen-Amussat:* by a vertical incision from the twelfth rib downward to the crest of the ilium; next, the posterior side of the *descending colon,* which is not covered by the peritoneum, is sought for, stitched to the wound, and opened.

2. *The intraperitoneal lumbar colostomy according to Fine:* by a vertical incision 15 to 20 centimeters long from the tip of the eleventh rib downward the peritoneum is opened; stitching of the anterior wall of the descending colon to the margins of the wound.

Most generally employed and most practical is the *inguinal colostomy of the sigmoid flexure* (anus inguinalis, sigmoidostomy), first recommended by *Littré* (inguinal anus).

The operation is made on the left side in the same manner as *temporary* colostomy described above (see page 698, 1 to 4).

3. The S. Romanum (sigmoid flexure) can be recognized by its appendices epiploicæ, and is sought and drawn forward from the wound as far as its mesenteric insertion; under this, through a slit made bluntly in the mesentery, a gauze compress or a *small rod* (hard rubber, glass probe, sound, etc.), wrapped with iodoform gauze, is introduced transversely, so that the same rests like a bridge upon the margins of the skin, while the intestine rides upon it (*Maydl*, Fig. 1302).

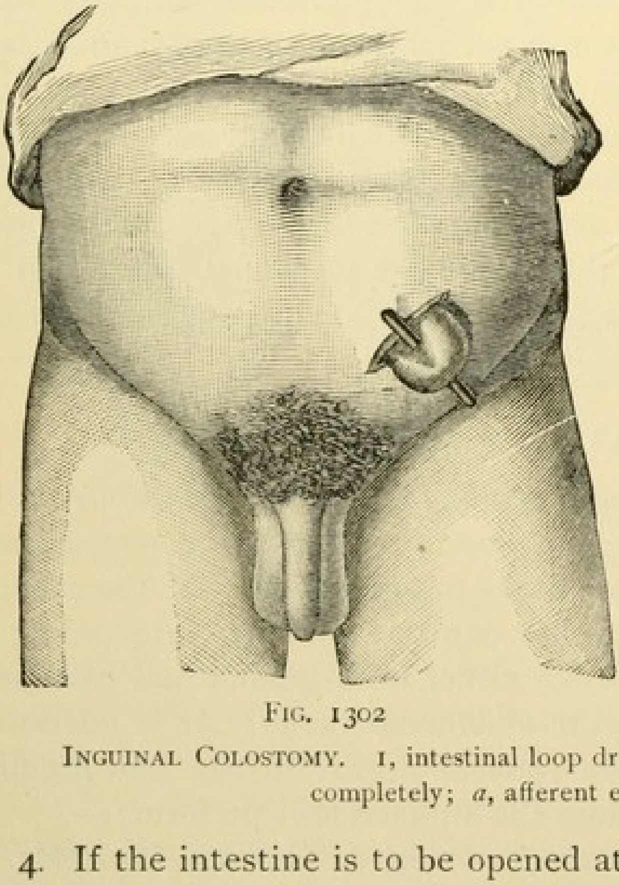


Fig. 1302

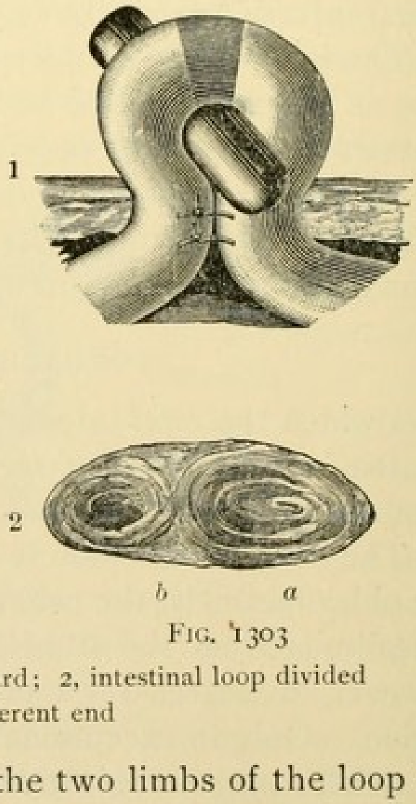


Fig. 1303

Inguinal Colostomy. 1, intestinal loop drawn forward; 2, intestinal loop divided completely; *a*, afferent end; *b*, efferent end

4. If the intestine is to be opened at once, the two limbs of the loop are sutured together by serous sutures, below the bridge (Fig. 1303, 1), as well as to the margins of the wound, so that the proximal portion has ample space and the distal part is compressed by the latter (*Kocher*). But if the

operation can be made *in two stages,* then only the limbs are stitched together by a few sutures, and the whole is wrapped with iodoform gauze. The opening is not made until after two to three days, when adhesions have formed.

(It is always necessary to suture the base of the loop to the parietal peritoneum. In one case in which this was not done by the editor, during a violent fit of vomiting extensive prolapse of the small intestines occurred.)

5. *The intestine is then divided in a transverse direction,* preferably with the red-hot knife point of the thermo-cautery. After the lumen has been opened, the aperture is enlarged very gradually (in a rapid evacuation of fæces, collapse and sudden death may occur, *Schönborn*). First, only about one-third of the circumference of the intestine is opened; next, thick rubber tubes are introduced into the two bowel ends, and the contents of the intestine are thoroughly washed out by irrigation. The complete division down to the bridge (Fig. 1303, 2) is not performed until after the expiration of fourteen days.

If the operation is made as a palliative measure in incurable disease of the rectum (cancer), it is advantageous, for irrigating the distal excluded inferior extremity more conveniently, to divide the intestine at once completely, and *to suture each extremity separately into the wound,* so that, if possible, a skin bridge about 1 centimeter wide is formed between the two intestinal openings (*Hahn, König*). *Witzel* makes the abdominal wound more than 12 centimeters long, so that a *broad* bridge can be sutured between the two openings stitched to the angles of the wound.

This is preferable to complete division and *closing* the lower extremity after inversion of its margin by serous sutures and *returning* the bowel end into the pelvis (*Madelung*).

The often observed descent of rectal tumors and the prolapses of the colon through the anus, which are often very extensive, suggest the idea that it may be possible to make high-seated but non-adherent tumors still accessible from the anus by tying the portion to be returned securely to a long rubber tube, which is introduced from the anus by applying over it the occlusion suture. Next, after a forcible dilatation of the anus by daily slow traction on the tube, the operator seeks to make a prolapse of the lower end together with the tumor. If the tumor then lies near the anus or in front of it, it is cut off as described in removing a prolapse of the rectum (*von Esmarch*).

ENTERORRHAPHY

Intestinal suture serves for uniting intestinal wounds.

I. **In partial division of the intestinal wall.** For intestinal sutures are used very fine silk and fine round needles, either entirely straight (English pearl needles, No. 12), or curved only at their points, or semicircular. *Von Hagedorn's* needles are also very useful. (Ordinary sewing needles of different sizes are very useful in all kinds of intestinal work.)

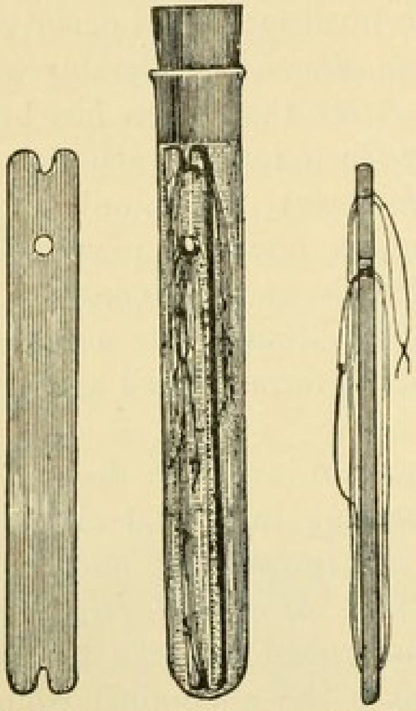


FIG. 1304 FIG. 1305 FIG. 1306

VON ESMARCH'S NEEDLE CASE FOR INTESTINAL SUTURE

To avoid losing time during the operation, by tedious threading of the needle, it is well to have a sufficient number of threaded sterilized needles on hand (for instance, in the intestinal needle-case, Fig. 1305, or some similar arrangement).

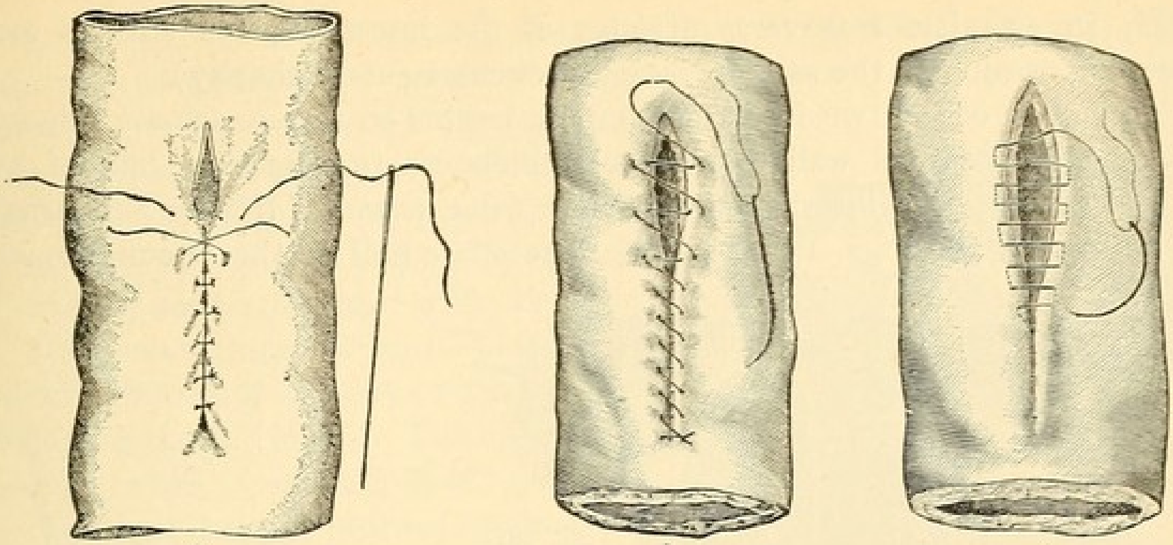
The type of all intestinal sutures now in use is

LEMBERT'S SEROUS SUTURE

1. In making this suture, the needle is inserted about 4 millimeters from the margin of the wound, is carried for some distance between the mucous membrane and the muscular coat, and brought out again closely in front of the margin of the wound. On the other side, the procedure is made in a reversed direction. In tying the knot, the margins of the wound are *inverted;* and *the serous surfaces are brought in accurate contact with one another* (Figs. 1307, 1310). Instead of the interrupted suture, the operator may also use the continuous suture, which can be made more rapidly (Fig. 1308).

(The student should be made familiar with the importance of including in the suture a few fibres of the submucous fibrous coat so well studied and described by *Halsted.* These fibres are the main support of the seromuscular suture.)

2. **Czerny's double-rowed suture** is an improvement upon the former (*so-called* **étage suture**). In the first row of sutures, the wound margins of the serous and the muscular coats are united, and a row of *Lembert's* sutures is applied over them, either interruptedly or continuously (Fig. 1311).



a Fig. 1307 Lembert's — *b* Fig. 1308 Enterorraphy — *c* Fig. 1309 Cushing's

a, interrupted suture; *b*, continuous suture; *c*, quilt suture

3. **Cushing's rectangular suture** is a buried quilt-suture, in which the suturing is done continuously according to *Lembert's* principle. After a *Lembert's* interrupted suture has been applied, the needle is inserted about 3 to 4 millimeters distant from the margin of the wound; it is then carried under the serous coat, through the muscular coat about 3 millimeters distant, and parallel to the margins of the wound; it is brought out again at this place, and carried to the opposite side, where the procedure is continued in

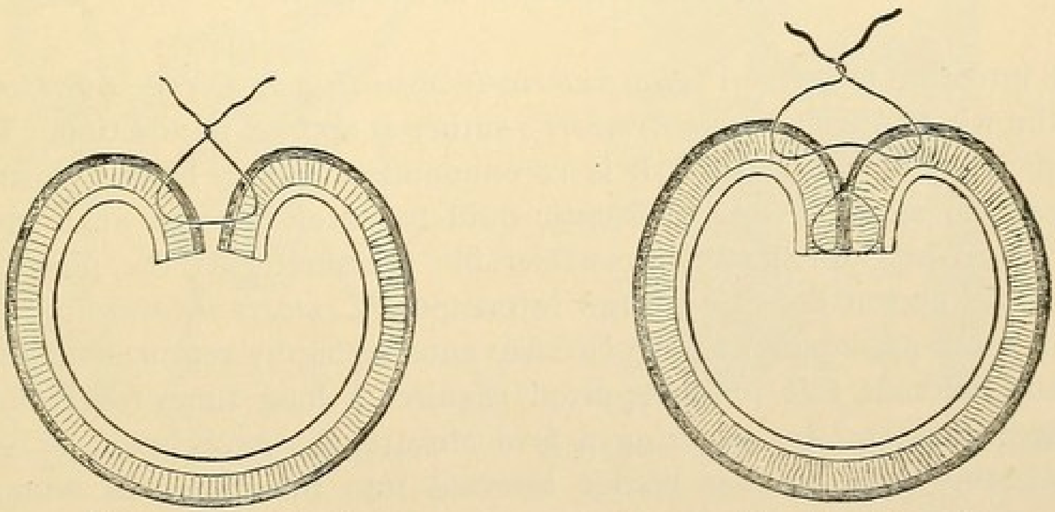


Fig. 1310. Lembert's — Fig. 1311. Czerny's

Diagram of Enterorraphy

a similar manner; by traction on the thread, the suture forms a straight line (Fig. 1309). If necessary, an ordinary row of *Lembert's* sutures may be applied over this.

II. **In complete transverse division of the intestines**, the sutures are applied according to the same principles (**circular enterorrhaphy**).

The union of the two intestinal lumina begins on the *mesenteric* side by uniting the intestinal wall in its whole thickness to about one-half of its circumference with interrupted sutures *from within* (*Wölfler's* **internal enterorrhaphy**, see Figs. 1312, 1313). The other half of the circumference

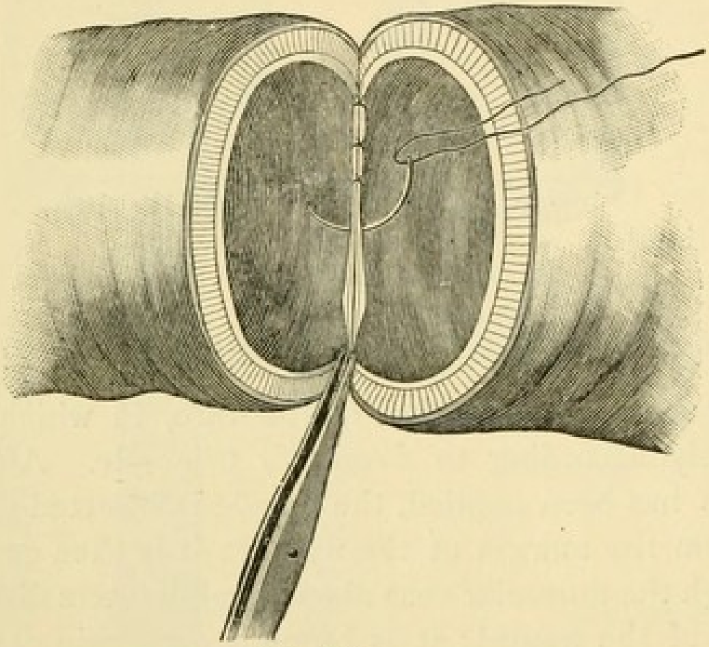


FIG. 1312

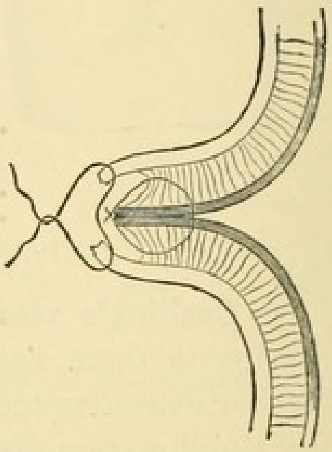


FIG. 1313

WÖLFLER'S INTERNAL ENTERORRAPHY

of the intestine is sutured again *exteriorly according to Czerny's method*, and over the whole a continuous *Lembert's* suture is applied in addition. To test the efficiency of the sutures, it is recommended, shortly before closing the last part, to allow a weak antiseptic fluid to enter through an introduced point of an irrigator, under a considerable pressure. At the place where the sutures appear defective, a few interrupted *Lembert* sutures are applied.

Since the application of the circular enterorrhaphy requires much practice, and, without this practice, often requires a long time, for facilitating this operation and for securing a firm closure, the experiment of uniting the intestine over circular bodies inserted into the intestinal lumen and subsequently evacuated with the fæces was made as early as the Middle Ages. The "four masters" used for this purpose the dried trachea of an animal; *Jobert*, a metal ring; *Amussat*, a grooved wooden ring. Absorbable rings and plates were also used; pieces of macaroni (*Alessandri*), decalcified bone tubes (*Neuber*, Fig. 1314), decalcified bone plates (*Senn*,

Fig. 1323), perforated potato plates and tubes (*Landerer*), turnip plates (*Baracz*), catgut rings wrapped with rubber ligatures or covered with portions of rubber tubes (*Brokaw*), and others. The cartilage plate suture (*Madelung*) is applied externally in the form of a quilt suture. Likewise, *Jobert's* old method of invagination (Fig. 1316) has been attempted with these insertions.

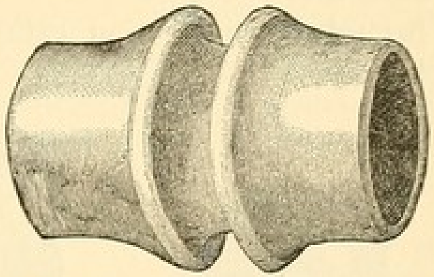


FIG. 1314. NEUBER'S DECALCIFIED BONE TUBE

In recent times, the much praised and much rejected **button of Murphy** (Figs. 1317–1320) has been mostly employed. The two parts of this button, made of nickel-plated sheet iron, consist of bell-shaped concave plates, perforated in the middle, and having a tube-shaped extension; these two extensions fit into one another, and are kept in position by a spring catch. The margins of the intestinal wound are first hemmed with a continuous suture which includes all the coats; one half of the button is then introduced into the lumen; and, by tightening the suture, the lumen of the intestine embraces the tube with the serous coat outside. The same pro-

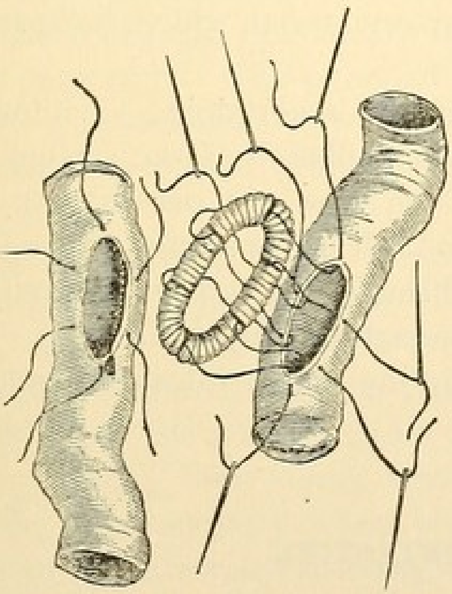


FIG. 1315. BROKAW'S CATGUT RING

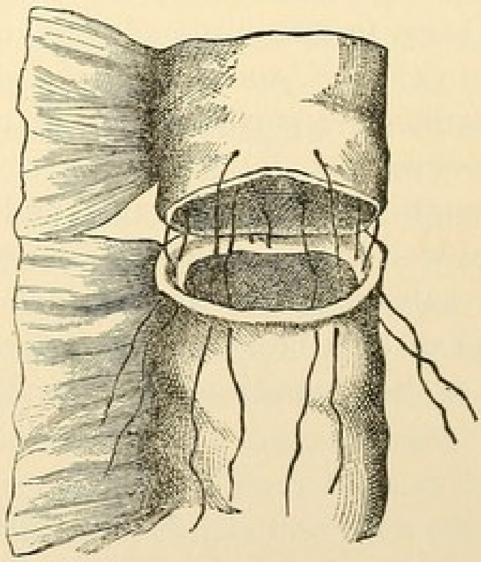


FIG. 1316. JOBERT'S METHOD OF INVAGINATION

cedure is repeated on the other side; then the two tubes are inserted into each other, and the two halves of the button are firmly closed by pressure with the fingers. During this procedure, care must be taken that the little mucous membrane folds are well included between the two sections of the button. The intestinal ends are now well united; the serous surfaces unite promptly; the intestinal rings wedged between the margins of the button become necrosed; the button becomes detached after one or two weeks, falls into the lumen of the intestine, and is evacuated with the fæces. The intestinal connection established by it has the exact circumference of the button.

Fig. 1317

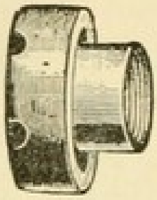


Fig. 1318

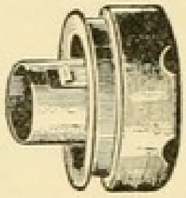


Fig. 1319

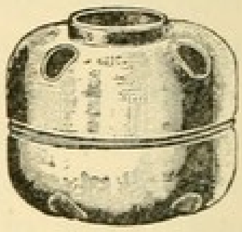


Fig. 1320

Murphy's Intestinal Button

The operation can be made in this manner very rapidly in a few minutes, and hence is especially adapted to very feeble and exhausted patients.

Of course, it is here again necessary that the surgeon be master of the technique, and that he use only buttons of perfect construction. *Frank* had buttons (intestinal coupler) made of absorbable material, which, however, so far seem to offer little advantage.

In case of *penetrating abdominal wounds*, for ascertaining whether any intestines are perforated, *Senn* recommends insufflation of the rectum with *hydrogen gas*, by means of a rubber balloon; the gas passes with ease through the ileocæcal valve, and escapes from all the openings of the intestinal wall into the abdominal cavity, then through the abdominal wound to the outside, where its presence can be demonstrated by *igniting it.* This gas can also be successfully forced through the whole intestinal canal as far as the stomach and out of the mouth.

RESECTION OF THE INTESTINE

The *excision of a portion of the intestinal canal* is to be made: —

(*a*) in *wounds* of the intestine with *contusion* and laceration of its margins.

(*b*) in *gangrene* following volvulus and after separation of the mesentery, and in gangrenous hernias.

(*c*) in *stricture* from cicatrized ulcers or malignant tumors.

(*d*) in adhesions with the latter, which cannot be separated.

(*e*) in *anus præternaturalis* (artificial anus).

The resection must be made throughout in healthy tissue, else gangrene, etc., threaten. It is advisable to cut away rather too much than too little, for even the resection of more than a meter's length of the intestine does not constitute any special source of danger to nutrition. If the surgeon is uncertain about the limit between the healthy and the diseased tissue, it is safest, first only to open the prolapsed loop (artificial anus), and subsequently resort to resection.

The operation is made in the following manner: —

1. From the abdominal incision, the part of the intestine involved is drawn forward, and after its contents have been stripped out with the fingers toward both sides, it is placed outside the abdominal cavity upon warm sterilized gauze compresses, and covered by them as far as possible. If the abdominal incision is very large, it is diminished by a few temporary sutures, to protect against *loss of heat and from infection* (*Madelung*).

2. To prevent the intestinal contents from flowing into the empty loop again, the same is *closed* at both sides, and held firmly either by the fingers of an assistant (the tips of which, if necessary, are compressed by rubber rings) or by strong *silk threads* drawn only moderately tight and passing through a slit made in the mesentery, by strips of iodoform wick, or by the intestinal clamps, such as are used by *Rydygier*, *Heineke*, *Lücke*, and others (see page 687). The points of compression should be made obliquely about 2 to 3 centimeters beyond the intended incisions, so that on the mesenteric side less is clamped off (*Kocher*) and the circulation is not at all impaired.

3. *Detachment of the mesentery. A wedge*, corresponding to the intestinal portion to be amputated, is excised from the same (Fig. 1321); the several injured blood vessels are carefully ligated, and the margins of the wound are sutured together either by applying the sutures according to the thickness of the adipose tissue of the mesentery through its entire thickness, or by uniting both layers separately by the continuous catgut suture; still better, the mesentery, when healthy, is detached *transversely* from its insertion on the intestine (*Kocher*), after each visible vessel has first been sutured close to the intestine. After the intestinal resection has been completed, the superfluous portion of the mesentery is sutured in the form of a longitudinal fold (Figs. 1321, 1322).

In both methods, special care must be taken that *not more of the mesentery is detached than belongs to the intestinal portion to be excised*, and also that, in enterorrhaphy, no lacerations at the mesenteric insertion be made subsequently by violent traction (threatening gangrene).

4. By two sweeps with the scissors, which remain at a distance of at least 2 centimeters from the clamps, *the intestinal portion is excised*, and the interior of the two stumps is immediately sponged with antiseptic solutions. If the two intestinal lumina are of unequal size, *the narrower portion must be cut off in an oblique direction* (*elliptically*) (at the expense of the convex border); else, the wider lumen (thick intestine) is first narrowed by a pouch suture. The hypsiloid suture for correcting the inequality is not to be recommended.

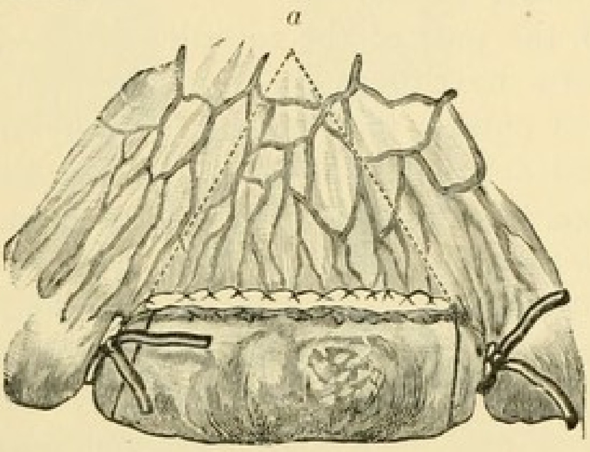


Fig. 1321

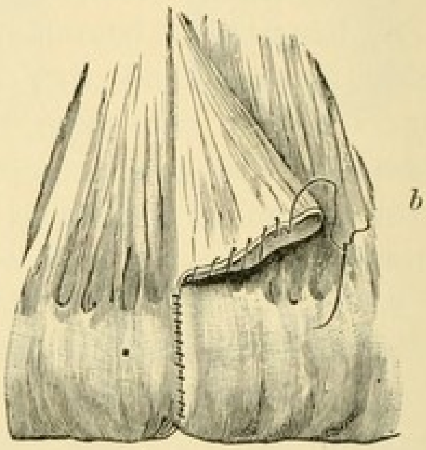


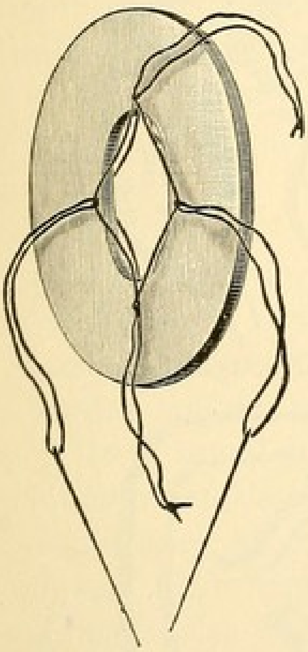
Fig. 1322

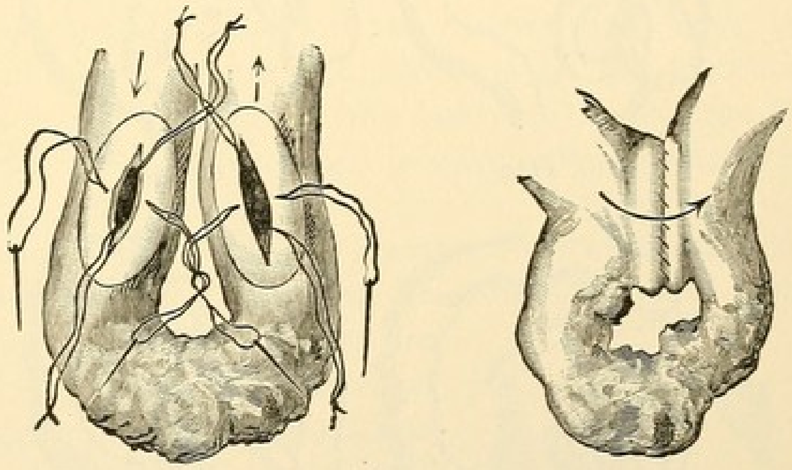
Kocher's Method of detaching Mesentery. *a* . . . . ., cuneiform excision; *b*, applying suture and forming longitudinal fold

5. Next, the continuity of the intestine is restored by a *circular enterorrhaphy*, and is returned into the abdominal cavity; the abdominal incision is closed in the usual manner. *Von Bergmann* protects himself from failures in enterorrhaphy after resection by applying strips of iodoform gauze on both sides of the sutured portion. The ends of the strips are carried out of the abdominal wound. If gangrene (or peritonitis) sets in, it remains localized, as the pre-peritoneal cavity is protected by adhesions around the gauze.

During the first days after the operation, the patient is kept under the influence of opium, and nourished only by enemata; from the third day on, he may receive fluid nourishment; the return to solid diet must be very gradual.

If the intestinal resection appears to be impossible, because intestinal tumors are extensively adherent to the surrounding parts, or if fistulas and callosities render the extirpation of the intestinal section impossible, it is preferable to eliminate the diseased portion by making an artificial channel between the intestinal portions lying above and below the tumor (**entero-anastomosis**), with the intestine apposed *laterally* (*Maisonneuve*, 1854; *Billroth*, 1882), either in the manner described in *gastro-enterostomy*, or, more rapidly and simply, according to *Senn's* method. He introduces into each of the two *longitudinal incisions that have been made in the intestinal wall* an oval decalcified *bone plate,* which has, in its middle portion, an oval opening, to the margins of which four aseptic silk threads are fastened; the two threads at the long side of the bone plate are provided with fine needles (Fig. 1323, *a*); these are passed *from the inside* through the muscular and serous coats of the margins of the intestinal wound, and then the four corresponding pairs of threads are tied together. Thereby the serous surfaces of the two intestinal portions are pressed against each other with moderate firmness, and the intestinal contents can pass through the openings of the bone plates fitting upon each other (Fig. 1323, *b* and *c*). Very soon





a *b* *c*

FIG. 1323. SENN'S ENTERO-ANASTOMOSIS. *a*, bone plate; *b*, introducing plates; *c*, suture Bone plates fitting upon each other

a broad adhesion of the intestinal walls takes place between and near the plates; the latter, after they have answered their mechanical purpose, become softened by the intestinal contents, and are digested.

To perform this operation, only *a very short time* is required. For safety's sake, the serous membranes of the intestinal walls lying in approximation may be stitched together in their whole extent by a few *Lembert* sutures (Fig. 1323, *c*).

For these plates, which must be kept on hand, *catgut*, if necessary, *and rubber rings* may be substituted; over a bundle of catgut, several rubber tubes about 2 centimeters long are drawn, and tied together in a ring (*Brokaw*, Fig. 1315). *Murphy's* button (Fig. 1317) is also extensively used for this purpose.

But for removing in the diseased section the continuous irritation by the fæces and peristalsis, *Sälzer* (1891) introduced **local exclusion of the diseased part**, — that is, the excision of a portion of the alimentary canal from the remaining intestinal canal in such a manner that the excised diseased intestinal portion remains in its natural position, but that its ends are sutured or implanted into the abdominal wound, while the extremities of the healthy, functionating intestine are united together. The operator can proceed variously, either by suturing both extremities of the eliminated portion and by

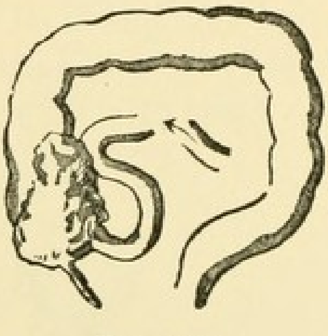


Fig. 1324

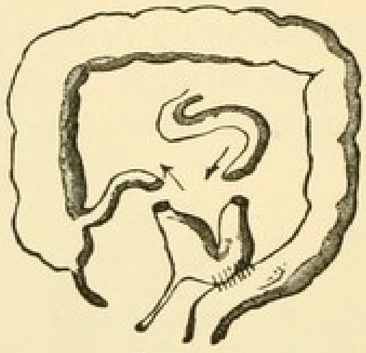


Fig. 1325

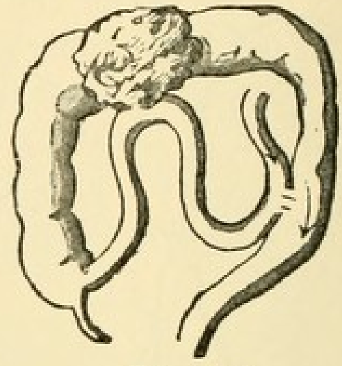


Fig. 1326

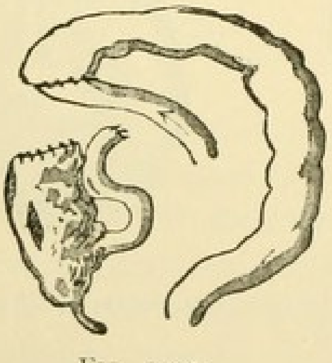


Fig. 1327

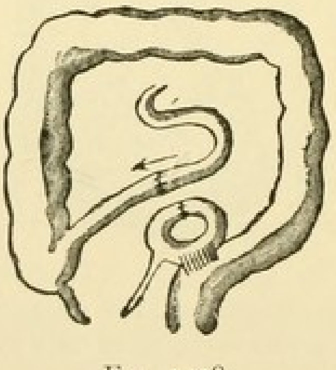


Fig. 1328

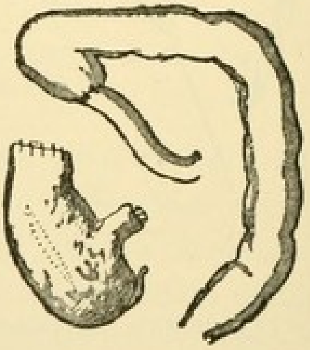


Fig. 1329

Various Methods of Local Exclusion of Diseased Intestine (von Eiselsberg)

Figs. 1324, 1327: exclusion of ileocæcal part; an abdominal fistula exists in the cæcum. Figs. 1325, 1328: exclusion and circular union of part of small intestine, firmly adherent to sigmoid flexure. Fig. 1329: total exclusion of an ileocæcal part

burying it (in already existing abdominal fistulas in the eliminated portion), or by suturing both extremities into the abdominal wound, or, finally, by suturing to the peritoneum only the distal end (as a safety valve) and burying the sutured proximal portion, — this procedure is the one to be recommended. The two healthy intestinal portions are then sutured together wound to wound (circular union), by lateral grafting of the proximal portion into the sutured distal one, or by occlusion of both extremities and lateral anastomosis. The success of this operation in most cases is surprisingly good. The excluded portion can be treated with remedies through the fistula, and can be irrigated; subsequently, with an improved condition of the patient, it can be extirpated.

(*Hochenegg*, *Frank*, *von Eiselsberg*, *Bier*, and several others have made this operation successfully.)

In *pericæcal abscesses* (*perityphlitis*) from suppuration and perforation of the vermiform appendix (**epityphlitis**, appendicitis), **the resection of the diseased vermiform appendix** is the best means to ward off the dangers of threatening general peritonitis and its recurrence. If possible, in recurrent epityphlitis, the resection is not made during the attack, but during a free interval.

For this purpose an *incision* is made 10 to 12 centimeters long, either in the same manner as *for ligating the iliac artery* (see page 270), or at the external border of the rectus abdominis muscle (*Gerster*). The vermiform appendix lies 5 centimeters inwardly (toward the median line) from the anterior superior spine of the ilium in the direction of the umbilicus (*McBurney*). After incision and irrigation of the cavity of the abscess, the appendix is sought for at this place (sometimes it is surrounded by cicatricial bands), and drawn forward very cautiously.

It is found in very various positions and lengths, downward from the junction of the ilium with the cæcum. Next, the mesenteriolum (little duplicature of the peritoneum) and its artery are ligated and separated. The appendix is divided transversely, near the cæcum, all around as far as the mucous membrane; the latter is ligated, and divided in front of the ligature with the knife or the thermo-cautery. Next, the serous and muscular coats are drawn over the stump of mucous membrane, and likewise ligated. The little that remains may then be inverted into the cæcum, and the depression caused thereby can be sutured according to *Lembert*. The abdominal wound is then either closed, or, if it is a matter of abscesses, tamponed. If *any perforations are found in the cæcum*, they can likewise be closed by *Lembert's* sutures or by a lateral ligature (see Fig. 1233).

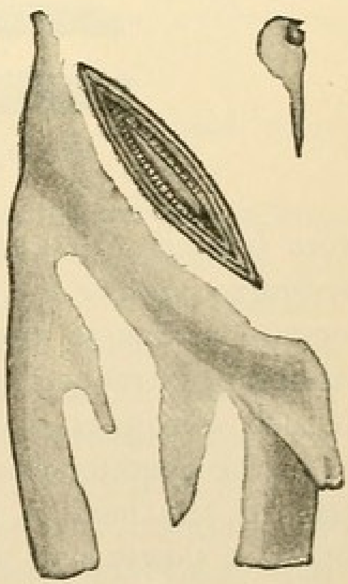


FIG. 1330. CÆCAL INCISION

(Doyen's method of removing the appendix in the relapsing form of appendicitis has much to recommend it. After the appendix has been liberated, the muscular and mucous walls are crushed by applying at the proposed point of amputation compression forceps. This leaves only the serous coat, which is included in a fine catgut ligature. The stump is covered by a tobacco-pouch suture.)

ANUS PRÆTERNATURALIS,

which either originates of itself after the opening of *fæcal abscesses*, or is made purposely if, in herniotomy, the intestinal loop is found to be gangrenous, as a rule must be closed by artificial means.

In anus præternaturalis of long standing the proximal and the distal intestinal ends place themselves in approximation more or less at an acute angle, and a broad connective tissue *adhesion of their mesenteric surfaces* is formed there, — the so-called **spur**, a band-like projection which *almost completely prevents* the flow of the fæces into the distal end. In order that the fæces may pass through the natural channel, *the removal of this spur* is necessary.

For this purpose *the intestinal scissors*, *intestinal clamps*, devised first by *Dupuytren*, and subsequently largely improved (*Blasius*, *Collin*, Fig. 1331),

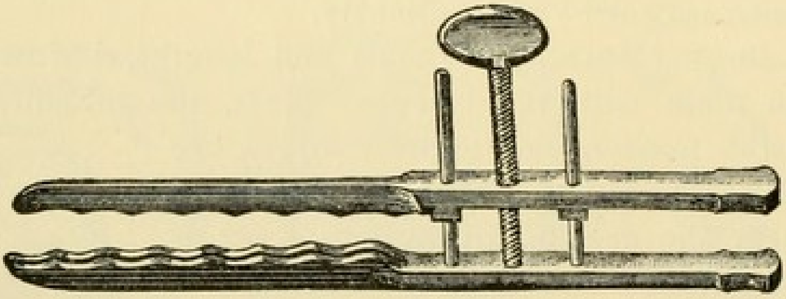


FIG. 1331. DUPUYTREN-BLASIUS' INTESTINAL CLAMPS

were formerly used exclusively. The same were intended to destroy by *pressure-gangrene* the spur-like septum. After the spur has been drawn forward as far as possible with tenaculum forceps, the two blades of the clamp are introduced under the protection of the fingers; they are applied in such a manner that they grasp about $1\frac{1}{2}$ to 2 centimeters of the spur. After the operator has once more convinced himself that the clamp has not grasped any healthy intestinal loops in the depth, the clamp is screwed together slowly and loosely, during which procedure the patient should not experience any considerable pains (Fig. 1332, *a*). Every day the screw is turned tighter, until after three to eight days the spur is divided, and the instrument falls off of its own accord. A small cleft has been formed in the spur. Since this is not yet sufficient, the same procedure must be repeated on the adjacent parts. During the treatment the patient receives opium internally and non-stimulating bland food.

If the obstruction has been removed in this manner, *the healing of the abdominal wound* sometimes takes place spontaneously; to promote cicatrization, the thermo-cautery is applied; still more rapidly is closure obtained by a plastic operation. In a simpler manner, *Köhler* forced back the obstructing spur by means of caoutchouc tubes as thick as the thumb and 24 centimeters long; these were inserted into both extremities. Defæcation subsequently very largely took place "per anum," and the opening decreased considerably in size.

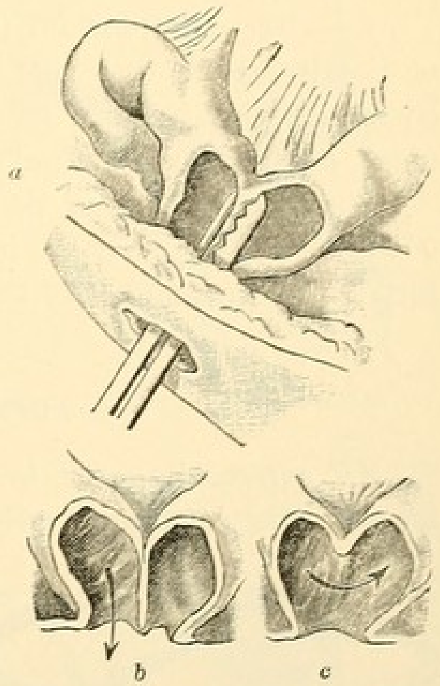


FIG. 1332. ANUS PRÆTERNATURALIS. *a*, clamp applied; *b*, section of spur; *c*, after operation

With a view of saving the patient the annoyance of continuous escape of fæces through the artificial outlet, the opening can be closed with compresses, in the same manner as a bottle is closed with a cork. *Lauenstein* used for this purpose hard or soft rubber plugs; *von Bergmann*, a double rubber ball (like a shirt button) for insufflation (Figs. 1333, 1334).

In modern times, however, under the protection of asepsis, the operator is justified in opening the abdominal cavity and *in resecting the adherent portion of the intestine*, whereby success is obtained more rapidly.

1. First, for securing more effective asepsis, the opening in the abdominal wall with the two intestinal lumina is circumscribed with the knife in the shape of a myrtle leaf; the skin lying between the margins of the incision and the intestinal openings is dissected off from the fascia, and folded together over the intestinal opening. The margins are then placed perpendicularly to each other, and united by a continuous suture so closely that no intestinal contents can escape.

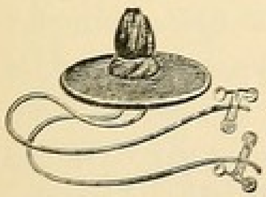


FIG. 1333

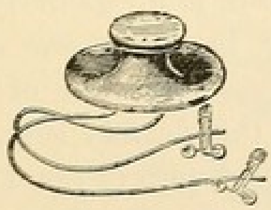


FIG. 1334

VON BERGMANN'S DOUBLE RUBBER BALL

(The editor has for a number of years resorted to transverse preliminary suturing of the intestinal opening as a safe precaution against infection during the operation. After the field of operation is once more disinfected and the intestine detached, this row of sutures is covered by Lembert stitches.)

2. The abdominal cavity is now opened; the intestinal loop is detached and drawn forward from the wound. The latter is decreased in length temporarily by a few sutures.

3. After clamping off the two ends in the manner described in resection of the intestine, they are separated transversely at a suitable place, and a corresponding portion of the mesentery is detached. Then follows the union of the two intestinal ends by *circular enterorrhaphy* (see page 704).

This operation can be performed with greater facility by resorting to *Trendelenburg's position,* in which all movable intestines gravitate toward the diaphragm, and only the adherent intestinal loop remains in the wound.

OPERATIONS FOR HERNIA

All enteroceles must be *retained,* if possible, by suitable **trusses**; else the swelling constantly enlarges, and the danger of *strangulation* is always increased. The wearing of a truss in infants and young children may often effect a radical cure.

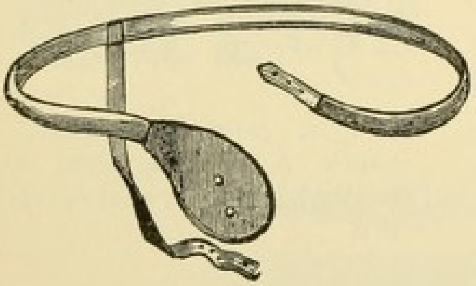


FIG. 1335. GERMAN TRUSS

Trusses in reality are composed of a *pad* (*pelotte,* cushion), which is pressed against the seat of the hernial protrusion, or the mouth of the hernial sac, by means of an elastic steel spring applied around the pelvis, so as to prevent effectually and permanently the descent of the abdominal contents.

In the **German truss** (Fig. 1335), the pad is *immovable,* and is connected at an obtuse angle with the spring encircling the pelvis on the *diseased* side. By a strap or belt, the pad is held in position more securely (Figs. 1336, 1337).

In the **English truss** (*Salmon*), the pad, *movable on a ball-and-socket joint,* is connected with the spring, which, by means of a posterior pad, is supported on the sacrum, and encircles the *healthy* side of the pelvis. In this truss, the strap can often be dispensed with (Figs. 1339, 1340). Of the many modifications of the pads we may mention here only the glycerine pad, which can be filled from without and the pressure regulated at pleasure (Fig. 1338), and the circular air pad, which is said to apply itself everywhere, more accurately over the hernial canal, than the common leather pads.

In the **truss for umbilical hernia**, the pad is pressed upon the hernial opening by means of a circular *elastic strap* surrounding the abdomen. *In small children*, umbilical hernias can be most successfully treated in most cases by small pads (balls of cotton), which are kept in position by strips of

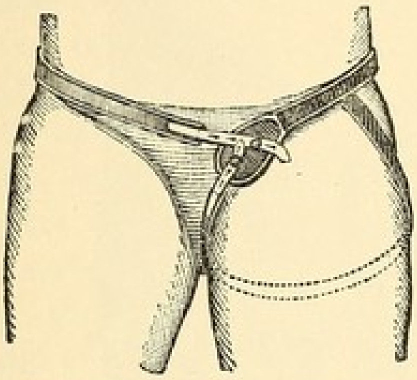


FIG. 1336. For Inguinal Hernia

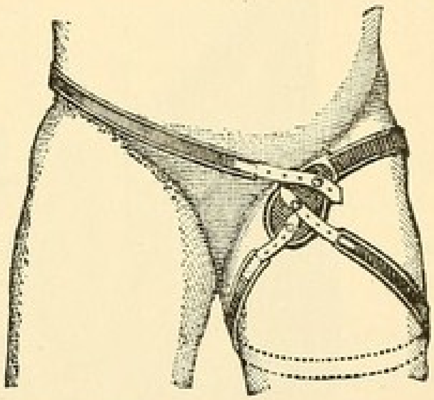


FIG. 1337. For Femoral Hernia

GERMAN TRUSS APPLIED

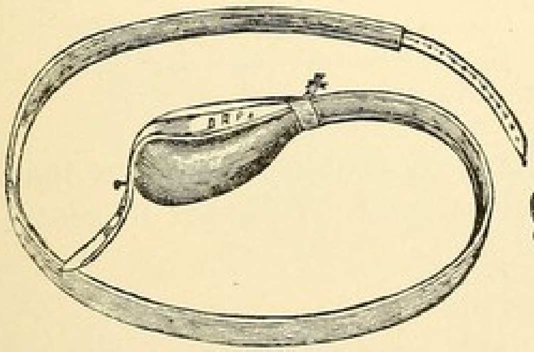


FIG. 1338
TRUSS WITH GLYCERINE PAD

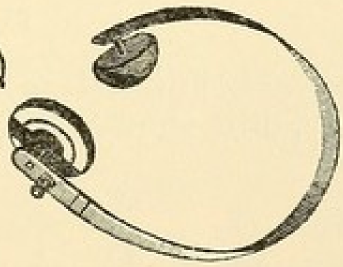


FIG. 1339

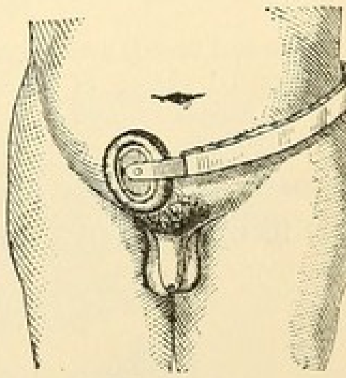


FIG. 1340

ENGLISH TRUSS

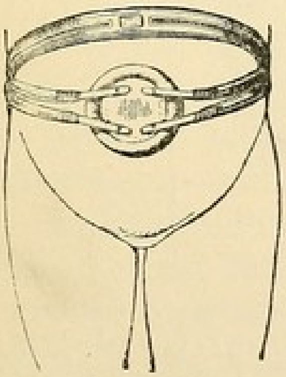


FIG. 1341

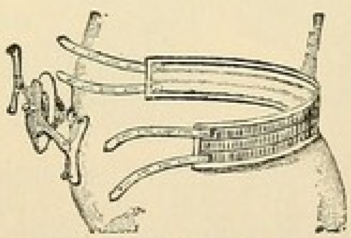


FIG. 1342

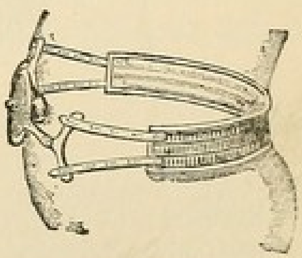


FIG. 1343

TRUSSES FOR UMBILICAL HERNIA

adhesive plaster upon the skin, raised in two folds on each side of the hernial opening, or by means of a rubber bandage, with a small hemispherical rubber ball, which must be applied over the hernial canal (Figs. 1341–1343).

Each truss should be manufactured by the trussmaker, under the supervision of the surgeon, since it is often very difficult, and sometimes almost

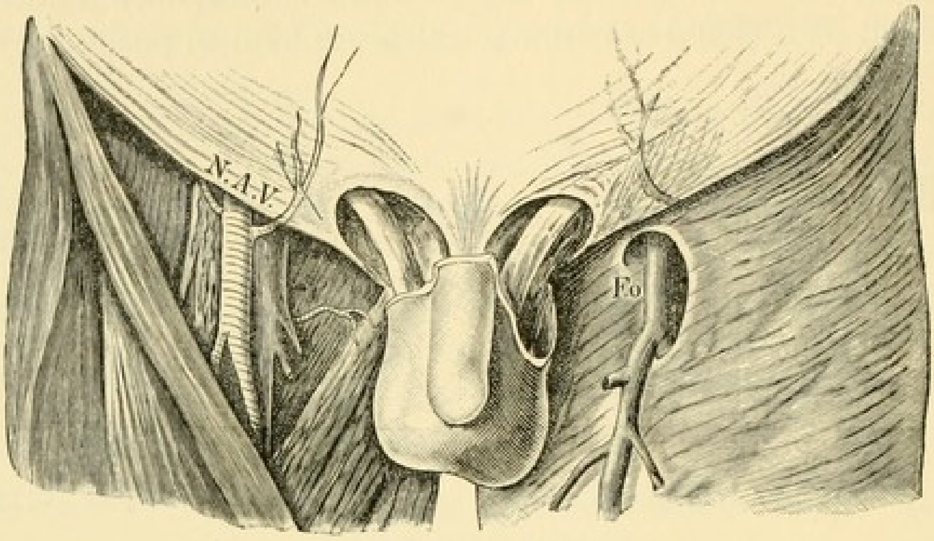


FIG. 1344. ANATOMY OF INGUINAL REGIONS

Femoral vessels and epigastric artery
External orifice of inguinal canal and spermatic cord

Fascia lata and saphenous opening (*Fo*) through which the saphenous vein passes to join femoral

impossible, to make a perfectly fitting truss; a badly fitting truss, or one that fails to operate effectively, does more harm than good. In order to ascer-

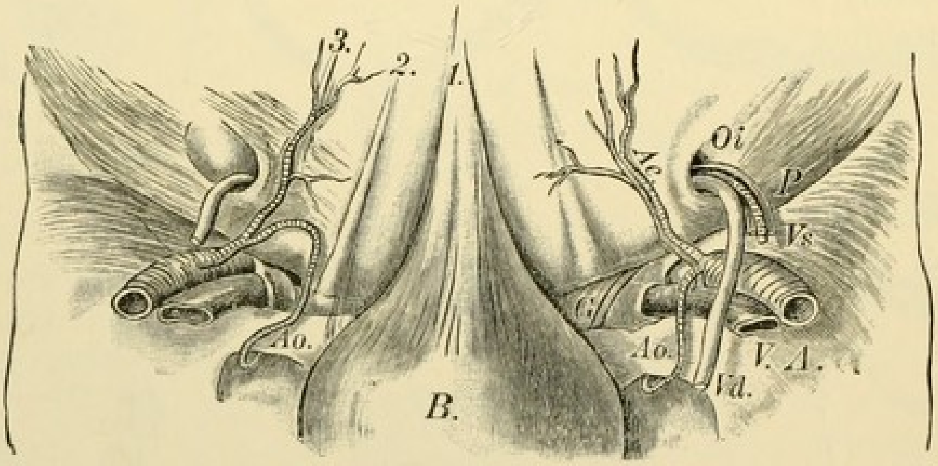


FIG. 1345. ANATOMY OF INGUINAL REGION (Internal Abdominal Side). *B.* bladder; *P.* Poupart's ligament; *G.* Gimbernat's ligament; *Oi.* internal orifice of inguinal canal; *A.V.* femoral artery and vein; *Ae.* epigastric artery; *Ao.* obturator artery (coming off from the anterior division of the internal iliac); *Vs.* spermatic vessels; *Vd.* vas deferens. 1, middle hypogastric or urachal fold; 2, hypogastric fold; 3, epigastric fold. Between 1 and 2 lies internal inguinal fossa; between 2 and 3 lies middle inguinal fossa; externally of 3 lies external inguinal fossa

tain whether a truss safely prevents the hernial protrusion, the patient is requested to bring into play the muscular apparatus by which the abdomen is compressed (a crouching position, coughing), to spread his legs, to ascend stairs, etc.

If a hernia is strangulated, an attempt should *always* be made to reduce it into the abdominal cavity in a bloodless manner (**taxis**) (provided the surgeon can exclude gangrene).

The procedure is as follows: —

The patient lies upon his back, with *his pelvis elevated* and his legs and thighs flexed for relaxing the abdominal walls and, hence, removing all tension from the hernial opening. Next, by a gentle, gradually increasing pressure with the finger tips and the whole hand, the operator attempts to reduce the hernial contents into the abdominal cavity. If, by this manipulation, the hernia does not soon recede, the surgeon may try to obtain the desired end by *drawing forward* the hernia and by *lateral manipulations* to and fro, *by massage*, and by directing the pressure upon *the neck of the hernial sac*, and by reducing always only a little of the contents at a time.

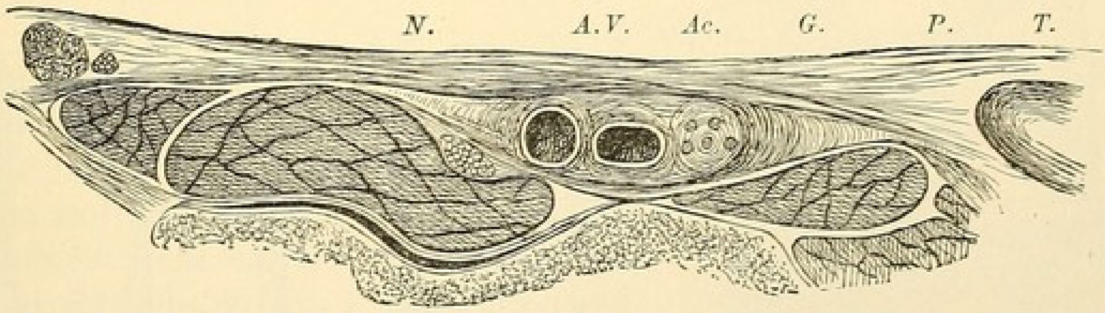


FIG. 1346. FRONTAL SECTION THROUGH CRURAL ARCH. *N.* crural nerve; *A.V.* femoral artery and vein; *Ac.* crural ring (weak spot where femoral hernias frequently occur) (crural septum); *G.* Gimbernat's ligament; *P.* Poupart's ligament; *T.* tuberculum pubicum

The use of anæsthesia may essentially aid these attempts, by securing complete relaxation of the abdominal muscles and insensibility of the patient to pain. The application of cold (ice bag, spraying with ether or ethyl chloride) is often of signal service.

In large old inguinal hernias, sometimes reduction is effected by applying an elastic bandage over the whole hernia, and by applying an ice bag.

All these attempts must be made quietly and persistently, without exerting too much force; they must not be continued too long (about a quarter to half an hour); for *herniotomy* is safer and less dangerous than taxis continued too long and made too forcibly (laceration of the hernial sac, of the intestine, "reposition en bloc").

NOTE. — The old procedure of Fabricius ab Aquapendente, of suspending the patient by his legs and shaking him, has sometimes, in desperate cases, brought about the desired result, since in this position the intestines gravitate toward the diaphragm, and hence produce traction from within upon the incarcerated intestinal loop. *Trendelenburg's high pelvic position* operates in the same manner; with this, anæsthesia can also be employed.

If, however, all these endeavors have proved unsuccessful, herniotomy must be made at once.

HERNIOTOMY

1. **External incision** across the most prominent part of the swelling at the place of strangulation, after a transverse fold of the skin has been raised; it is advisable to make the incision not too small (Fig. 1347).

2. **Exposure and incision of the hernial sac.** Between two forceps at the eminence of the swelling, *near the neck of the hernial sac*, gradually all movable layers of cellular tissue covering the hernial sac are carefully raised and divided in the manner described in the chapter on *ligation of arteries* (page 251). The incisions must divide only the raised fold.

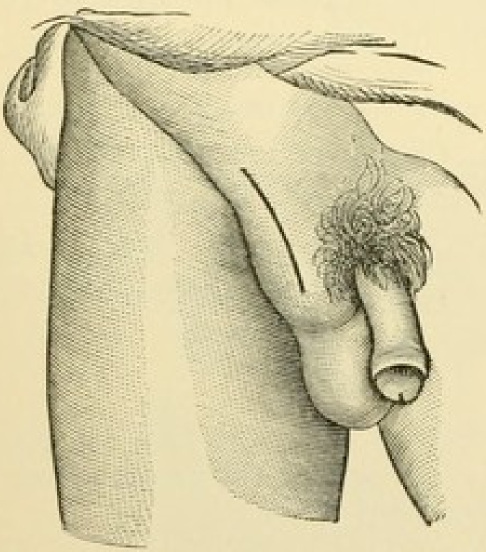


FIG. 1347. HERNIOTOMY (External incision)

As soon as the cellular tissue folds can be raised, with difficulty, or not at all, the operator may assume that he has reached the hernial sac; into the short incision that has been made, a grooved director is introduced in the direction of the two angles of the wound, and upon it all of the layers of the hernial sac are divided until the entire anterior wall of the hernial sac is freely exposed.

The hernial sac as a rule *may be recognized* by its smooth surface, by the small adipose lobules (subserous fat) lying scattered upon it, and by the serous effusion shining through the same. Hence, if the operator is in doubt whether the hernial sac or an intestinal loop lies before him, he should attempt to raise a small fold with his fingers, and rub the inner surfaces of the fold upon each other. If the membrane, on palpation, appears to be thin-walled, it is the exposed hernial sac, for the œdematous swollen intestinal walls are much thicker on palpation, and cannot be raised at all in folds. If the hernial contents are *adherent* to the hernial sac under the incision, so that no thin fold can be raised with the finger tips, the operator seeks and generally finds another place, the condition of which no longer leaves any doubt. Here the hernial sac is now raised between two forceps, so that a small fold is formed, and with the knife or scissors *a small incision* is made, from which the serous effusion immediately escapes with some force; into this opening, the operator introduces a grooved director, upon which *he divides* the hernial sac *in its entire length*, so that he is able to survey the entire hernial contents.

3. With the finger, introduced toward the neck of the hernial sac, he examines the *seat of the strangulation*, and ascertains whether any adhesions exist, by palpating the hernial contents on all sides with the finger. If adhesions are found, they must be separated carefully and bluntly; but if they are too firm, they are detached with the knife in such a manner that thin portions of the wall of the hernial sac remain adherent to the intestinal wall.

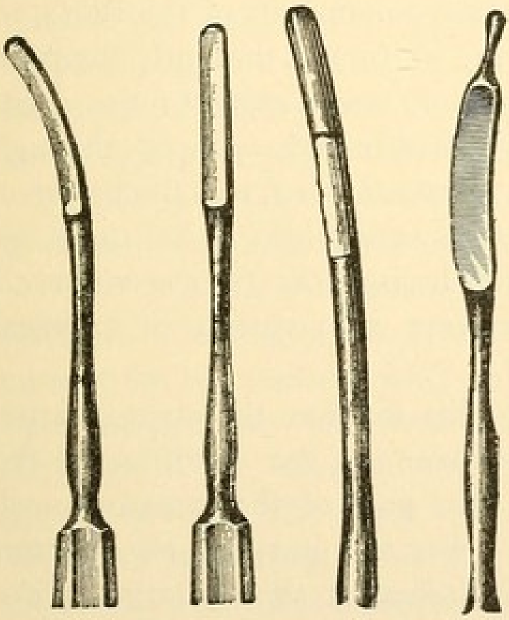


FIG. 1348. HERNIA KNIVES (Herniotomes)

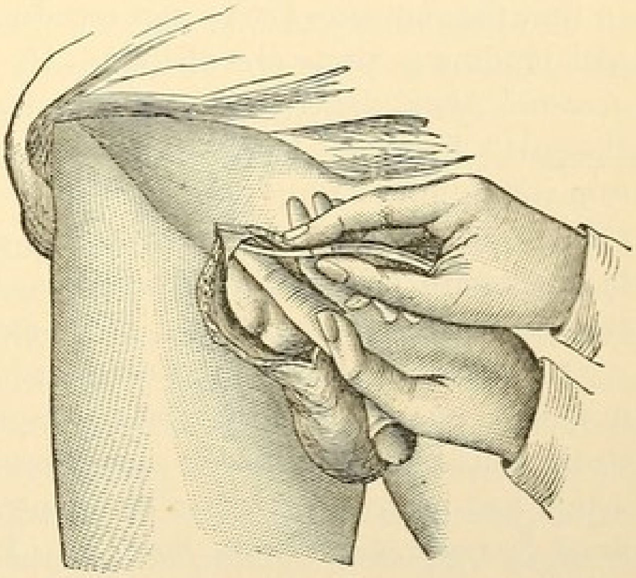


FIG. 1349. HERNIOTOMY (Relieving strangulation)

4. **Relieving the strangulation**. A *hernia knife* (*herniotome*) (Fig. 1348) is pressed lengthwise with the blade upon the volar surface of the left forefinger, and the finger is advanced as far as possible toward the hernial opening, until its point feels the incarcerating ring. In this position, with a slowly increasing pressure, the œdema of the intestinal loop can often be displaced so far that the tip of the finger can penetrate into the constricted portion of the hernial canal. Next, the blunt end of the herniotome is pushed over the tip of the finger into the abdominal cavity; the edge of the knife is directed against the strangulating margin; and the margin *is nicked by pressing* the back of the knife with the finger. Pulling and cutting move-

ments *must be avoided.* These nicks may be repeated *at several places* of the hernial ring (*Vidal*) (and then only superficially), until the finger tip can be pushed with ease into the abdominal cavity alongside the strangulated intestine.

The location of the strangulating ring at which these nicks are made depends entirely on the kind of hernia.

In external inguinal hernia, *the hernial ring is incised in an outward direction;* in **internal inguinal hernia,** *inward* (to avoid *the epigastric artery*). If any doubt exists as to which of the two kinds of hernia is present, the incision is made **in an upward direction** (*Scarpa*).

In internal femoral hernia, *the incision is made* **inward** *toward Gimbernat's ligament;* and, since the *obturator artery*, springing from the *epigastric artery*, may take its course at this place (corona mortis) (Fig. 1345), the cut must be made *only by pressure*, — not by drawing movements of the knife, — so that the movable artery can recede from the knife and that only the rigid and tendinous parts are divided. By an incision made *outward* the great *femoral blood vessels* would be endangered if directed *upward* through Poupart's ligament, the *epigastric artery*, *the spermatic cord*, and the ligamentum rotundum or teres; *inferiorly*, *the saphenous vein* might be injured. *In strangulations in* **the fossa ovalis,** the operator incises *the falciform process* **in an inward and upward direction.** In the very rare variety of **external femoral hernia,** the incision is made **outward.**

5. **Returning the hernial contents.** If in this manner the strangulation has been removed, the operator has next to examine the condition of the strangulated intestinal loop and, above all, that part of the intestinal wall which had been subjected to direct pressure. For this purpose, *the intestine must be somewhat drawn forward.* If at the place of strangulation a *discolored gray streak is found*, it is to be feared that *perforation* will occur at this place; the same fear must be entertained if the intestinal loop itself presents *a dark bluish, black, or brownish color*, with a *dull* surface, having lost its *glistening, shiny appearance;* such a loop *must not be returned.*

6. If the intestine is still in good condition — that is, if it displays a *smooth, glistening surface*, if it is colored *pale red* to *dark bluish red* (venous stasis), if it turns somewhat paler from pressure of the finger, and if peristalsis is excited on touching it with a crystal of sodium chloride — it is *gently sponged with an antiseptic solution, and returned into the abdominal cavity* by pressure of the fingers as in taxis. If any difficulties arise during this manipulation, the hernial sac *is drawn tense* at its margin with dissecting forceps, whereby the obstructing formation of folds is removed.

7. The hernial sac and its neck can now be treated as described in the **radical operation** (see page 722).

If, however, the intestine presents *a suspicious appearance*, it may perhaps be returned, but *a drainage tube must be introduced into the neck of the hernial sac*, and the wound must be *tamponed* to prevent retention of pus, and peritonitis.

If a perforation is to be apprehended from *gangrene* of the intestinal loop, the intestine is not returned; the operator allows it to remain *outside of the abdominal cavity* in order to see whether it recovers and gradually recedes into the abdominal cavity, or whether a perforation takes place (*anus præternaturalis*).

But, *if gangrene is already clearly manifest*, the intestinal loop must be prevented from slipping back, and must be *fastened* in front of the neck of the hernial sac, preferably by a thin bar or drainage tube wrapped with iodoform gauze. This bar is pushed through a buttonhole made in the mesentery (Fig. 1302); besides, the intestinal wall may be stitched to the surrounding parts by interrupted sutures, so that it cannot recede.

If the gangrenous hernia has perforated into the hernial sac, a free incision of the hernial sac is sufficient.

The immediate resection of the gangrenous intestinal portion with subsequent *enterorrhaphy* has often been made successfully. Since, however, it cannot be ascertained, with any degree of accuracy, how far the inflammation extends into the intestinal wall, and since the sutures do not hold securely in the inflamed tissue, a failure of the operation is always to be apprehended. The long duration of such an operation under anæsthesia, with patients whose general condition has suffered from the strangulation, must also be well considered. The latter disadvantage, however, might be avoided by postponing enterorrhaphy (which takes a very long time) until the following day; it is then made *without anæsthesia*, since the operation causes but little pain. *Helferich* makes above the gangrenous place an intestinal anastomosis, which can be rapidly effected.

If other contents than the intestinal loop are found in the hernia, the operator must attempt to return the same into the abdominal cavity, if in a normal condition (*ovary*, *bladder*). If he finds adherent, knotty, indurated, and *hypertrophic* (*lipomatous*) *omentum*, *it is cut off* near the neck of the hernial sac after previous multiple *manifold ligations*, and the pedicle is returned into the abdominal cavity.

(The stump of the omentum, especially if it is large, should never be reduced into the free abdominal cavity, because it retracts and in the small intestinal area visceral adhesions are very liable to occur which may become the direct cause of intestinal obstruction. The stump should be anchored above the inguinal canal to the abdominal wall with a strong catgut suture.)

RADICAL OPERATION FOR HERNIA

is made (*a*) after *herniotomy*, if the intestine and the surrounding tissues are in a favorable condition.

(*b*) In *reducible hernias*, when they cause trouble and can be kept in position by means of trusses only with difficulty, or not at all.

(*c*) In *irreducible hernias*, if they become troublesome.

(*a*) IN INGUINAL HERNIA

The procedure is as follows: —

1. **External incision** by raising a fold of integument over the eminence and largest diameter of the hernia.

2. Careful **exposure of the hernial sac** between two dissecting forceps in the manner described on page 718; likewise, the several layers of the loose cellular tissue surrounding the hernial sac, as far as they are not too firmly adherent, may be divided upon a grooved director, or upon a *Kocher's* director, until the hernial sac itself is reached. From the same, the layers of cellular tissue are freed bluntly on all sides with the handle of a knife, or a *Kocher's* director, until the whole hernial sac is entirely exposed as far as its neck.

3. The neck of the hernial sac is detached bluntly on all sides of the inguinal canal, and as high up as possible. After the hernial contents have been returned into the abdominal cavity by gentle stroking and compressing manipulations, **strong traction is made upon the empty hernial sac**, and its neck is **firmly ligated** as high up as possible with strong catgut ligatures; to guard against *slipping of the ligature*, its ends can be carried with a needle *through* the hernial sac closely below the ligature, and tied around it on both sides.

4. A little below the place of ligation, the hernial sac is **cut off** transversely with knife or scissors, and the stump is returned into the abdominal cavity through the hernial opening.

If, in case of adhesions of the hernial contents, the hernial sac must be freely opened to enable the surgeon to find and separate the adhesion, *Czerny* recommends uniting, by a continuous suture from within, the serous surfaces of the neck of the hernial sac, forcibly drawn forward.

5. **Closure of the inguinal canal.** *Its pillars are united by interrupted sutures.* For suturing, either *strong silk thread* or *silkworm gut* or, best of all, *silver wire* is used, the ends of which are not knotted, but twisted (*Schede*). If the operator sutures with silk, the *continuous bodice suture* or *Czerny's lace suture* may be used.

Vivifying the pillars of the canal is unnecessary, as well as a complete closure of the same, which, in inguinal hernia, must be omitted even, in order not to compress the spermatic cord emerging from the lower angle of the canal. Provided the canal remains permanently contracted, the success of the operation is well assured.

In congenital inguinal hernia, the spermatic cord is found attached to the entire length of the hernial sac, so that it is difficult to separate it. In this case, it is advisable to leave the hernial sac together with the testicles in the scrotum, and to detach it from the spermatic cord only above in front of the neck of the hernial sac, and to ligate the latter. The lower portion of the sac containing the testicle is incised, and obliterated by tamponing (*Schede*, *Kraske*, *König*).

In *adherent hernias*, the adhesions must be separated after opening the hernial sac, and the hernial contents must be returned. If the operator finds degenerated omentum, it should be cut off after previous ligation. If the isolation of the hernial sac causes any difficulties — especially as is the case in large hernias in old people — or if the hernial sac is inflamed, which occurs in some herniotomies, it is advisable not to separate the hernial sac, but to tampon it after incision, and to close the wound later by secondary sutures.

6. The wound of the skin is closed in its whole extent by sutures; for dressing, iodoform collodion, plaster of oxide of zinc gauze, etc., are very convenient; or the usual antiseptic compress held in by a spica bandage is applied.

During the first three or four days after the operation, the patient receives small doses of opium and fluid nourishment. The bowels should not move before the fourth or fifth day. The wound of the skin heals completely after eight or ten days.

To secure the success of the operation, the patient is obliged in most cases to wear a *truss* to prevent a yielding of the cicatrix, and thereby a recurrence of the hernia. In spite of all these precautions, after the just-described simple ligation of the neck of the hernial sac and the suturing of the canal, relapse is comparatively frequent.

Macewen, Bassini, and many others recently tried by another procedure *to obtain permanent success without the wearing of trusses after the operation.*

Starting with the idea that by simply ligating or suturing the hernial sac *a funnel-like pouch* always remains on the peritoneal disk above the canal, into which, during coughing, etc., the contents of the abdominal cavity are impelled like a wave, and which tends to enlarge the canal like a wedge, Macewen tried to prevent this unfortunate condition and the consequent relapse. **He forms a plug of the folded hernial sac**, which, having been returned into the abdominal cavity, resists the pressure of the abdominal contents like a pad. The walls of the canal, from which the neck of the hernial sac has been detached bluntly, are contracted by a double suture, drawing the internal pillar of the canal toward the external one and toward the strong ligament of Poupart.

The operation in inguinal hernia is made in the following manner: —

1. After reduction of the hernia, *the skin incision* is made across the hernial neck, and the external inguinal ring is exposed (Fig. 1350); the finger penetrates into the inguinal canal, and locates the position of *the epigastric artery*.

2. *The hernial sac is detached*, together with the adipose tissue adhering to it, and is drawn downward and made tense; the finger, introduced into the inguinal canal, detaches the sac from the spermatic cord and all around from the abdominal walls as far as and above the internal inguinal ring (Fig. 1351).

3. **Suturing of the hernial sac.**

A needle with a strong catgut thread knotted at the end is passed through the lower end of the hernial sac, and then carried through the sac in an upward direction several times in turns (Fig. 1352, *a*). By drawing the ligature tight, *the sac is folded* together *into a puckered mass* like a furled sail (Fig. 1352, *b*); the free end of the thread is inserted into a hernia needle provided with a handle, carried upward through the hernial canal, and brought out again 1 centimeter above the internal opening, through the anterior abdominal wall, while the skin is drawn laterally (Fig. 1352, *c*, *d*).

The ligature is taken out of the needle and drawn tight until the folded hernial sac disappears in the inguinal canal and places itself like a ball valve *in front of the internal inguinal opening*. The ligature is held firmly by an assistant until the inguinal canal is closed; afterward it is fastened by several stitches through the superficial layer of the external oblique muscle.

4. **Suturing of the inguinal canal.**

For this purpose *Macewen* uses two eye-needles provided with handles, one of which is bent off laterally to the right, the other to the left (Fig. 1353, *a*, *c*). The left forefinger is introduced into the canal, and searches for the

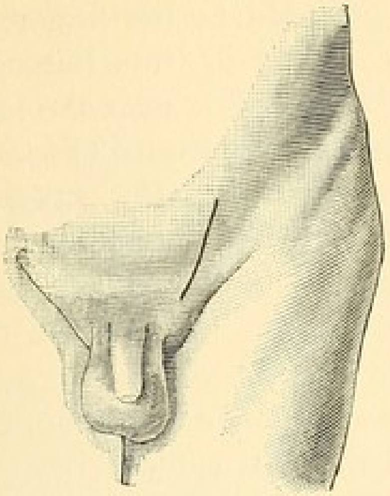


FIG. 1350. External incision

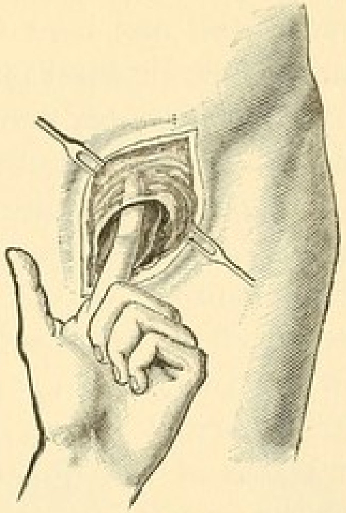
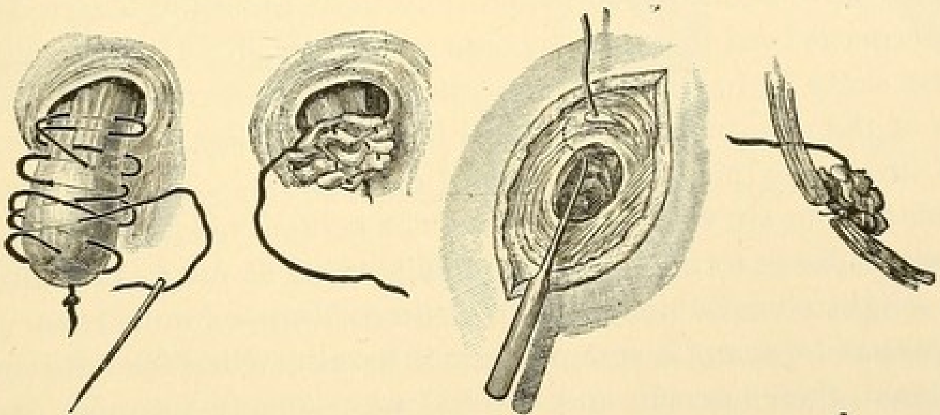
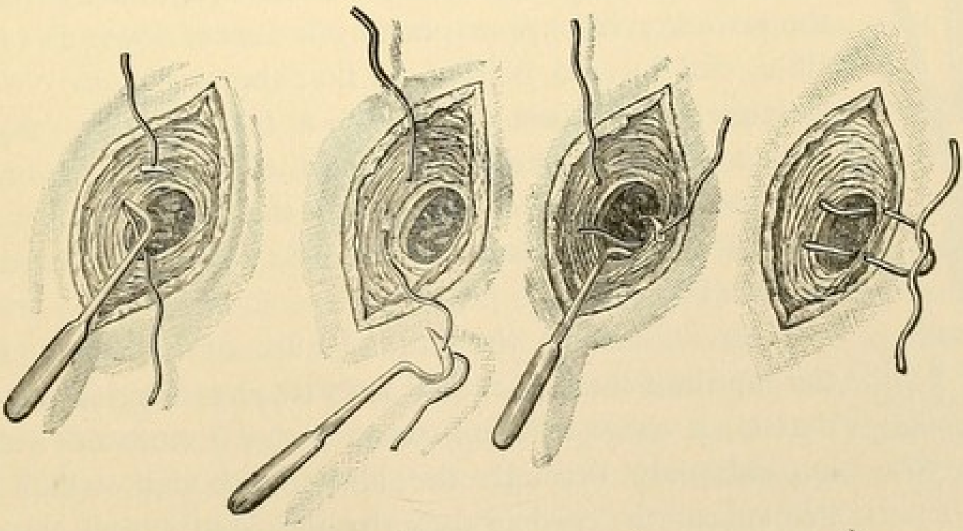


FIG. 1351



a b c d

FIG. 1352. Suturing Hernial Sac



a b c d

FIG. 1353. Suturing Inguinal Canal

MACEWEN'S RADICAL OPERATION FOR INGUINAL HERNIA epigastric artery, which must be avoided. Guided by the finger, with the hernia needle (the one bent to the left) a strong ligature (silver wire) is carried through the internal pillar at two places, — first near the lower margin from without inward, then above from within outward (Fig. 1353, *a*); the suture is held above, and the needle is withdrawn (Fig. 1353, *b*). The lower end of the ligature is inserted into the other hernia needle, and, guided by the finger, is carried from within outward through Poupart's ligament and the united aponeurosis of the three abdominal muscles opposite the lower suture opening of the other side. After the ligature has been removed, the needle is withdrawn (Fig. 1353, *c*). In the same manner the upper end of the ligature is carried from within outward through a place lying opposite the internal side of the upper point of insertion. The two ends of the ligature are then tied together upon the external oblique muscle (Fig. 1353, *d*), after they have been drawn moderately tight upon the inserted finger so that the spermatic cord does not become strangulated. If the inguinal canal is large, the same suture can be applied once more farther down, whereby the pillars of the canal are pressed still more firmly against each other.

5. *The wound of the skin* is *sutured* completely. The patient remains in bed from four to six weeks. He does not resume his work until after the eighth week, and has to take good care of himself as far as the third month. He wears a light truss, which, after that time, becomes unnecessary.

In congenital inguinal hernia, the sac is first detached from its connection with the canal, then opened, and divided transversely into two parts, carefully avoiding the spermatic cord.

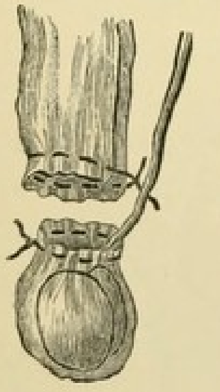


FIG. 1354
MACEWEN'S RADICAL OPERATION FOR CONGENITAL INGUINAL HERNIA

From the lower portion, a tunica vaginalis is formed for the testicle; the upper portion is drawn down as far as possible, and incised behind, so that the spermatic cord can be isolated; it is then closed by a few sutures. Next, it is folded together like a pouch in the same manner as in acquired hernia, drawn up over the internal inguinal ring, and the canal is closed, while the spermatic cord is protected (Fig. 1354).

Bassini effects the radical cure of hernia by restoring **the inguinal canal just as it is in its physiological condition** — that is, a canal with *an anterior and a posterior wall* coursing **obliquely** through the abdominal wall, which permits the spermatic cord to pass through, but which closes like a valve (like the mouth of the ureter in the wall of the bladder) when the muscles are in action, by which the abdomen is compressed (like the vesical aperture of the ureter in the wall of the bladder). He proceeds in the following manner: —

1. *Skin incision* across the hernial region, exposing the aponeurosis of the external oblique muscle corresponding to the inguinal canal.

2. *Division of the aponeurosis of the external oblique muscle* from the external ring as far as, and beyond, the internal inguinal ring; the same is detached in two flaps from the muscle in an upward and downward direction (Fig. 1355, *a*).

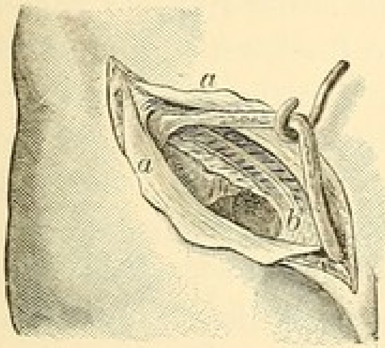


Fig. 1355

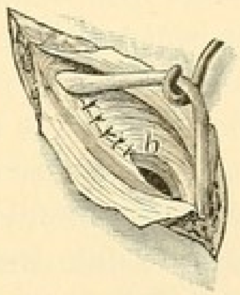


Fig. 1356

Fig. 1357

Bassini's Radical Operation for Inguinal Hernia

The hernial sac is then detached at this place from the spermatic cord as far as, and beyond, its orifice in the iliac fossa. Next, the floor of the sac is opened, and the hernial contents are returned after the detachment of any adhesions. The neck of the sac is twisted, and a straight needle with a double ligature is passed through it on a level with the internal inguinal ring. It is then *ligated* on both sides, and *cut off* $\frac{1}{2}$ centimeter in front of the ligature. The peritoneum ligated in this manner recedes into the iliac fossa.

3. After the spermatic cord has been raised and the two flaps of the aponeurosis of the external oblique muscle have been stretched, the groove, formed by Poupart's ligament, can be surveyed beyond the place of entrance of the spermatic cord. Then the external margin of the rectus abdominis muscle and *the conjoined tendon* (internal oblique muscle, transversalis, and Cooper's vertical fascia, or Scarpa's) *are detached* from the aponeurosis of the external oblique muscle (Fig. 1355, *b*), and sutured for about 5 to 7 centimeters to the posterior free margin of *Poupart's ligament* beginning at the pubis. The spermatic cord is transferred into the upper angle of the wound, and thus placed about 1 centimeter outward and upward; *thereby the internal ring and the posterior wall of the inguinal canal* are reproduced (Fig. 1356, *b*).

4. The spermatic cord is returned into its normal position; the *aponeurosis is sutured* over it as far as the lower angle of the wound, which remains open (*external inguinal ring*, Fig. 1357). The *wound of the skin* is closed completely by sutures.

Healing takes place in about fourteen days; the patient *need not* wear a truss. *Relapse* after this operation, now made most frequently, has occurred *only in exceptional cases.*

Bottini incises the inguinal canal in the same manner as *Bassini;* but, on the lower and upper side of the internal abdominal ring, he passes two or three strong catgut loops with a *Hagedorn* needle from within outward in such a manner that they grasp on the superior side the transverse muscle, the internal oblique, and the aponeurosis of the external oblique muscle, while on the inferior side they pierce the whole thickness of *Poupart's* ligament. Next, the loops are firmly tied together, and the closure, if necessary, is still further strengthened by another catgut suture.

To avoid as much as possible the weak place, which is not overcome even by *Bassini's* method, *Frank* proceeds as follows: —

After division of the skin and the hernial sac, the latter is removed at its neck after double ligation.

Next, the periosteum is reflected from the middle part of the horizontal ramus of the pubis; the lateral margin of the rectus muscle is separated, and with a curved chisel, a *groove is made* in the ramus of the pubis in the direction of the spermatic cord, large enough to receive the little finger. *Into this groove, the spermatic cord is placed.* Next, the periosteum, the external margin of the rectus, and finally the layer consisting of transverse fascia, the transversalis muscle, and the internal oblique muscle are, in their respective order, sutured to *Poupart's* ligament; the aponeurosis of the external oblique muscle is finally sutured continuously separately.

If the hernial sac is firmly adherent it is not extirpated, but is tamponed like a hydrocele treated by incision. It heals by granulation.

Wölfler's method is very much the same as *Bassini's.*

After exposure of the external abdominal ring and division of the fascia-like layers above the neck of the hernial sac, the hernial sac, without being freed further, is divided on a grooved director, and the margins retracted with dissecting forceps; the intestines are pushed back and retained above at the internal inguinal ring by a gauze tampon. With the pelvis elevated, after removal of the tampon, the neck of the hernial sac is sutured from within with the interrupted or purse-string suture (external iliac artery!); the internal surface of the sac is cauterized with the thermo-cautery. Next, the hernial sac is sutured. The same remains in its position; only when it can be detached very easily is it forced into the upper part of the inguinal canal. Then **the spermatic cord is transposed**; the testicle is drawn from the scrotum after division of Hunter's ligament. It is placed behind the rectus muscle (which is dissected free) into the space between the two recti muscles, and returned finally into the scrotum, where it is sutured to Hunter's ligament. The spermatic cord then occupies a transverse position behind the rectus muscle and obliquely in front of it. Since the inguinal canal is no longer required, it can be sutured completely by stitching to Poupart's ligament the transversalis muscle and, if necessary, also the internal oblique muscle, and finally the external margin of the rectus. Over this follows the careful suturing of the aponeurosis of the external oblique muscle and the pillars of the external abdominal ring formed by it.

Kocher also obtained the best results without dividing the abdominal muscles by **transposing the hernial sac**; this can be easily done:—

1. The skin incision, made as usual, exposes the outer surface of the fascia of the external oblique and the neck of the hernial sac; the hernial sac is isolated completely.

2. Into the fascia, a small opening is cut in a lateral direction from the middle of Poupart's ligament (region of the internal inguinal ring); through

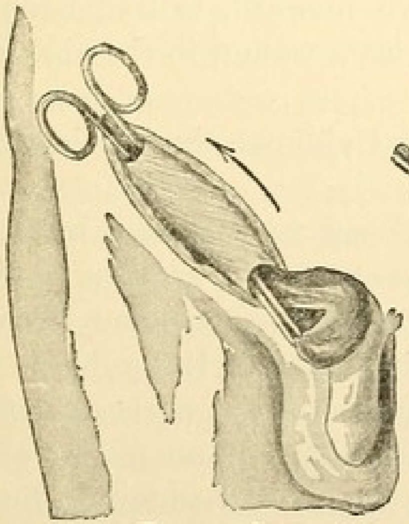


FIG. 1358

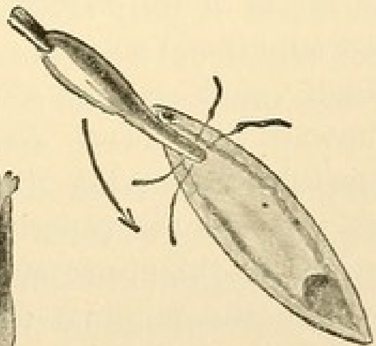


FIG. 1359

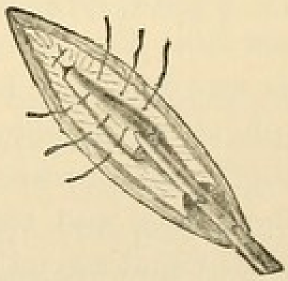


FIG. 1360

KOCHER'S RADICAL OPERATION FOR INGUINAL HERNIA

this opening and the anterior wall of the inguinal canal, a pair of slightly curved dressing forceps is inserted and carried along the inguinal canal in front of the spermatic cord as far as the external inguinal ring. The exposed hernial sac is grasped with the forceps (Fig. 1358), and drawn back through the inguinal canal and out of the little opening.

3. While the hernial sac is drawn outward and upward, the portion of the hernial sac lying in the abdominal wall is firmly tied after passing the ligature with a needle around it and through the abdominal wall. Closely above it, a second suture, applied through the whole thickness of the abdominal wall, increases the resistance (Fig. 1359).

4. The hernial sac, folded together, is placed upon the external surface of the oblique abdominal fascia (anterior wall of the inguinal canal) toward the median line (Fig. 1360), and fastened here with two or three sutures reaching down as deep as possible (canal suture). The spermatic cord remains uninjured, if protected by the finger, and drawn tense in a downward direction.

5. To prevent *with certainty* the protrusion of the hernial sac in the direction of the spermatic cord, the sac can be sutured toward the anterior superior spine of the ilium, to the fascia; or **an invagination displacement** is made — that is, the little incision in the region of the internal abdominal ring is deepened *down to the peritoneum.* The latter is grasped with little hooks, and incised. The forceps are then inserted *into the abdominal cavity* as far as the apex of the hernial sac, which is inverted toward it, so that it can be readily grasped. When the forceps are withdrawn, the hernial sac becomes inverted like the finger of a glove, and the peritoneal surface is outside. The hernial sac, having been drawn forward, is transfixed and ligated on both sides; a few sutures close the little wound in the abdominal wall.

Next, by inverting the fascia of the external oblique, the inguinal canal can be contracted by a few superficial sutures.

In women, large inguinal canals can be closed very readily by a *periosteum bone flap* turned upward (*Borchardt, Körte*). The soft parts of the pubis are detached by carefully preserving the periosteum; and from the symphysis to the obturator foramen the superior layer of the pubis is chiselled off; next, turned upward on the upper margin of the horizontal ramus of the pubis, and turned into the inguinal opening. The pillars of the inguinal canal are united over the bone plate, the divided adductor muscles are fastened to the pubis, and the deep wound of the soft parts is sutured in layers.

(*b*) FEMORAL HERNIA

Since the normal crural canal, a funnel tapering downward, is closed by the lamina cribrosa connected directly with the fascia lata, Poupart's ligament, and the pectineal fascia, *Bassini* established the normal position and tension of these parts forced apart by the hernia, as follows. After the neck of the hernial sac has been exposed, ligated, doubly divided, and returned into the abdominal cavity, he closes the canal with six to seven sutures in the following manner: —

The first suture, close to the spine of the pubis, passes through Poupart's ligament and, at the side of the crest of the pubis, through the pectineal fascia. Likewise the two following sutures are applied toward the crural vein; the three following sutures grasp the falciform process of the fascia lata and the pectineal fascia. The last suture is placed on the proximal side of the point of exit of the saphenous vein. If the sutures are tied by commencing from above, a C-shaped suture line is formed, which lies close to the pubis. The patient can leave his bed after eight or ten days, without wearing a truss.

Fabricius effects the closure of the femoral funnel and as firm a stitching as possible of Poupart's ligament to the horizontal ramus of the pubis in the following manner: —

From a skin incision 10 to 12 centimeters long over Poupart's ligament as far as the spine of the pubis, he opens the hernial sac, returns its contents, and, finally, the ligated and cut-off neck of the hernial sac. He then pushes the vessels forcibly outward, and sutures the somewhat detached ligament of Poupart with a strongly curved needle to the horizontal ramus of the pubic bone through the pectineal fascia, the pectineus muscle, and the periosteum (epigastric artery and vein!). It is advisable, for strengthening the closure, to fasten again, with two or three sutures at the side of the large vessels, the superficial layer of the fascia lata to the pectineal fascia in the median side of the crural vein, and also to contract the *external inguinal ring* by a few sutures.

In large femoral hernias *Salzer* closes the hernial canal over the amputated neck of the hernial sac by a *flap from the pectineal fascia*. He forms this flap by a convex curved incision beginning at the pectineal crest and ending in a downward direction at Gimbernat's ligament; this flap is turned upward, and sutured without any tension to the internal third of Poupart's ligament.

(*c*) UMBILICAL HERNIA

Gersuny strengthened the yielding fibrous linea alba in the following manner: Having transversely sutured the hernial opening (umbilical margins), — which, of itself, has no permanent success, — he united over it the recti muscles, after having divided longitudinally their sheath at the free margin.

More certain in its results, however, is the excision of the umbilical ring, **omphalectomy** (*Keen, Condamin, von Bruns*), by including the whole thickness of the abdominal wall.

The umbilical region is circumscribed by two semilunar incisions, extending to the internal margin of the recti muscles, and advancing *outside of* the hernial sac to its neck; these incisions open the abdominal cavity outside of the hernial sac. From the wound, the hernial canal and neck of the hernial sac can be incised; the hernial contents can be well inspected, and returned or removed (masses of omentum).

The wound is closed in the same manner as after an ordinary laparotomy. The peritoneum and the posterior sheath of the rectus, the recti and their anterior sheath, and, finally, the skin, are all united in order.

OPERATIONS ON THE LIVER AND GALL BLADDER

Operation for echinococcus of the liver can be made in various ways.

Formerly (before antisepsis was introduced) these cysts were evacuated by *puncture* with the trocar and by *aspiration;* the trocar canula remained in position; and around it, by adhesions, a fistula was formed, out of which the purulent cystic contents slowly escaped. *Simon* opened the sac at two points with two trocars, so that between the two openings a bridge of skin 3 to 4 centimeters wide remained, which was divided, after adhesions had formed. Escharotics were also used to exclude the free peritoneal cavity by adhesions.

Aseptically performed, **the broad opening of the cyst in two stages** (*von Volkmann*) is the best and safest procedure.

1. Over the most prominent part of the swelling, the abdominal wall is incised as far as seems necessary, parallel to the costal arch, at the external margin of the rectus muscle, or in the median line. After the hemorrhage has been arrested, the peritoneum is opened, and stitched to the margins of the skin. The cyst or the layer of hepatic tissue covering it is exposed. Next, the gaping wound is packed with gauze, and a protective dressing is applied.

2. After seven to nine days, within which time sufficiently firm *adhesions* between the layers of the peritoneum caused by the irritation have formed, the *cyst is opened,* either with the knife, if the sac itself is exposed, or with the thermo-cautery, if the incision has to be made through the hepatic tissue lying over the same; by puncturing it with a *Pravaz* syringe, information is obtained as to the thickness of the glandular tissue overlying the cyst

wall. The opening is made as large as the skin-incision; while the fluid from the secondary cysts oozes out, the finger is introduced deeply and examines the wall of the primary cyst for any other firmly adhering secondary cysts, which are removed with dressing forceps. Next, sufficient irrigation (with *sublimate solution*) and tamponade or drainage of the cavity of the wound are made; the wound closes gradually by granulation from below, after the wall of the primary cyst has been eliminated.

Instead of the simple incision of the abdominal walls, *Leisrink* recommended previous *stitching of the cystic sac* to the parietal peritoneum by a few *quilt sutures*, whereby the adhesions would take place sooner and with greater certainty (fourth to fifth day).

Since an *infection* of the peritoneal cavity, if the same is not completely and perfectly shut out from the seat of operation, is to be apprehended from the *dissemination of echinococcus germs*, it seems less safe to make the operation *in one sitting* (*Lindemann*, *Landau*); after the peritoneum has been opened, the cystic contents are evacuated by aspiration to such an extent that the cyst wall becomes flaccid; it is then incised, and the margins of the incision are sutured to the peritoneum lining the incision.

Traumatic **abscesses of the liver** are treated according to similar principles. The **resection** of portions of the liver for constricted lobe ("Schnürleber") caused by constriction of the waist or tight lacing (*Langenbuch*) and in echinococci (*Loreta*) has been made recently with good success; the hemorrhage from the surfaces of the incision must be arrested by acupressure with round needles or by the thermo-cautery; also the superior and the inferior margins of the hepatic wound can be sutured together. (Suturing of the liver as a hemostatic resource is a very unreliable agent, owing to the great fragility and vascularity of the organ. The iodoform gauze tampon is more effective and serves at the same time as a useful capillary drain when brought out of the abdominal incision.) Single pedunculated flaps are ligated by elastic constriction. Even after removal of more than half the liver, the lost portion is *regenerated* in a short time (*Ponfick*).

CHOLECYSTOTOMY

The opening of the gall bladder by incision may be made for *biliary calculi*, provided the gall bladder itself is healthy and not very firmly adherent to its surrounding parts.

1. *The incision of the abdominal wall* extends along the external margin of the right rectus abdominis muscle from the costal arch downward (*longi-*

tudinal incision), or it extends as an *oblique incision* from the tip of the tenth costal cartilage inward and downward toward the umbilicus (*Tait*), or it is made transversely a little above or upon the lower border of the liver (*hepatic border incision*) (*Courvoisier*).

2. After incision of the abdominal wall, the liver, if possible, is turned over, and the gall bladder is drawn forward into the abdominal wound as far as possible, and is *held firmly* by means of a ligature loop passed through it; it is *punctured* with a fine trocar. After its contents have been evacuated, the cavity is irrigated with a disinfecting solution (boric, salicylic).

3. Next, from the place of puncturing, the gall bladder is *incised*, preferably transversely, and parallel to the lower hepatic border, until the finger can be inserted into the cavity.

4. Any *biliary calculi* present *are removed* with the finger or the forceps, retractors, etc.; concretions firmly lodged in the *cystic duct* or concealed in the pocket-like diverticula of the walls can be pushed upward from the outside with the fingers; or, if necessary, the operator may try to crush them by pressure.

5. After all the stones have been thus removed, the wound of the gall bladder is sutured with "*the most painstaking care possible*" by a double row of *serous sutures according to Czerny* (see Fig. 1311); the *gall bladder* is then returned into the abdominal cavity (**cholecystendysis**, *Courvoisier*); or its sutured part is fastened to the parietal layer of the periosteum (**cholecystopexia**).

6. The abdominal walls are likewise completely united by suture.

This so-called *ideal cholecystotomy* (*Bernays*) reproduces in the best possible manner the original normal conditions, but can be resorted to with safety only when the walls of the gall bladder are healthy; in inflamed tissue, the sutures would easily tear out, or leakage might take place from a subsequent occurrence of inflammatory hydrops. Hence, if in cholelithiasis the cystic wall is at the same time *considerably diseased*, and if such firm *adhesions* exist that the *extirpation* of the gall bladder seems not advisable, and if the operator is not perfectly sure whether calculi remain in the bile ducts, it is better to perform

CHOLECYSTOSTOMY,

that is, *to establish a biliary fistula*. After incision of the abdominal wall, drawing forward the bladder, puncturing and disinfecting its cavity, and removal of calculi as described above, the opened gall bladder is *sutured* to the margins of the abdominal wound. First, its serous coat is united with the parietal peritoneum all around by sutures applied very closely, in order to close the abdominal cavity. Next, the mucous membrane of the gall bladder is sutured to the external skin, and thus a *lip-shaped fistula* is produced. Into the same, a short drainage tube or an iodoform wick is introduced.

In place of *this natural cholecystostomy* (*at one sitting*) (*Lawson, Tait*), the operation may be made also *in two stages* (*Riedel, Bardenheuer*); first, the fundus of the gall bladder is stitched *unopened* to the abdominal wound with sutures, grasping only the walls without injuring its lumen; and, after a few days, when the adhesions have become firm and the closure of the abdominal cavity seems to be assured, the opening is made, and the calculi are removed.

It is true this procedure offers the greatest safety, but it has the disadvantage of often creating a permanent *suppurating and biliary fistula*. Its very long continuance often exerts an unfavorable influence upon the condition of the patient, especially since further disadvantages are also caused by stitching the gall bladder to the abdominal wall. If, however, the fistula closes up (or if it is cured by an operation), conditions for the *recurrence* of the original disease have been thereby created (lithiasis).

Hence, *Langenbuch* (1883) recommended removing all these complications and disadvantages with one stroke by

CHOLECYSTECTOMY

The *excision of the entire gall bladder* is indicated: —

(*a*) In *vesicular cholelithiasis* of long standing and frequent recurrence.

(*b*) In *dropsy of the gall bladder* from obstruction of the cystic duct.

(*c*) In *serious disease of the wall of the gall bladder* (empyema, ulcers, tumors).

(*d*) In *ruptures or wounds* of the gall bladder, which cannot be sutured, and in *biliary fistulas*.

On the other hand, the operation should not be made: —

(*a*) In the case of firm adhesions with the surrounding parts, especially with the liver.

(*b*) In obstructions of the common duct, which cannot be removed.

(*c*) In cases in which many small calculi are present in the bile ducts.

1. A ⊣-*like incision of the abdominal walls*. *Longitudinal incision* 10 to 15 centimeters long along the outer margin of the right rectus muscle, upon which a *transverse incision* of equal length is made along the lower margin of the liver.

2. The *colon* and the small intestines are pushed *downward* with a flat sponge, the right hepatic lobe is drawn *upward* so that *the hepatoduodenal ligament*, in which the large bile ducts lie and which can be palpated, becomes tense. The ligament is incised; if a calculus is discovered in the common duct, the operation must not be performed.

3. After the gall bladder has been exposed as far as *the cystic duct*, the latter is encircled with an aneurism needle armed with a silk ligature, 1 to 2 centimeters distant from the hilum of the bladder, and doubly ligated. If the operator detects calculi in the same, they must first be pushed backward in the gall bladder.

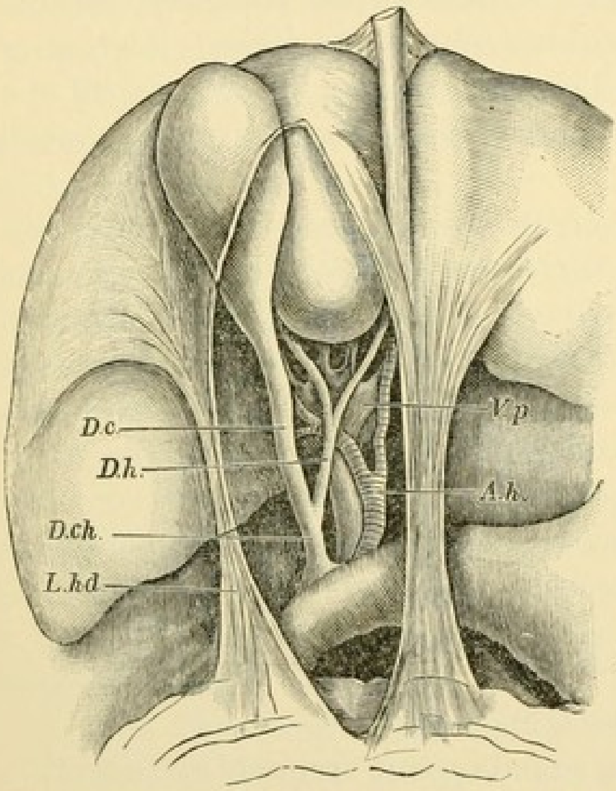


FIG. 1361. ANATOMY OF LOWER SURFACE OF THE LIVER (according to Henle). *L.hd.* hepatogastric ligament (divided longitudinally); *D.h.* hepatic duct; *D.c.* cystic duct; *D.ch.* common bile duct; *A.h.* hepatic artery; *V.p.* portal vein

4. Next, the gall bladder *is detached from its recess in the fissure of the liver.* After its peritoneal covering has been carefully incised, the operator easily succeeds in separating it from the liver, bluntly, by traction, or by cautious incisions with the scissors. Any hemorrhage from the liver substance is arrested either by pressure or with the thermo-cautery.

5. *Cutting off the bladder* between the two ligatures in the cystic duct. The remaining stump is folded together, and securely sutured.

6. Thereupon the abdominal wound is closed completely.

If the **common duct** *is obstructed* by impaction of calculi, by cicatricial bands and adhesions to the surrounding parts, by the pressure of the largely distended gall bladder (on account of its contents), or by tumors of the neighboring parts (*acute and chronic common duct obstruction*), the surgeon must endeavor to reëstablish the escape of bile into the intestine, in order to remove the danger of *cholæmia.* If it is a question of an impacted gall stone, the operator may try to render it movable by pressure with the fingers, or to crush it gently with forceps — the blades of which are covered with rubber tubing (**choledocho-lithotripsy**) — from the outside through the walls of the choledoch duct. This should be done very carefully, without injuring the internal wall of the canal, already in a state of inflammation.

If this does not prove successful, it is better to open the wall of the gall duct over the stone by a longitudinal incision. The escaping bile is carefully absorbed with sponges or gauze; and after the removal of the obstruction, the wound is closed again by 3–5 silk sutures (**choledocho-lithectomy**). The operator should never omit probing the gall duct upward and downward. A thick drainage tube is finally introduced as far as the place of suture. If the obstacle cannot be removed (extensive tumors and adhesions), an escape for the bile outward may be best established by cholecystostomy, and again administered to the patient with the food; else, after ligation of the common duct, *a fistula between the gall bladder and the small intestine* may be made by broadly suturing the gall bladder to the duodenum or the small intestine below, in a similar manner as described in gastro-enterostomy and in enteroanastomosis (**cholecysto-enterostomy**). This operation was first made by *von Winiwarter*—"a triumph of surgical technique and perseverance"—and, after him, by *Kappeler* and others. *Murphy's* button has also been employed successfully in this operation. (It has proved to be of special signal success in this operation.)

OPERATIONS ON THE SPLEEN

SPLENECTOMY

Excision of the spleen is justifiable in a complete *prolapse, cysts and tumors* of the same, *in abscesses, in floating spleen* only when the inconveniences caused by the same are very great and cannot be overcome by the wearing of well-fitting bandages. On the other hand, the extirpation of the spleen *should not be made* in tumors caused by serious changes in the blood (*leucæmia, malaria, amyloid degeneration*, etc.).

The difficulty of extirpation consists especially in the separation of the most extensive *adhesions* to the surrounding parts and the safe *ligation of the pedicle*.

1. The *abdominal incision* of the greatest service is in the *linea alba* and varies in length according to the size of the spleen to be removed. Sometimes a transverse incision must be added to it.

2. After the peritoneal cavity has been opened, the hand is introduced into the abdominal cavity; and the surgeon ascertains by direct palpation the existence of adhesions of the spleen, especially with the diaphragm.

If he becomes convinced from this examination that very extensive adhesions may frustrate the success of the operation, it is advisable to abandon the extirpation and to close the abdominal wound.

3. If the operation is decided upon, the adhesions, especially of the *spleno-phrenic ligament*, are then detached. This is done with the knife after double ligation of isolated portions of the bands; mostly, however, on account of *broad surface adhesions*, this method cannot be employed, and the separation must then be made with the thermo-cautery. Care should be taken under all circumstances that the *capsule of the spleen is protected*, as otherwise profuse parenchymatous hemorrhage may ensue. If any portion of its surface is adherent to any part of the neighboring organs (pancreas), it is preferable to remove a piece from the latter.

Adhesions to the omentum may be divided subsequently, — when the spleen, after a previous double ligation, has been detached on all sides, and can be rolled out of the abdominal wound.

4. Next follows *the ligation of the pedicle of the gastrosplenic ligament*, in which *the splenic artery and vein* take their course. If this pedicle is short, the greatest difficulties may arise in ligating it, and a portion of the spleen adhering to the pedicle must be left attached to the stump.

For ligation, a strong silk thread or rubber band (*Olshausen*) can be especially recommended, in which case, two additional simple knots are placed upon a surgeon's knot; the ends, if necessary, are brought around the pedicle once more, and tied on the other side.

After division of the pedicle a finger's breadth in front of the ligature, the lumina of the several blood vessels are sought for in the surface of the incision, and are tied separately.

5. The stump of the pedicle is *returned* into the abdominal cavity or fastened in the wound, for the purpose of facilitating the arrest of bleeding in the event of secondary hemorrhage (*Péan*); the remaining portion of the wound is sutured.

If the spleen removed is very large, after the removal of which a dead space remains in the abdominal cavity, tamponade (according to *Miculicz* — see page 675) of the cavity produced is especially to be recommended on account of the danger of secondary hemorrhage from the separated adhesions (*Ledderhose*).

Under some circumstances — for instance, in cysts or a partial crushing — only a portion of the spleen should be removed (**resection**); the hemorrhage from the surface of the incision is arrested by tamponade, by indirect ligature, or with the thermo-cautery; also, by elastic constriction with a rubber tube, portions of the spleen can be ligated (*Lücke*).

Splenoplexy — that is, the stitching of a floating spleen — in most cases proves unsatisfactory. The spleen, however, has been elevated and immobilized by inserting it into a pouch cut into the parietal peritoneum and open in an upward direction (*Rydygier*), and by stitching it extraperitoneally under the costal arch (*Bardenheuer*).

OPERATIONS ON THE KIDNEY

NEPHROTOMY

Incision of the kidney or its pelvis (*pyelotomy*) may become necessary: —

(*a*) In foreign bodies and calculi, and in anuria and colic caused thereby.

(*b*) In abscesses, echinococci, and single cysts.

(*c*) In hydronephrosis and pyonephrosis.

NEPHRECTOMY

(*Simon*, 1869)

Extirpation of one kidney is made, if the other *kidney is perfectly sound*, and if no "*horseshoe kidney*" exists: —

(*a*) In *injuries* (with violent continuous hemorrhages) of the kidney or the ureter.

(*b*) In *suppurative affections* (pyelitis and pyelonephrosis calculosa and tuberculosa).

(*c*) In incurable *ureteric fistulas*.

(*d*) In malignant *neoplasms*.

(*e*) In *migrating or movable kidney*, but only if, after an unsuccessful nephrorrhaphy, the kidney causes serious symptoms, and is degenerated.

Of *the presence of the other kidney* the surgeon assures himself by bimanual palpation, either in the dorsal position with the thighs and legs flexed, or better, in the lateral position, with the side to be examined upward, whereby the hip and the knees are slightly flexed. *Simon* palpated the kidney by rectal palpation. It is safer, however, to palpate the kidney by direct exposure from the abdomen or extraperitoneally (*Fenger*) in the lumbar region. *Kocher* introduces the hand into the abdominal cavity from the transverse incision made for extirpating the kidney, and palpates the other kidney (*Thornton*).

Of the normal condition of the opposite kidney, the surgeon can convince himself by obtaining the urine from each kidney *separately*, for examination, by catheterizing the ureter. This is accomplished most easily by the use of the *cystoscope*; the older procedures — compressing one ureter or ligating it temporarily — have in most cases been rendered obsolete.

To **expose the kidney** extraperitoneally, various methods of incision have been devised, of which the following are the most important: —

1. *Simon's posterior vertical lumbar incision* (Fig. 1364) along the external margin of the erector spinæ muscle begins across the 11th rib, extends over the 12th rib, and ends in the median line between the 12th rib and the crest of the ilium (exposes the hilum of the kidney most advantageously).

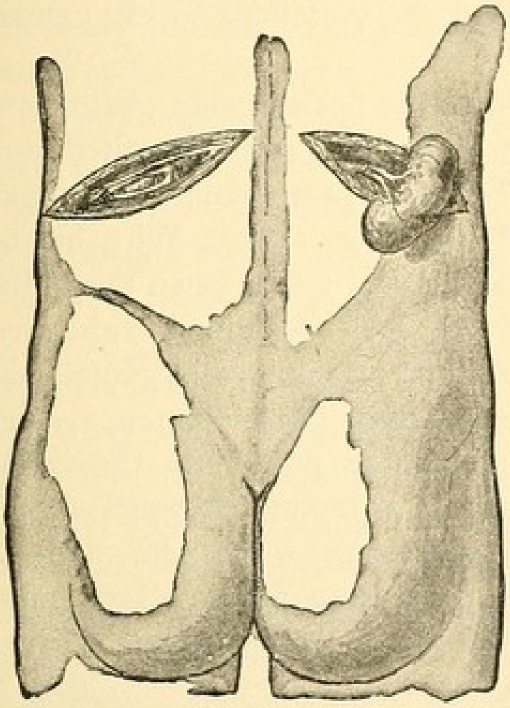


FIG. 1362. Transverse Lumbar Incision

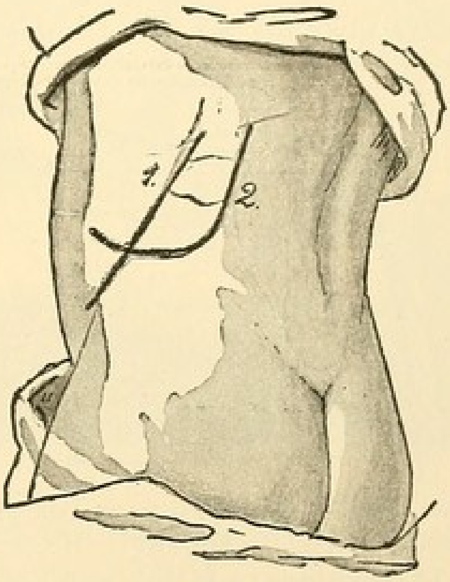


FIG. 1363. Lateral Lumbar Incisions 1, von Bergmann's; 2, König's

NEPHROTOMY

2. *The transverse lumbar incision according to Czerny, Braun, Kocher, Küster*, extends 1 centimeter below the last rib and parallel to the same from the margin of the erector spinæ about 8 to 10 centimeters forward as far as the axillary line (colon! peritoneum!) (Fig. 1362).

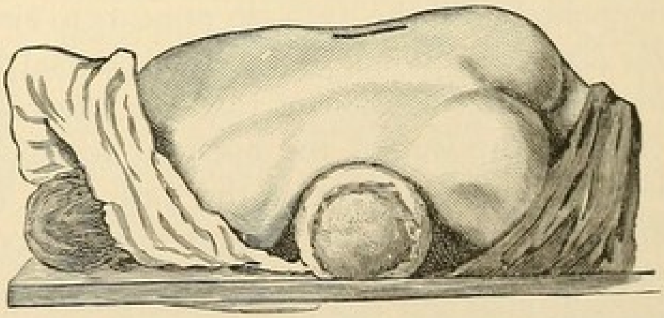


FIG. 1364. SIMON'S POSITION FOR EXPOSING KIDNEY

3. *Von Bergmann's lateral lumbar or oblique lumbar incision* extends from the anterior end of the 12th rib, descending obliquely forward and downward as far as the junction of the external and middle third of Poupart's ligament (this incision affords the largest space) (Fig. 1363, 1).

4. *Bardenheuer's renal incision* extends from the end of the 11th rib downward to the middle of the crest of the ilium. At its extremities, along the ribs and the crest of the ilium, transverse incisions are added (trap-door incision).

König's retroperitoneal laparotomy incision extends from the 12th rib vertically along the margin of the sacrolumbar muscle toward the crest of the ilium, then in the form of a curve toward the umbilicus to the external border of the rectus muscle.

The patient lies during the operation with his healthy side over a large circular cushion, so that the lumbar region on the side to be operated upon becomes prominent and is made tense (Fig. 1364). With his fist, an assistant may push the kidney in a backward and upward direction by making well-directed pressure from the abdomen. *Lange* places the patient in the ventral position, inclined toward the diseased side, which is made to project by a pillow placed under the body opposite the kidneys (Fig. 1365).

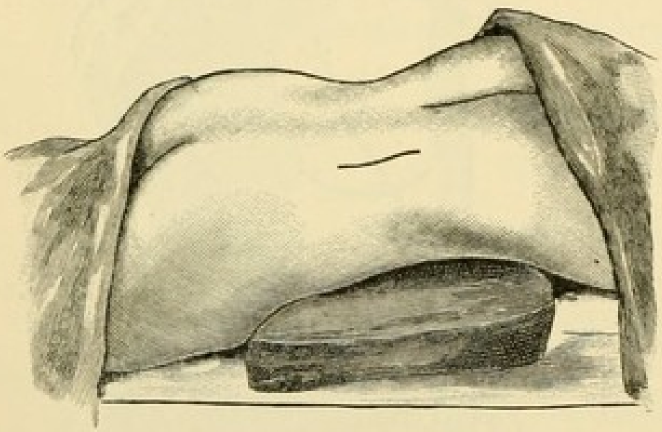


Fig. 1365. Lange's Position for exposing Kidney

For most cases, as a *normal procedure*, *Simon's* method is to be recommended :—

1. *External incision*, see page 741. Having divided the superficial fascia and the lower margin of the latissimus dorsi muscle, the tough superficial fascia sheath of the sacrolumbalis (*lumbodorsal fascia, lamina superficialis*) is incised; the rounded margin of this muscle is exposed and the incision deepened until the 12th rib appears to view in the upper angle of the wound; *the lamina profunda* of the lumbodorsal fascia is then reached; the same is incised; after ligation of the XII intercostal artery and the I lumbar artery crossing the wound, the operator reaches the *quadratus lumborum* inserted into the lower margin of the 12th rib. (Since, according to *Pansch*, there are cases in which the pleura extends as far as the level of the transverse process of the first lumbar vertebra, the incision through the deep layer of the fascia must be made only as far as 2–3 centimeters from the lower margin of the 12th rib.)

2. *Division of the quadratus lumborum* in a longitudinal direction ; the divided margins are drawn apart with blunt retractors ; the entire muscle

can also be drawn laterally; under this lies the tough fibrous layer of the peritoneum, which divides the anterior surface of the muscle from the kidney. Having incised this fascia, the lower pole of the kidney appears embedded in loose fatty connective tissue (adipose capsule of kidney).

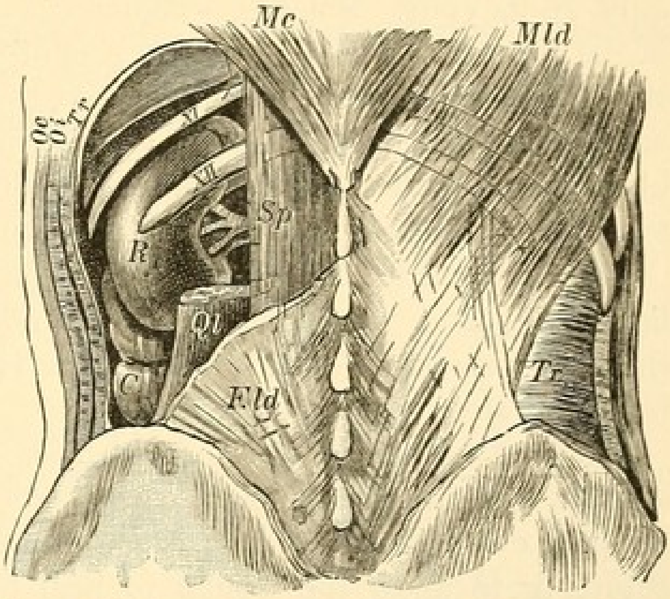


FIG. 1366. TOPOGRAPHY OF RENAL REGION. *Mc*, m. cucullaris; *Mld*, latissimus dorsi; *Sp*, m. sacrospinalis (sacrolumbalis); *Ql*, m. quadratus lumborum; *Oe*, m. obliquus ext. abd.; *Oi*, m. obliquus int. abd.; *Tr*, m. transversus abd.; *Fld*, fascia lumbodorsalis; *R*, kidney; *C*, colon desc.

3. *Exposure of the kidney.* First, the superior half, situated under the ribs, is bluntly separated from its surrounding tissues with the forefinger; next, the kidney is grasped with three fingers, somewhat drawn forward, and *slowly and carefully* enucleated with the forefinger; only the firmer adhesions at both poles are divided with knife or scissors. If the operation is performed for injury, the wound can be sutured and the hemorrhage arrested. If it is done for the removal of calculi, after a previous exploration with needles (akidopeirastic), the kidney is divided longitudinally on its convex side by a sufficient incision (as in post mortems), and the calculi are extracted with forceps, spoons, or wire loops (*Lange*) from the renal pelvis or the calyces (**nephrolithotomy**). If the kidney is healthy and the ureter permeable, the visceral wound is then closed by several sutures piercing the kidney tissue. If the incision has been made through the renal pelvis, the wound is reunited by sutures which invert the margins of the wound. But if suppuration is present, or if the kidney is not entirely

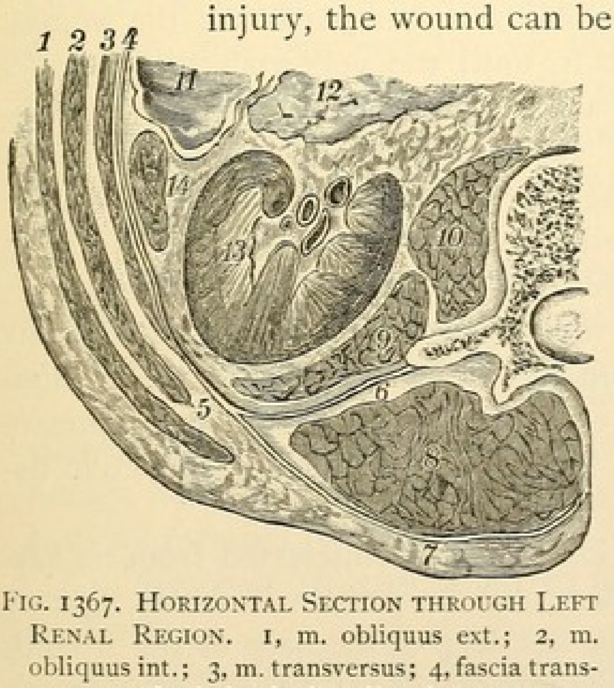


FIG. 1367. HORIZONTAL SECTION THROUGH LEFT RENAL REGION. 1, m. obliquus ext.; 2, m. obliquus int.; 3, m. transversus; 4, fascia transversa; 5, fascia lumbodorsalis; 6, its posterior layer; 7, its anterior layer; 8, m. sacrospinalis; 9, m. quadratus lumborum; 10, m. psoas; 11, colon descend.; 12, pancreas; 13, kidney; 14, spleen

healthy, it is better to drain and tampon the wound of the soft parts sutured only at its ends. Smaller, well-defined tumors of the cortex can be excised in the form of a wedge; the margins of the wound are sutured (**renal resection**). If **nephrectomy** must be made, the kidney is enucleated still farther, and the adipose capsule is carefully stripped off from its pedicle, until the blood vessels and the ureter can be distinguished. (The ureter lies nearest to the back; behind it lies the artery; and deepest of all, the vein.)

4. *Ligation of the pedicle.* First, all the parts entering the hilum are ligated (*ligature "en masse"*); next, the kidney is cut off a little in front of the ligature, and all visible lumina are *singly* ligated. The exposed ureter is ligated after previous invagination.

5. The wound of the soft parts can be closed completely by buried sutures, or drained and only partly sutured. It is safer, however, first to tampon everything; and, perhaps, subsequently to apply the secondary suture or to allow the wound to heal by granulation.

If, on account of greater accessibility (in large tumors), the operator desires to employ one of the *lateral lumbar incisions*, then the operation is made in a somewhat different manner.

1. *External incision* according to *von Bergmann* (Fig. 1363, 1).

2. Careful division of the *external oblique muscle* in the entire length of the wound, then of the *internal oblique* in the upper portion of the wound, and of the *transversalis* lying beneath it, until the yellowish *transversalis fascia* appears to view; under it lies a layer of loose largely adipose connective tissue, the præperitoneal fat. Between this and the transversalis fascia, the finger or a broad grooved director is introduced; and upon it the transverse fascia is divided to the extent of the external wound.

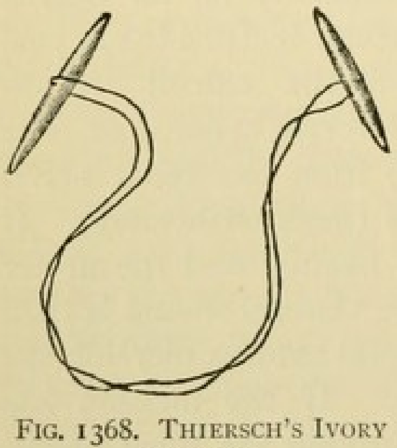


FIG. 1368. THIERSCH'S IVORY SPINDLE

3. After the exposed *parietal peritoneum* has been displaced by the finger toward the median line, the lower extremity of the kidney appears embedded in loose, largely adipose connective tissue (adipose capsule).

4. The kidney is now enucleated from its surrounding tissues, and its pedicle is firmly ligated. If the pedicle lies deep at the base of the wound, *Thiersch's ivory spindle* (Fig. 1368) and the forceps devised by *Lange* to place the ligature render excellent service (Fig. 1369).

5. The wound is tamponed in its whole extent.

In very large and firm renal tumors, and with a diagnosis not perfectly satisfactory, the **transperitoneal nephrectomy** (*Sänger*) has also been made. The incision is made through the linea alba or along the external border of the rectus muscle on the diseased side. In order to reach the kidney, the peritoneum must be opened twice. The enucleation and care of the pedicle is performed similarly as described above; the cavity of the wound is drained by a counter opening made in the lumbar region; the posterior peritoneal layer is sutured; the abdominal wound is united as in laparotomy. The success of this operation is not so good as in the extraperitoneal operation.

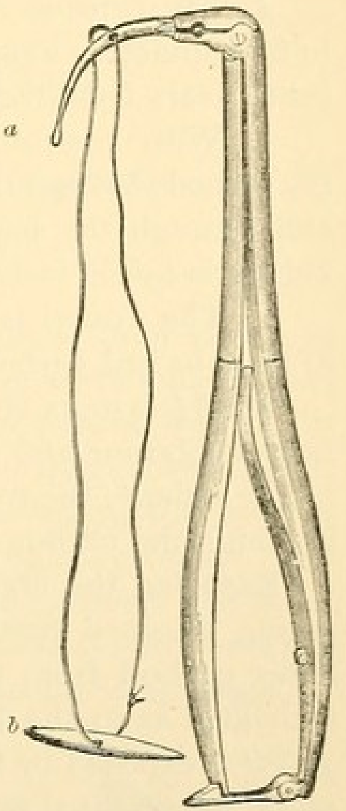


FIG. 1369
a, Lange's forceps
b, Thiersch's ivory spindle for placing strong ligatures in deep wounds

If the case is one of *hydronephrosis*, caused by an abnormally high and valve-forming insertion of the ureter in the renal pelvis, the cyst is emptied first with a trocar, a hand's breadth distant from the ureter posteriorly; next, the anterior wall is divided longitudinally from the same place downward, and the orifice of the ureter is searched for from the interior of the opened cyst; then, from the point of insertion, the ureter and the cyst wall are incised with the scissors, the whole length of the swelling, in a downward direction, and the margins of the wound of the incised ureter are sutured closely to the margins of the wound of the cyst wall, so that the opening is displaced to the most dependent part of the swelling (*Trendelenburg*).

Larger sacs of the renal pelvis, which cannot be removed, are sutured into the wound of the soft parts, incised longitudinally, and drained.

NEPHROPEXY,

fixation of the kidney by sutures (*Hahn*, 1881), is indicated in *wandering kidney*, when the symptoms caused by the same cannot be removed by suitable external mechanical support.

1. *External incision* about 10 centimeters long, according to *Braun* or to *Simon*.

2. After division of the *latissimus dorsi* and the *lumbodorsal fascia*, a mass of fat protrudes; this is cut off.

3. Next there appears to view a brownish red flaccid membrane, which becomes more prominent during inspiration and when the kidney is pressed

forward by the hand of the assistant (*adipose capsule*). After incision of the same, masses of fat again appear; these are carefully cut away with the scissors until the renal surface can be distinctly recognized.

4. The capsule of the kidney is divided longitudinally by an incision 4 to 6 centimeters long, and bluntly separated on both sides for about 1 to 2 centimeters from the underlying renal parenchyma.

5. With a strongly curved (round) needle, 4 to 6 *strong silk sutures* are placed through the divided capsule of the kidney, the *renal parenchyma*, and through the margin of the wound of the skin incision, whereby the kidney is safely fastened in the wound.

6. The wound is *tamponed*, and heals by granulation. The patient has to keep in bed perfectly quiet for at least six weeks.

Riedel fastens the movable kidney to the anterior surface of the quadratus lumborum and to the diaphragm. *Miculicz* established a firm adhesion of the kidney, the colon, and the duodenum from an abdominal incision by brushing the peritoneum covering the kidney with celloidine or collodion.

Exposing the ureter (*ureterotomy*, *Israel*) for removing calculi, for extirpating diseased portions, suturing injuries and fistulas, is possible for the *upper* portion from the lumbar incisions; for the *lower* section, the skin is divided as in the ligation of the common iliac artery; its course *in the pelvis* is exposed by the peritoneal flap incision (see Fig. 1494) and the parasacral longitudinal incision (Fig. 1496).

(The editor has for the last five years resorted to nephropexy without suturing with the most gratifying results. The kidney is exposed by Simon's incision. The fatty capsule is freely excised; the lower lobe of the kidney, drawn well into the incision, is surrounded with iodoform gauze, which remains for at least one week. After its removal the granulating surfaces are brought in and out by the bloodless suture. A compress is placed below the costal arch over the kidney, and held in place by a firm abdominal bandage. The patient must remain in bed, lying on the back or side operated upon for four weeks. Of the many cases operated upon by this method, none has relapsed.)

OPERATIONS ON THE PELVIS

OPERATIONS ON THE URETHRA AND THE BLADDER

CATHETERISM

The urethra in the male is a membranous canal, the walls of which, in the ordinary relaxed state, lie flat against each other. In its various sections it has an unequal *elasticity*, as the accompanying joined cast of wax of the urethra (according to *Sir Everard Home*) indicates. The inequality depends essentially on the *yielding power* of the tissues surrounding the mucous membrane; for since the injection mass operated with equal pressure upon the walls of the whole urethra, those places will appear *the most distended* where the surrounding tissues (the vascular cavernous tissue) lying between the mucous membrane and the firm tunica albuginea can be compressed.

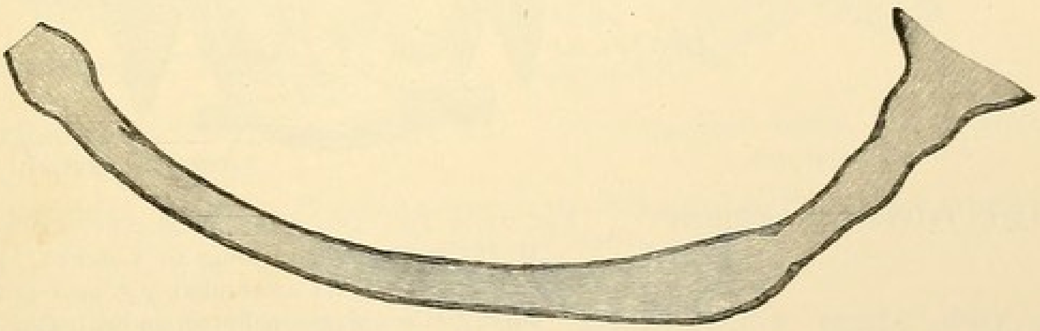


FIG. 1370. MALE URETHRA (Home's Cast of Wax)

Hence *its narrowest places are the external urinary meatus* surrounded by the albuginea of the glans and *the extremity of the cavernous part* emerging from the opening in the rigid lamina media of the perineal fascia (*triangular ligament*, Fig. 1371) (isthmus urethræ), while the *navicular fossa* lying behind the meatus and *the bulbous portion* appear widest, because they are surrounded by a larger mass of the soft vascular corpus spongiosum urethræ. The part of the urethra lying between these distended portions, *pars cavernosa*, shows a uniform elasticity corresponding to its surrounding parts.

Of the *pelvic portion of the urethra* lying behind the triangular ligament, *the anterior half* (*pars muscularis sive membranacea*) is surrounded by a strong set of voluntary muscles (*compressor urethræ*, Fig. 1373). Under some circumstances this muscle in the living may cause great obstacles to the dilatation of the urethra (**spasmus urethræ**), and also in the cadaver it can be forced apart *only very little;* the *posterior half*, surrounded by the smooth musculature of the prostate (*pars prostatica*), is very elastic in the living,

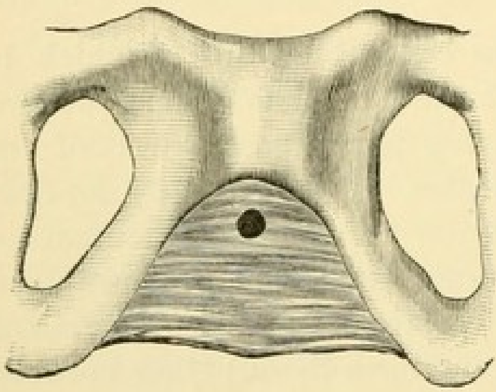


FIG. 1371. TRIANGULAR LIGAMENT

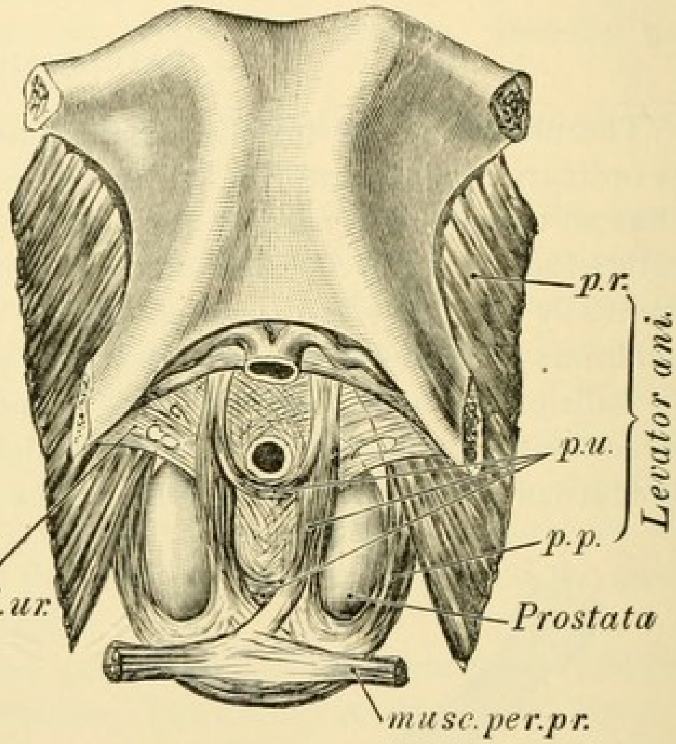


FIG. 1372. LIG. TRIANGULARE, M. LEVATOR ANI, AND M. PERINEI PROF. according to Luschka. *p.r.* pars rectalis; *p.u.* pars urethralis; *p.p.* pars prostatica; *musc. per. pr.* M. perinei prof. undus.; *Lig. tri. ur.* Ligamentum triangulare urethræ

while in the cadaver the tough substance of the prostate yields less readily to the pressure of the injection mass; hence this part appears comparatively too narrow in the cast.

The pars cavernosa with the penis is freely movable toward all sides (*pars pendula, penilis*), only its posterior third (root of the penis) is connected more firmly with the symphysis by the suspensory ligament of the penis. The isthmus, on the other hand, is fixed by the firm triangular ligament; from here the pelvic portion of the urethra (*pars pelvina*) is curved about a quarter of a circle in a posterior direction as far as the proximal end of the urethra.

In catheterization all these anatomical relations must be well considered. The *introduction of a catheter* is especially required: —

(*a*) For examining the urethra and the bladder.

(*b*) For evacuating or for filling the bladder.

Rigid (silver) instruments are used, the point of which is curved at an arch of about a quarter of a circle, or *soft* rubber catheters, to which any desired flexion can be given. The same should be used *only with aseptic precautionary measures.* The metallic catheters are sterilized by boiling for about ten minutes in soda solution in a suitable vessel, and are kept in alcohol until used; the soft instruments must be placed in a solution of

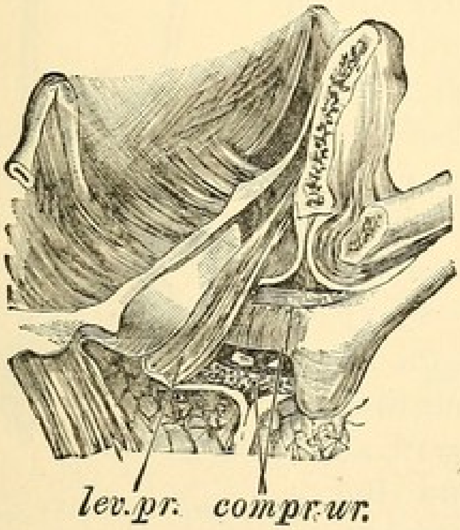


FIG. 1373. Lateral view. *lev. pr.* M. levator prostatæ

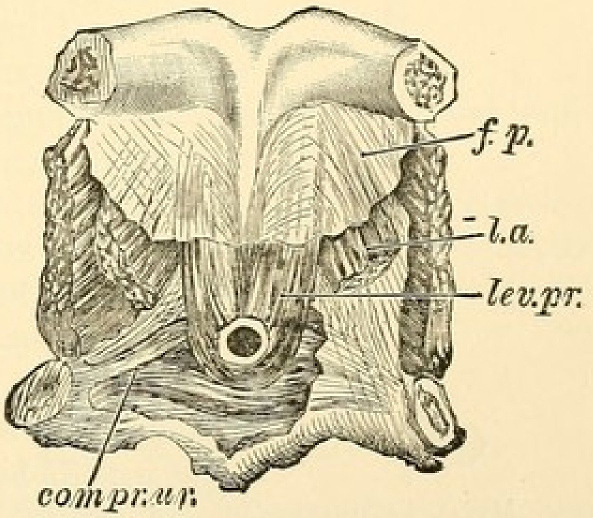


FIG. 1374. From within. *l. a.* M. levator ani; *f. p.* fascia pelvis

MUSCULUS COMPRESSOR URETHRÆ WITHIN THE UROGENITAL DIAPHRAGM (Henle) according to Maclise

5% carbolic acid for several hours before being used; they cannot withstand boiling to any great extent. Instruments of shellacked silk fabric lose their excellent smoothness even by the application of antiseptics; they are well wiped off before and after employment. Without being especially injured, all these instruments, however, can be kept permanently aseptic in special vessels by means of formaline gas. Before introduction, the instruments are lubricated with *boric vaseline, lanolin, or iodoform oil.* Also iodoform oil may be previously injected into the urethra with a small syringe; the urethra, if necessary, is cocainized.

The patient is placed in a dorsal recumbent position, his body lying horizontally, with the legs and thighs moderately flexed. A small cushion is placed under the pelvis.

In introducing a metal catheter with an ordinary curve (Fig. 1375, *a*), the operator takes his position *at the left side* of the patient, seizes the disinfected, moderately warm, and well-lubricated instrument with his right hand (like holding a pen), supports this hand by applying the little finger upon the middle of the abdomen, and introduces the point of the catheter into the external urethral orifice drawn apart with the tips of the fingers of the left hand; under moderate traction, he gently *draws the penis over the instrument* (Fig. 1377), while the point of the instrument at the same time is lowered downward as far as and behind the symphysis, until the bulbous portion of the urethra below the pubic arch in the region of the triangular ligament has been reached. Under constant general traction of the penis, the distal end of the catheter is slowly raised; exactly in the median line and without employing any force, the operator makes with the beak of the instrument a circular arch around the symphysis. Under proper guidance of the instrument, the beak usually passes easily through the isthmus into the membranous portion of the urethra (Fig. 1378). If any resistance is felt, care must be taken not to overcome the same by violence; if the point of the instrument has passed too far behind and below into the elastic bulbous portion, especially in old persons, it impinges against the posterior part of the triangular ligament. If too small a circular arch has been made with the point, it impinges above the isthmus upon the symphysis; if the instrument has not been guided exactly in the median line, the point may press against the portion laterally from the isthmus; in all these cases the catheter

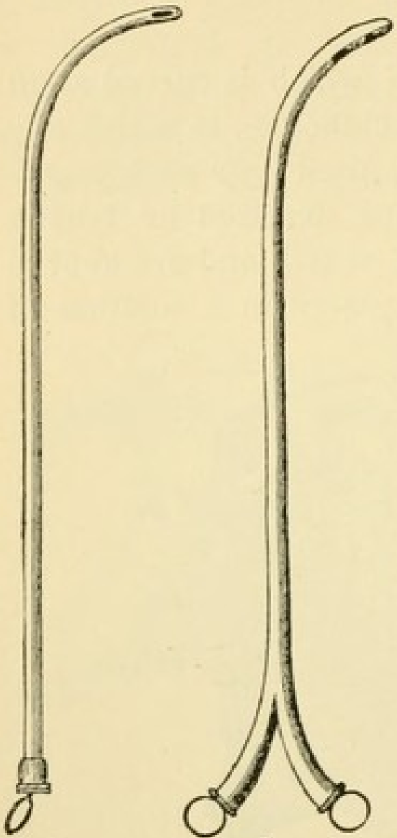

a b

FIG. 1375. METAL CATHETERS. *a*, common; *b*, with double canula

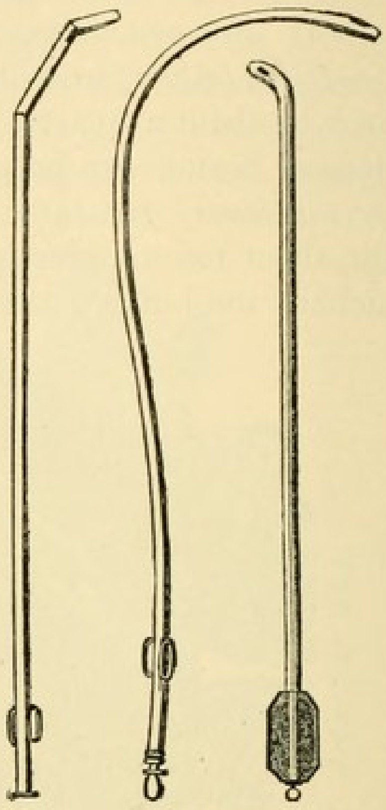

c a b

FIG. 1376. PROSTATE CATHETERS. *a*, strongly curved; *b*, with simple inflexion; *c*, or double inflexion (according to Mercier)

must be *slightly withdrawn*, and the motion must be repeated correctly. If *violence is employed*, danger of *making a false passage* arises, that is,

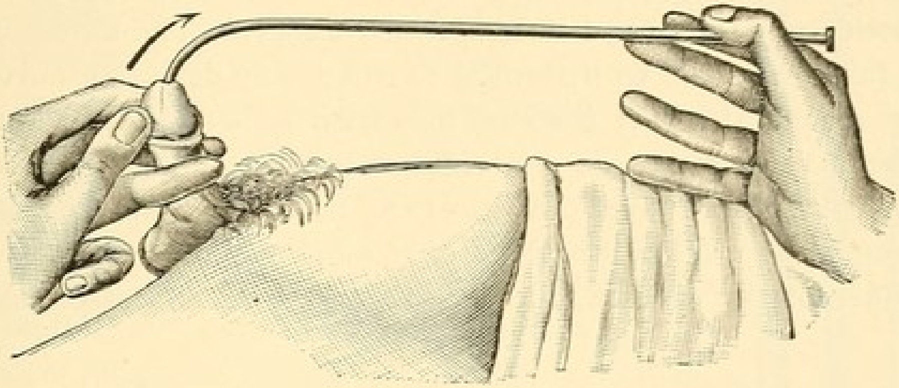


FIG. 1377

the point will penetrate through the wall of the urethra and into the surrounding loose fascia.

If the point has entered into the muscular part, not rarely a resistance is caused by the *spastic contraction of the compressor urethræ* (spasmus urethræ, Figs. 1373, 1374). The same is generally best overcome by *waiting*

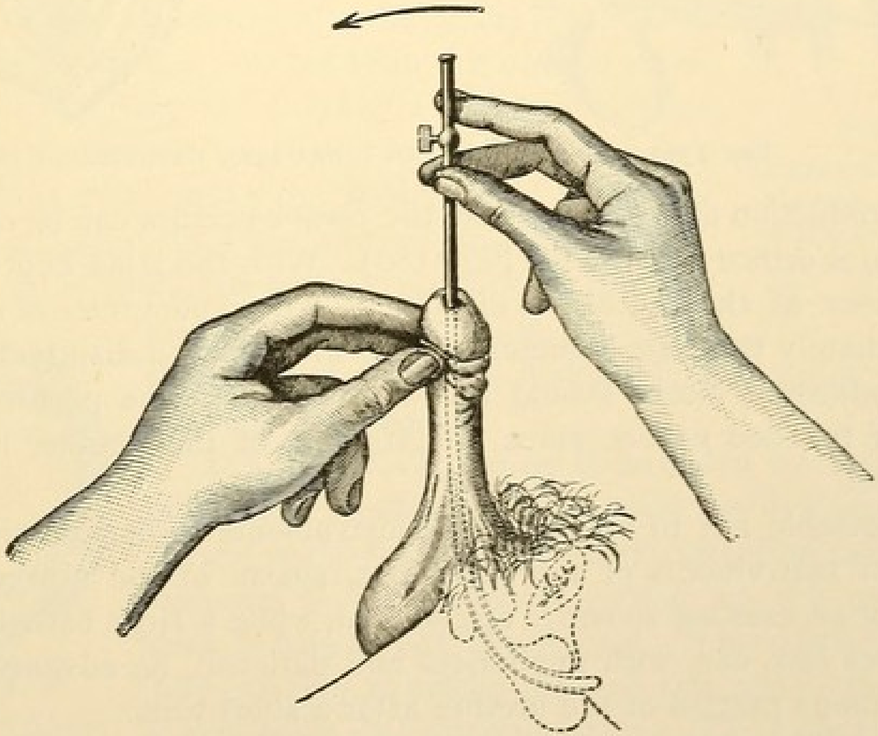


FIG. 1378

patiently a few minutes and by exerting a gentle pressure with the point, the position remaining unchanged. A skilful hand readily feels the gradual relaxation of the tense muscular fibres; thereupon the handle of the catheter is slowly depressed between the legs, whereby the beak, following the curve of the prostatic portion, slips into the bladder (Fig. 1379).

Introduction of flexible catheters is much easier. The catheters, consisting of silk fabric covered with shellac, to which any desirable curvature may be given by means of a wire inserted into their lumen, are introduced essentially in the same manner as the rigid metal instruments; the very soft catheters of vulcanized rubber (*Nélaton*) find their way easily and of their own accord through the urethra, provided only *small sections* at a time are *forced* into the orifice of the urethra, the penis being held and stretched with the left hand.

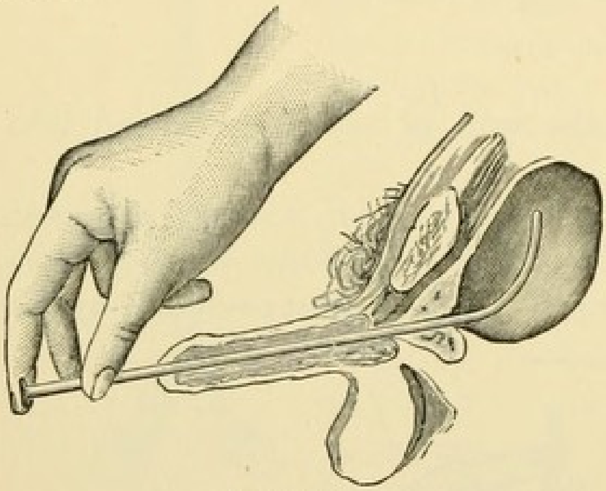


FIG. 1379

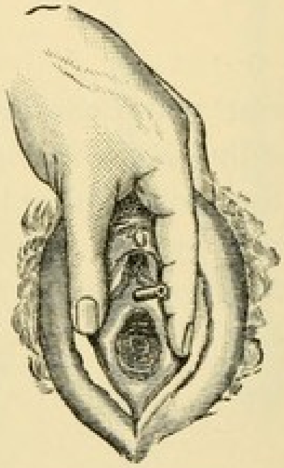


FIG. 1380. CATHETERISM IN THE FEMALE

The introduction of a catheter into the *female* urethra can be easily made, if the urethral orifice is exposed (Fig. 1380). With the labia kept well apart, first the orifice of the urethra is disinfected with a compress of cotton, and then immediately the little catheter (mostly of glass and disinfected by boiling) is introduced. Never should this little operation be performed in the dark, under the bed covers, since an infection of the bladder is often the consequence.

It is advisable not to use *too small* instruments in normal urethras; by the point of instruments of too small size, spasm of the urethra is easily provoked, or an existing spasm is aggravated, while a large cathether, whose point irritates less, can, with gentleness and patience, be advanced through the membranous portion of the urethra after a short time.

In hypertrophy of the prostate, when the prostatic portion of the urethra, in most cases, is elongated and often more curved, longer and more strongly curved catheters (*prostate catheters*, Fig. 1376, *a*) are used. In cases where the *middle lobe of the prostate* is much enlarged, the bladder is sometimes more easily reached with a *Mercier's* prostatic catheter, a straight catheter, whose beak is bent off at the lower end at an obtuse angle in a simple or double inflection (Fig. 1376, *b*, *c*). If, from an enlargement of the *lateral lobes*, the urethra is laterally compressed, *Hueter's* laterally *flattened* catheters may render good service.

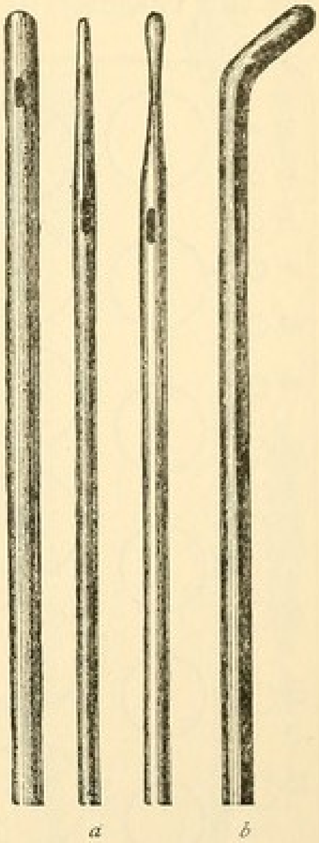


Fig. 1381
Flexible Catheters. *a*, common, cone-shaped, or probe-pointed; *b*, inflexed according to Mercier

For **washing out the bladder,** employ a common (*Nélaton*) catheter and the wound douche. After the contents of the bladder have been evacuated by means of the catheter, the glass point of the douche (the tube of which must *not contain any air*) is introduced into the opening of the catheter. By raising the douche, a certain quantity of fluid is allowed to enter; thereby the bladder becomes distended, and its wall is brought everywhere in contact with the fluid. (A great deal of harm has been done by overdistending the bladder by this method of irrigation. Never should more than one fluid used be injected at one time. Thompson's elastic bulb is a better instrument for grading the amount injected than the ordinary irrigator.) On removing the point of a douche, the contents of the bladder are evacuated in the form of a jet; this procedure of allowing the fluid to flow in and to flow out is repeated until the desired object has been attained. It is more convenient to employ catheters *with double canula* (Fig. 1375, *b*), the shaft of which is divided into an inlet canula and a discharge canula.

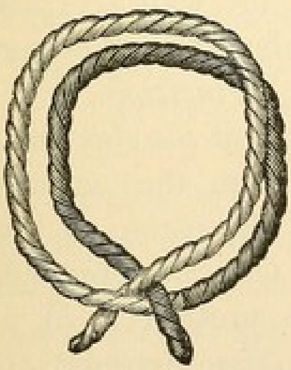


Fig. 1382. Clove-Hitch

If a (*Nélaton*) *catheter* is intended to remain in position in the urethra for some time, for draining the urine permanently from the bladder (**retention catheter**), it is fastened to the anterior portion of the penis with a thick cotton thread by making a clove-hitch (Fig. 1382). The catheter is placed through the same; the thread is drawn tight, and knotted again. The ends are fastened behind the glans by strips of adhesive plaster applied loosely around the penis. The catheter can also be fastened with a *safety pin to the prepuce* (or it can be stitched to it), as long as the patient is under anæsthesia. But the safest method of fastening it is *Dittel's*: —

A strip of adhesive plaster of a finger's breadth, perforated in the middle for the catheter, is fastened to the anterior and the posterior sides of the penis; the wall of the catheter, closely in front of the perforation, is pierced with a safety pin; and a second strip, with a similar opening, is fastened at the sides. For greater safety, the whole is strengthened with circular strips (Figs. 1383, 1384).

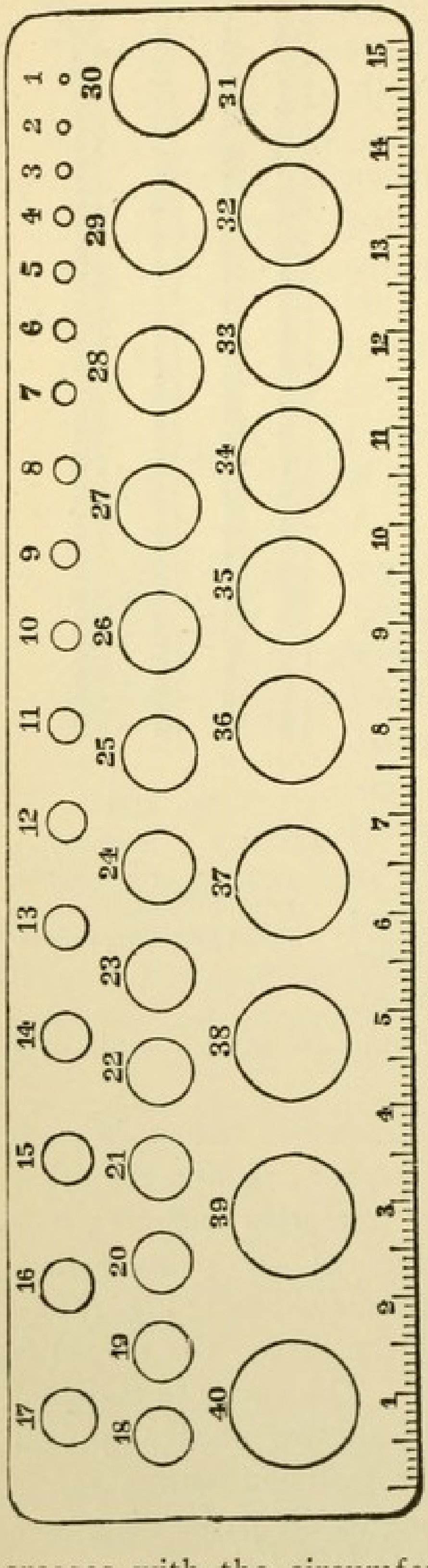


Fig. 1385. Otis's Scale for Urethral Instruments

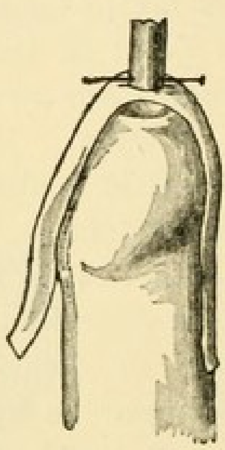


Fig. 1383

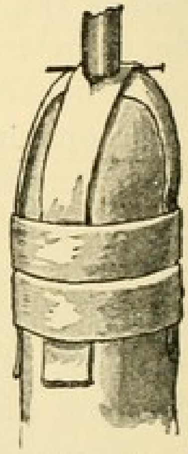


Fig. 1384

Dittel's Method of fastening Retention Catheter

STRICTURE OF THE URETHRA

A **stricture** — *that* is, a *lessening of the caliber* of a portion of the urethra, caused mostly by contraction of its wall (corpus spongiosum urethræ) — can be removed either by a bloodless *dilatation* or by *incision.*

For ascertaining the degree of the stricture, the operator has to start from the normal dilatability of the urethra. By means of his *urethrometer* (Fig. 1387), *Otis* has proved that the dilatability of the urethra is in a certain proportion to the circumference of the ordinary relaxed state of the penis. He found that the lumen of the urethra in the male is, on the average, about 32 millimeters in circumference; but this circumference increases with the circumference of the penis in the following gradation: —

CIRCUMFERENCE

OF THE PENIS	OF THE URETHRA
75 mm.	30 mm.
81 "	32 "
87 "	34 "
93 "	36 "
100 "	38 "
112 "	40 "

Even if, as a rule, only the more extensive strictures (*narrow strictures*) cause great trouble, still strictures of a less degree (*strictures of large caliber*) not rarely cause considerable disorder (gleet, nervous irritability, pollutions, etc.).

For a more exact diagnosis of the seat, the length, and the degree of the stricture, either *olive-pointed bougies*—that is, thin, metal rods (*bougies*), at the end of which is an olive-shaped point of varying diameter (Fig. 1386)—or, still better, *Otis's* **urethrometer** should be used. This instrument is a thin, metal rod, at the end of which a basketlike arrangement, formed by metal strips, may be distended by means of a screw to a circumference of 45 millimeters (Fig. 1387, *A* and *B*).

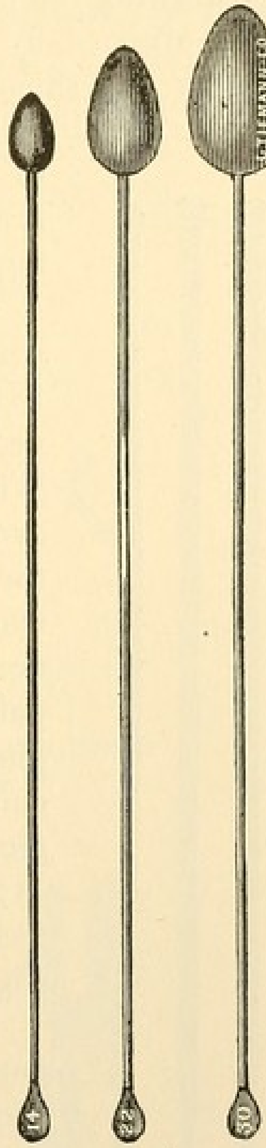


Fig. 1386. Olive-pointed Bougies according to Otis

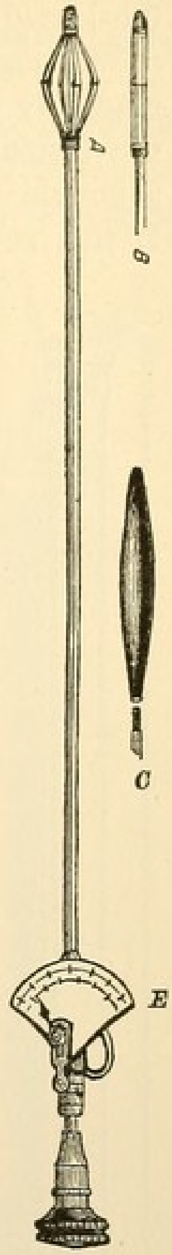


Fig. 1387. Urethrometer
A, open;
B, closed;
C, rubber cover

To protect the instrument from moisture, a thin rubber cover (*C*) is applied before it is introduced. The instrument is passed closed through the stricture; next, the basket is distended so far by means of the screw (*D*) that it cannot be withdrawn through the stricture. It is then slowly unscrewed, until it can be withdrawn through the stricture. Thereupon the operator reads from the scale (*E*) the caliber of the stricture, while its distance from the orifice of the urethra can be read from the scale on the shaft of the instrument.

In the **gradual dilatation by bougies** the operator proceeds as follows:—

He stands at the right side of the patient. After the urethra has been lubricated with an antiseptic preparation, by an injection of iodoform oil, a solid bougie is introduced, of a number corresponding to the measurement made, by gently drawing the penis up on the instrument (Fig. 1389, 3). If the instrument is arrested by any resistance, it should be withdrawn, and a bougie of smaller size should be employed *to pass through the stricture.* If this succeeds, on withdrawing the instrument the sensation is imparted to the operator, indicating that the point is firmly grasped (*engaged*) by the rigid surrounding tissue.

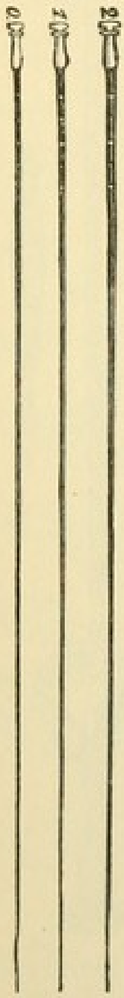


FIG. 1388 FILIFORM BOUGIES

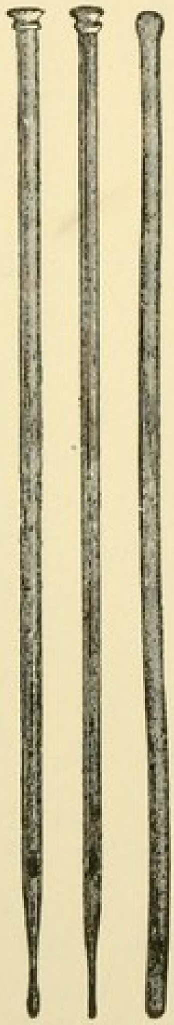


FIG. 1389 BOUGIES 1, probe-pointed; 2, cone-shaped; 3, with common point

For entering very narrow strictures, the finest bougies of catgut or whalebone (*filiform bougie,* Fig. 1388), or the fine olive-pointed and thin-necked bougies (Fig. 1389, 1), are selected. With these, under great tension of the penis, avoiding all violence, the operator tries to enter the lumen of the stricture by slow and careful manipulation. This should be done very patiently and gently without causing any great pain to the patient. If too much force is employed, the point, which has become soft, is curved in front of the obstruction, and the bougie is rolled up during introduction (Fig. 1391, *a*); or, worst of all, the point pierces the softer tissue *at the side* of the stricture (**false passage,** Fig. 1391, *b*).

If the operator meets with great difficulty in entering narrow strictures, owing to the eccentric location of the entrance to the canal, then a spiral curve should be given to the point of catgut string by winding it like a screw around a thicker bougie (Fig. 1390). If the bougie is then introduced in a spiral manner, the point is insinuated more easily into the stricture (Fig. 1391, *c*). Also in very difficult cases an endoscopic tube (such as is used for inspecting the urethra, Fig. 1392) may be filled with catgut ligatures (Fig. 1393). The endoscope is then introduced into the urethra as far as the stricture, and the operator, by careful probing, tries, with several catgut threads introduced at the same time by manipulating one after another, to enter the stricture (Fig. 1391, *d*).

(The insertion of a bundle of filiform whalebone bougies, large enough to fill the lumen of the urethra down to the stricture, and then manipulating the bougies in turn is simpler, more practical, and more successful.)

If the operator succeeds in *introducing* a fine catgut thread into the stricture, he should not try too long *to push it at once* through the stricture and into the bladder; for even if a complete retention of urine existed, the urine generally first trickles out slowly, then with increasing velocity.

Hence it is allowed to remain in position until it is ejected by the urine. In most cases, it is then comparatively easy

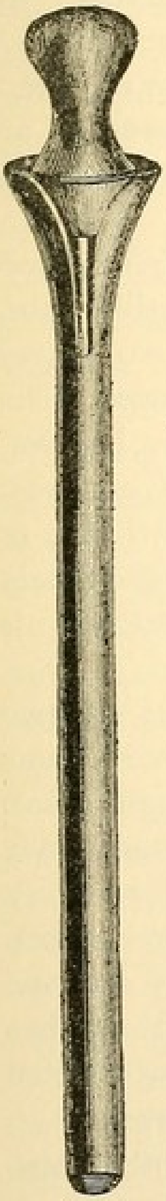


Fig. 1392 Otis's Endoscope

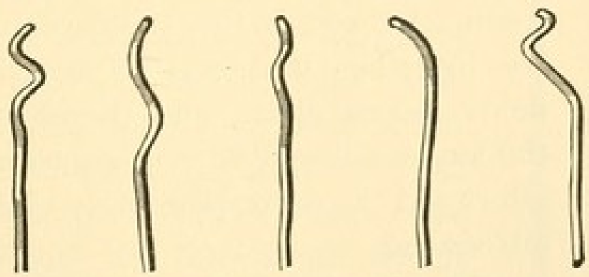
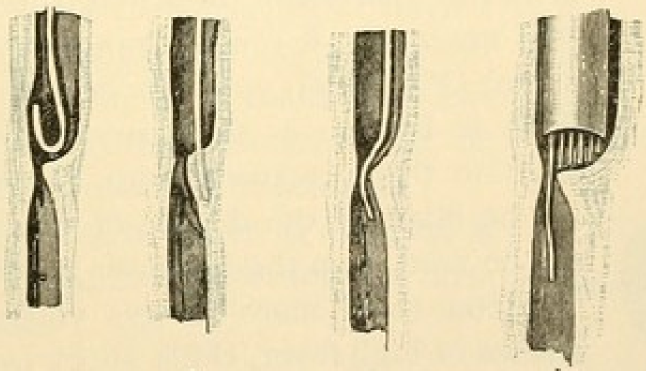


Fig. 1390. Catgut Strings with Curved Points according to Leroy d'Etiolles



a b c d

Fig. 1391. Introducing Bougie into Stricture of Eccentric Location

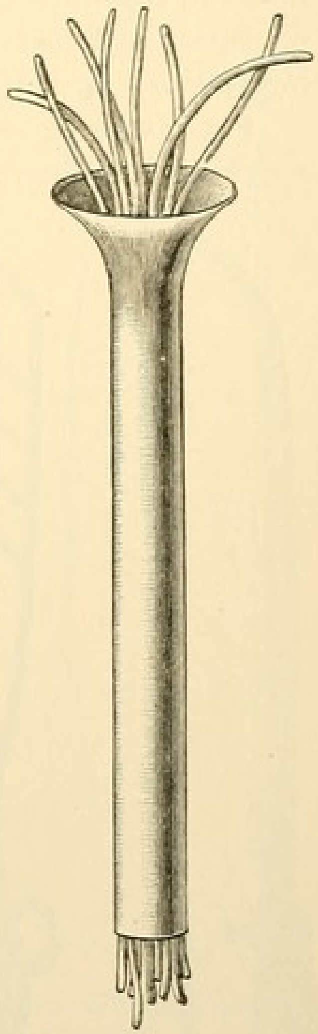


Fig. 1393 Endoscope filled with Catgut Strings (See also Fig. 1391, *d*)

immediately to introduce a larger number, because the catgut, by swelling, has enlarged the stricture. But if an instrument can be passed *through the stricture* and into the bladder, the operator has gained his point, and by daily introducing bougies of increasing caliber, he can gradually dilate the stricture. This dilatation may be promoted by leaving the instrument in position for some time (*retention bougie*), whereby an inflammatory softening of the contracted tissue is effected.

If the urethra has been thus dilated to the desired diameter, treatment with bougies must still be continued *for years* after increasing intervals. If this is neglected, in most cases — perhaps in all — the stricture recurs.

If the stricture obstinately resists a slow dilatation, or if, after an intermission, it recurs rapidly (with continuous gleet), it must be removed by an operation. This is done either by *forcible dilatation* of the cicatrized tissue (*divulsion*), or, better, *by internal urethrotomy.*

For divulsion — that is, *rupturing or bursting the stricture — Holt's divulsor* (Fig. 1394) is most frequently used. It consists of a catheterlike tube, divided throughout its length into two halves connected at the point. The instrument is introduced through the stricture into the bladder. By inserting wedges, the two halves are suddenly forced apart, and thereby the stricture or the surrounding tissue is ruptured; immediately afterward a correspondingly large catheter is introduced.

Thompson's dilator likewise consists of two bars, which by screw power can be forced apart considerably from one another at a certain point. With this instrument the stricture is dilated slowly — if necessary, it can be ruptured. *Oberländer's* dilator (Fig. 1396) operates in a similar manner. With it, by two or four bars gradually screwed apart to their greatest width, the whole urethra can be dilated; the degree of dilatation effected can be read from the indicator on the handle.

After these more or less violent operations, attacks of high fever, chills, shock (*urethral fever*), frequently occur; hence the internal cutting of the stricture, which operates more gently (internal urethrotomy), is preferably employed. If the operator desires to remove the stricture thoroughly by this incision, the contracted site of the spongy portion of the urethra must be so completely incised that the urethra can be dilated at once to its normal size (see page 754).

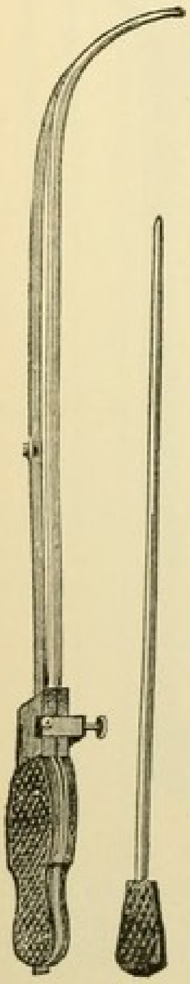


Fig. 1394
Holt's Divulsor

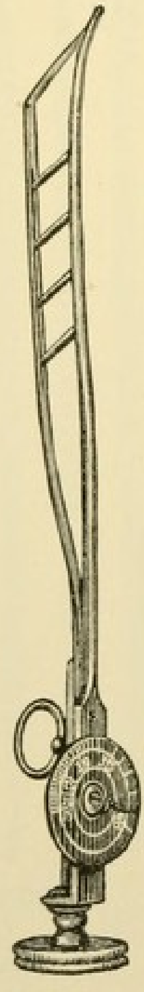


Fig. 1395
Oberländer's Dilator

INTERNAL URETHROTOMY

The internal incision for removing stricture is made only in contractions located in the spongy portion of the urethra, hence in front of the isthmus; while strictures in the membranous portion can be removed only by external urethrotomy.

Internal urethrotomy is made with small *guarded blades* buried in a long grooved director, which can be advanced or withdrawn by pressure or traction on the handle. The operation varies accordingly as the surgeon makes an incision from before backward, or *vice versa.*

If the stricture is very narrow, so that only a very fine guide-bougie can be introduced into the bladder, *Maisonneuve's urethrotome* (Fig. 1396) can be screwed on to it; and with the bougie as a guide, the rigid tissue of the stricture can be divided *from before backward* with the little knife, which cuts only at its anterior edge (not at the point).

It is safer to divide the stricture *from behind forward,* — for instance, with *Civiale's urethrotome* (Fig. 1397); this has at its point a bulb, in which the little knife lies concealed. Of course, the stricture must be passable for this bulbous enlargement.

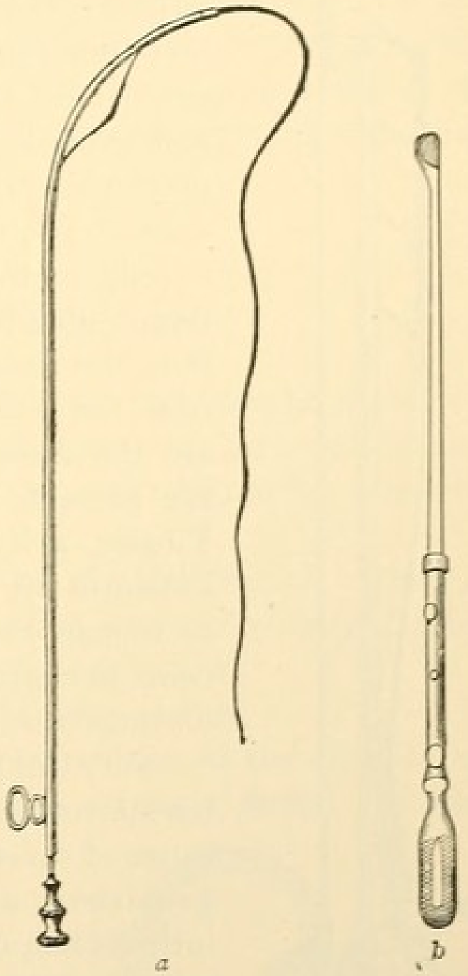


FIG. 1396 FIG. 1397
URETHROTOMES. *a*, Maisonneuve's; *b*, Civiale's

The best success, however, is obtained if the dilatation is combined with internal urethrotomy by the

INTERNAL DILATING URETHROTOMY

(*Otis*)

Otis's dilating urethrotome (Fig. 1398) consists of two divided metal bars, which can be forced apart by screw action. To a fine metal wire is fastened a small knife, which lies concealed in the upper end of one of the bars. By traction at the handle, it can be withdrawn from a groove of the staff, so that it projects near the end and divides any tense tissue. The instrument is introduced as far as, and through, the stricture, when it is dilated by the screw until the resistance is too great; the knife is made to project, and the instrument is withdrawn through the stricture, when the cutting through the indurated tissue produces a grating sound. The knife is then allowed to recede, the instrument is passed again through the stricture, the bars are screwed apart a little more than the first time; this procedure is continued until the index on the handle indicates that the desired dilatation has been reached — such as had been previously ascertained by the urethrometer, the normal width of the urethra under treatment. The incisions with the knife must always be made exactly in the median line, and only in an upward direction, — that is, toward the back of the urethra, — causing thus the least hemorrhage. Only in strictures located near the end of the urethra in the region of the glans are the incisions made downward. If several strictures are present, the operation is made separately for each. Finally, a Nélaton catheter, full size, and lubricated with iodoform oil, is introduced into the bladder, and allowed to remain two or three days, so that the urine does not come in contact with the fresh wound, and does not cause urethral fever.

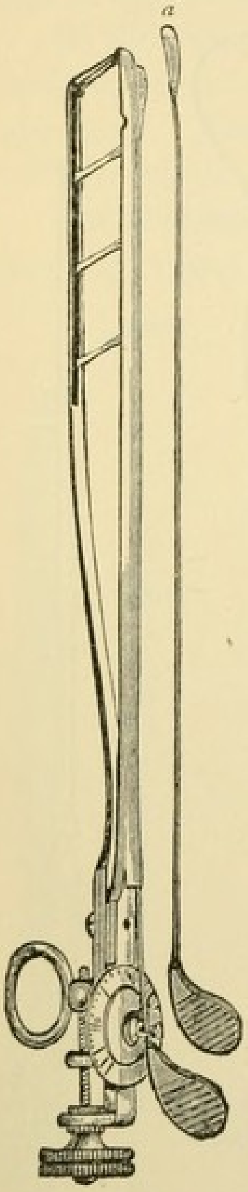


Fig. 1398
Otis's Dilating Urethrotome
a, knife

Very frequently the *external meatus of the urethra* is too narrow (congenital or acquired), and may become the cause of diverse disturbances of the sexual organs (chronic gonorrhœa, neurosis); moreover, this stenosis prevents the introduction of bougies of adequate width. If this is the case, the meatus must be incised in a downward direction until the size of the opening corresponds with the normal caliber of the urethra; this is ascertained from the measurement of the circumference of the penis (**meatotomy**).

This is best done by a simple incision with a probe-pointed knife. To prevent reunion of the normal surfaces, the margins of the incision of the mucous membrane should be united by fine sutures with the surface of the glans; or the point of the frenum of the prepuce, detached in the form of a flat flap, must be sutured as a little flap to the internal mucous membrane at the angle of the little wound. Troublesome hemorrhage during this operation may necessitate the ligation of the *artery of the frenulum*.

In the after treatment, an endoscopic tube, lubricated with iodoform oil, is introduced; it remains in position for two or three days, and the urine can easily be passed through it.

If profuse hemorrhage from the posterior portion of the urethra occurs after internal urethrotomy, the perineum is pressed against the catheter by a crutch propped between the footboard of the bed and the perineum (*Otis*). If, however, the bleeding takes place from an incision in the anterior portion of the urethra, the penis may be compressed by two lateral splints of pasteboard pressed together with a few fine rubber bands (*Smith*).

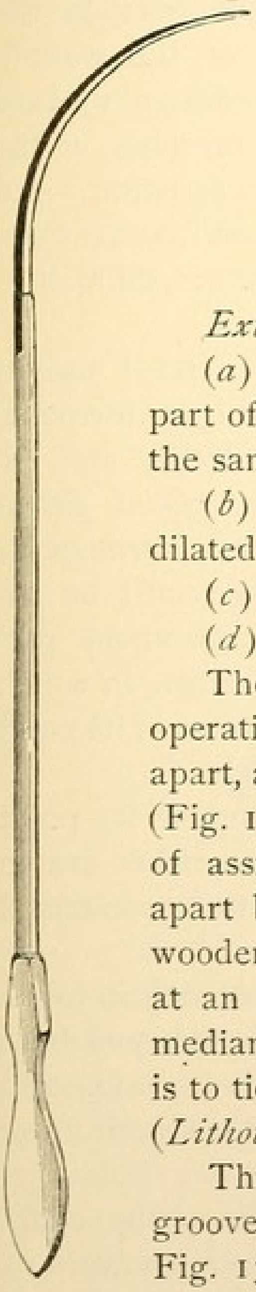


Fig. 1399 Syme's Guide Staff

EXTERNAL URETHROTOMY

External perineal urethrotomy (*Boutonnière*) must be made: —

(*a*) In *injuries* (contusions, lacerations) of the membranous part of the urethra, to prevent infiltration of urine or for removing the same.

(*b*) In cicatricial *strictures behind the bulb*, which cannot be dilated and which are impassable, and in *perineal urinary fistulæ*.

(*c*) As first step in performing *median section*.

(*d*) Removal of calculi impacted in the urethra.

The patient is placed in lithotomy position at the edge of the operating table. The legs and thighs, strongly flexed and wide apart, are held by two assistants (Fig. 1401); or, in the absence of assistants, they are spread apart by leg supports or by a wooden yoke holding the knees at an equal distance from the median line. The simplest way is to tie hands and feet together (*Lithotomy position*).

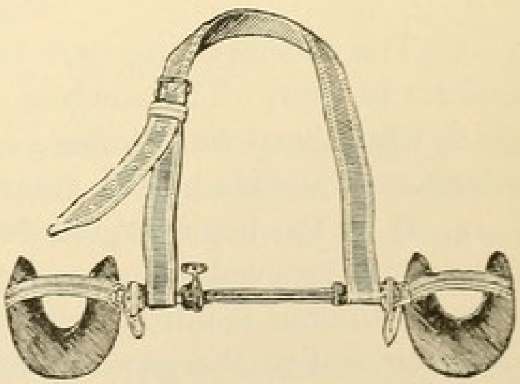


Fig. 1400. Wooden Yoke for Lithotomy Position

Through the urethra a grooved sound (or guide staff, Fig. 1399) is introduced into the bladder; if this is not possible, it is introduced as far as the seat of obstruction, and held immovably by an assistant exactly in the median line, the symphysis being used as a point of support for the hand.

1. Exactly in the median line between the elevated scrotum and the anus, into which the left forefinger is introduced, *an incision* is made about 3 to 4 centimeters long, ending 2 centimeters in front of the margin of the anus and penetrating only the skin and the cellular tissue; it must not injure the bulb in the upper angle of the wound. The bulb is drawn upward with a blunt retractor or the fingers of the assistant. An injury of the bulb causes violent hemorrhages, difficult to arrest.

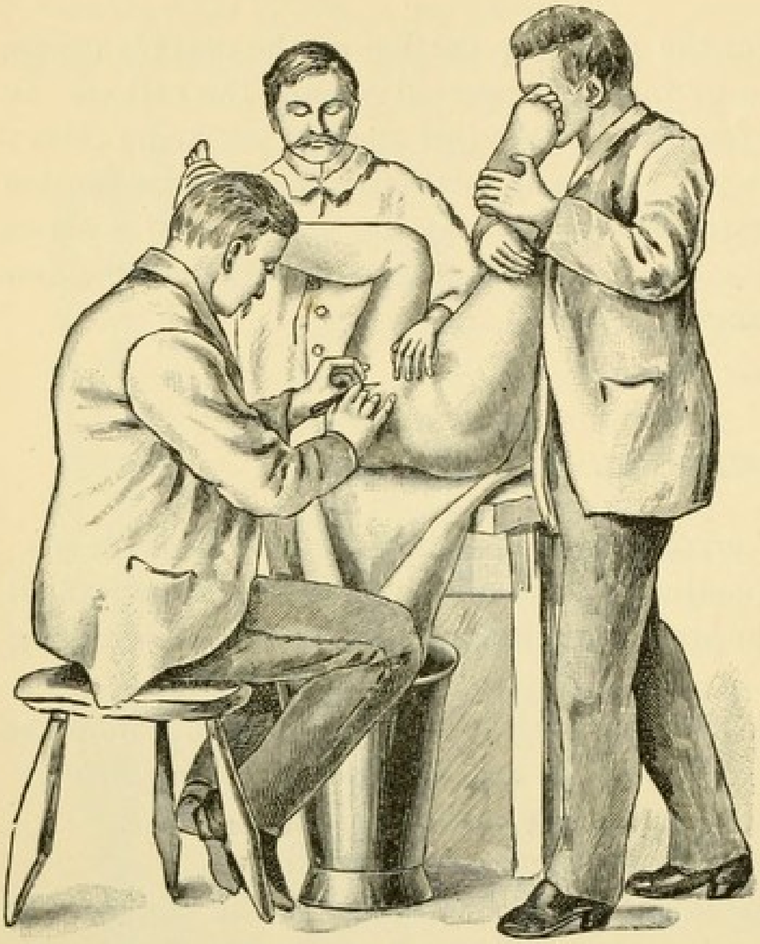


FIG. 1401. LITHOTOMY POSITION

2. By a careful use of the knife, the operator penetrates more deeply and divides the *superficial fascia* and the *superior transverse perinei muscles* until he exposes the membranous portion of the urethra, in which the grooved sound or its point is distinctly felt.

3. The membranous part is then incised until the sound or its point appears to view. The margins of the mucous membrane are either drawn apart with sharp little hooks, or, still better, are stitched to the external margins of the skin by two sutures.

4. If, at the beginning of the operation, the operator succeeded in introducing the grooved sound as far as and into the bladder, a ∼-shaped bent grooved director is introduced into the bladder alongside of the sound; and after removal of the grooved sound an elastic catheter is introduced upon the director.

5. If, however, on account of the great constriction, the probe could not be introduced into the bladder, but only as far as the anterior margin of the obstruction, it is of importance, after the exposure of the point of the probe, to find in the opened urethral lumen the internal opening of the urethra; this is often very difficult to do. In impermeable and *very narrow*

strictures, the small opening can be found more easily if traction is made on each side of the urethral wall by inserted silk thread loops. Next, with a fine probe, the operator makes an attempt to pass the stricture and to split it in its entire length as far as and into the healthy urethra. *Long cicatricial strictures* may also be excised entirely, and the healthy mucous membrane margins may be sutured (**urethrorrhaphy**). If the operator is compelled — for instance in the *resection* of strictures — to excise a portion, even 2 to 4 centimeters long, from the whole circumference of the urethra, both

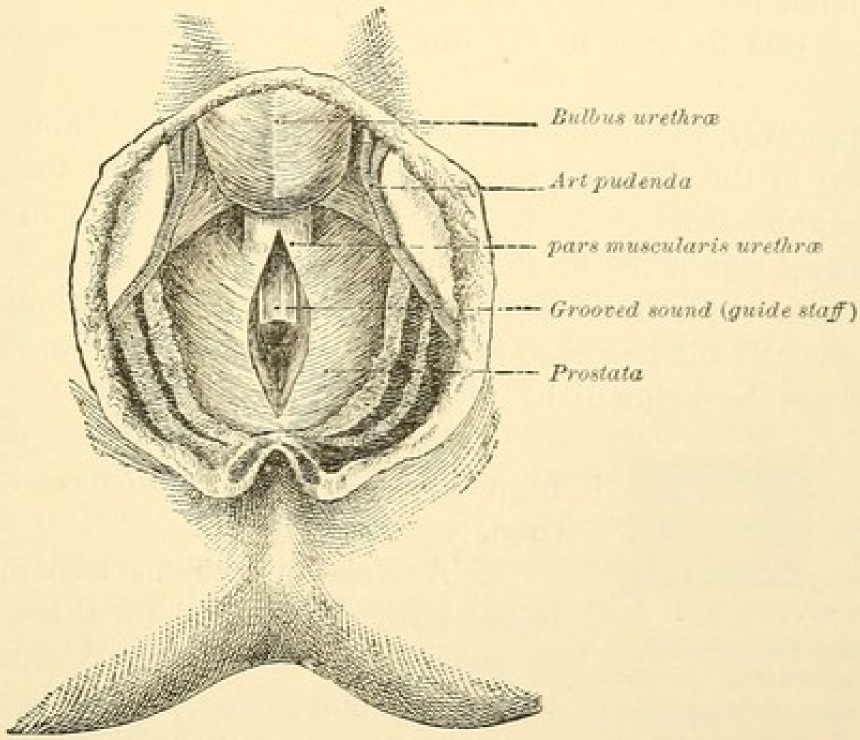


FIG. 1402. ANATOMY FOR EXTERNAL URETHROTOMY

stumps can be united again by fine submucous sutures over a catheter, if the tension is not too great. In incurable strictures, it is advisable to establish a perineal fistula (perineal **urethrostomy**, *Poncet*) by suturing the incised mucous membrane of the central urethral stump, to the margins of the skin (*König*).

6. It may be still more difficult to find *after injuries* the completely separated and contused proximal opening of the urethra in the contused tissue infiltrated with the extravasated blood.

After the coagula of blood have been thoroughly removed from the wound cavity, and the latter has been thoroughly irrigated with a disinfecting fluid, the margins of the wound are drawn apart with sharp retractors. Occasionally the central end of the urethra is at once recognized in the form of a movable projection infiltrated with blood, which appears in the form of a firm coagulum. Else the wounded patient is requested to urinate; or, if he is deeply anæsthetized, a strong pressure is made by the assistant over the full bladder. At the place where the urine oozes out, the surgeon tries to grasp the margins of the ruptured urethra with tenaculum forceps or fine hooks, and to draw it apart. If this succeeds, a ~-shaped grooved director, carrying an elastic catheter, may easily be introduced into the bladder. In deep-seated injuries of the membranous part of the urethra, Roser recommends incision of the anus, 1 and 2 centimeters high, and the extension of this incision in the direction of the perineum (*anal perineal incision*).

7. If, however, the injury of the urethra occurred behind the membranous portion in the *prostatic portion* of the urethra,— for instance, in fractures of the pubis from gunshot injuries, — it is not possible, in most cases, to find the vesical end of the urethra; and the danger of urinary infiltration as far as and into the cellular tissue of the pelvis becomes imminent, because the deep pelvic fascia has been injured. In such cases, the place of injury can sometimes be exposed by perineal incision (Fig. 562), or puncturing of the bladder or *high cystotomy* must be made; from this, *posterior catheterization* is practised.

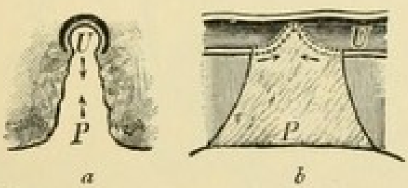


FIG. 1403. DIAGRAM OF EXTERNAL URETHROTOMY. *a*, transverse section; *b*, longitudinal section; *U*, urethra; *P*, perineum

8. A Nélaton catheter remains in position in the tamponed wound for three to four days, to prevent the urine from coming in contact with the wound; hence, it is advisable to attach to the catheter a rubber tube, as a siphon, to immerse the distal end of the tube in a vessel partly filled with an antiseptic solution, so that all urine is at once siphoned from the bladder.

9. The healing of the wound by granulation has a tendency to dilate that part of the urethra, because, by the *contraction of the cicatrix*, the floor of the mucous membrane of the urethra is drawn in a downward as well as a longitudinal direction (*Roser*, Fig. 1403).

URETHROPLASTY

is intended for *the closure of lip-shaped urethral fistulæ* caused by the injuries or ulcerations of the urethra. In most cases a final healing is effected with great difficulty.

Very small fistulæ, of the size of a millet seed, with soft, easily movable margins, can sometimes be closed *by simple vivifying and suturing*, in which case the interrupted suture or *Dieffenbach's purse-string suture* is used.

If, however, a somewhat larger defect must be closed, the attempt to approximate by sliding the vivified margins of the fistula over the defect must be made by *making lateral incisions* and detaching the bridge flaps, formed thereby from the underlying tissues. *Dieffenbach made longitudinal incisions* (Fig. 1404), and *Nélaton* undermined the surroundings of the fistula from two *transverse incisions* (Fig. 1405). The best effect is obtained by *the double plastic closure* of the defect. For this purpose, the fistula is circumscribed with a sharp knife in its entire extent along its margin; and with superficial incisions (always directed inward toward the median line) the mucous membrane is detached all around from its base, so that its margins can be turned over and made to touch each other; with fine, closely applied, interrupted catgut sutures the internal margins of the incision are then united, and thereby a new urethral lumen lined with mucous membrane is made (Fig. 1406, *c*). Over this *underlining* the wound of the external skin is then closed. Either the external lateral margins of the fistulous opening, circumscribed with the knife, are detached and rendered movable to such an extent that the two lateral halves formed can be stretched and united with each other over

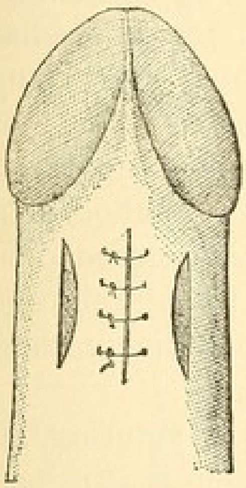


FIG. 1404. DIEFFENBACH'S URETHROPLASTY

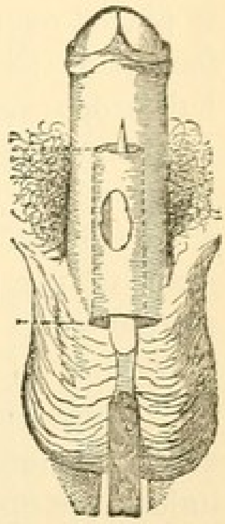


FIG. 1405. NÉLATON'S URETHROPLASTY

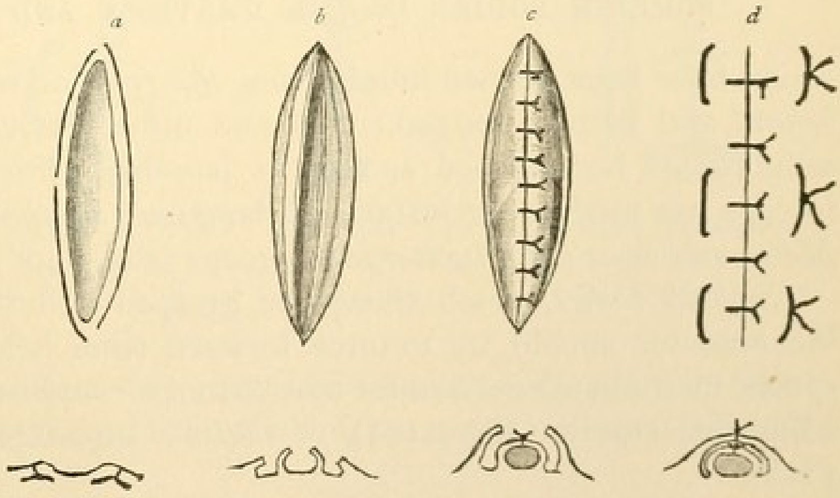


FIG. 1406. VON ESMARCH'S URETHROPLASTY WITH UNDERLINING. *a*, circumscribing with the knife margins of fistula; *b*, turning margins inward; *c*, suture; *d*, suturing approximated margins of skin with interrupted and quilt sutures. The four lower figures show their sectional view

the lining, or a pedunculated flap is excised from the very movable skin of the scrotum free from adipose tissue, and by twisting the pedicle sutured into the defect with interrupted sutures. This flap, of course, must be considerably larger than the surface of the wound to be covered. Finally, in very large and broad fistulæ, the definitive closure may be effected by double flaps. One flap is turned backward, and the other, by stretching, is placed over it in the manner described in the operation for epispadias (see page 789); but especial care must be taken that the inner flap has no hair-producing surface, else urinary concretions will form around the hair projecting into the urethra. If sufficient mucous membrane is not present, the urethral lining *should be grafted with skin* by *Thiersch's* method. In a very large defect of the urethra in the perineum, *Meusel* succeeded in grafting the internal layer of the prepuce — which can be entirely dispensed with — into the wound, and in forming with it the missing urethral portion.

To prevent the filtration of urine through the fresh line of suturing, an elastic catheter is introduced into the urethra; to this a siphon is attached, unless the operator desires to make in preference *external urethrotomy* for evacuation of the urine (*Thiersch, Dieffenbach*).

For the prevention of erections, which after the operation very frequently occur and burst the whole line of suturing, large doses of *bromide of potassium* are to be recommended.

FOREIGN BODIES IN THE URETHRA AND THE BLADDER,

which have been pushed into it *from the front* or which have entered *from behind* and become lodged (renal and urinary calculi, or fragments of the same), must be removed as soon as possible. For this purpose, long, fine forceps are used, — for instance, *Thompson's urethral forceps* (Fig. 1407) or *Matthieu's so-called alligator-jaw* forceps (Fig. 1408).

Smooth bodies, which cannot be grasped well from the urethral orifice, the operator should try to force forward from behind, with wire loops or special instruments devised for that purpose; very useful is *Leroy d'Etiolles'* adjustable curette (Fig. 1105), or *Collin's* adjustable hook (similar to Fig. 1218).

Moreover, a whole series of ingenious instruments have been invented for certain purposes. Figure 1410 shows *Nélaton's* adjustable *lithotrite* for the removal of small stones in the urethra; Fig. 1409, *Collin's catheter-catcher* for removing broken-off portions of the catheter from the bladder. In suitable cases, the position of the foreign body is ascertained by the use of the X-ray (*Röntgen*); the procedure of grasping the foreign body is then considerably facilitated. Its position may also be ascertained by cystoscopy. *Fine bodies* (needles, bristles) may be made visible by means of the endo-

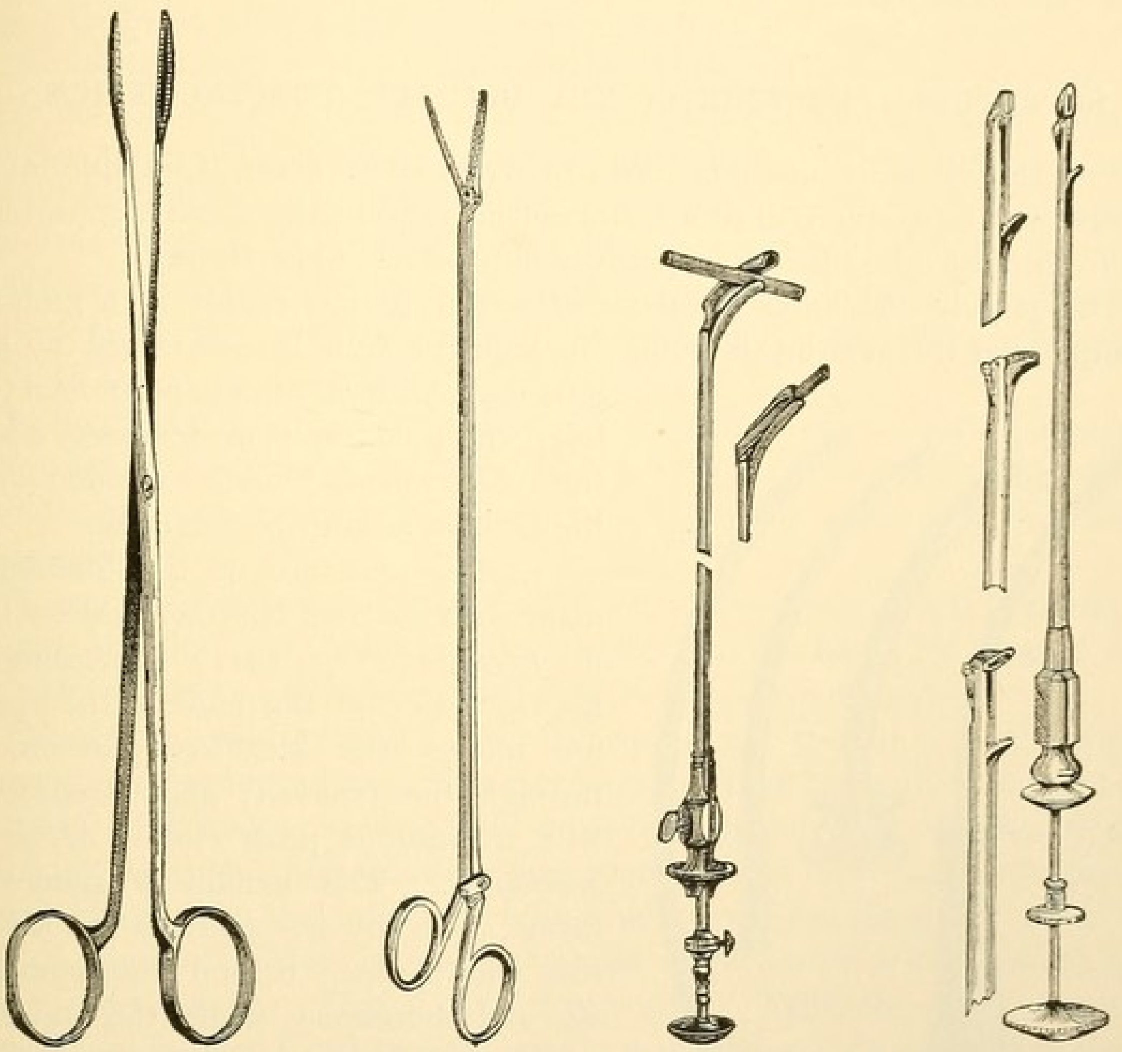


FIG. 1407. THOMPSON'S FIG. 1408. MATTHIEU'S (Alligator) URETHRAL FORCEPS FIG. 1409. COLLIN'S CATHETER-CATCHER FIG. 1410. NÉLATON'S LITHOTRITE FOR URETHRA

scopic tube. If a needle offers very great resistance to extraction, its point should be made to pierce through the wall of the penis and grasped with dressing forceps.

If the foreign body cannot be removed by these procedures, it must be exposed by an incision from the outside, by means of supra-pubic lithotomy or by *external perineal urethrotomy;* or, if it is lodged more anteriorly, by an incision over the foreign body. After the removal of the foreign body, the wound can be closed at once by sutures, though it must be protected from urine infiltration by introducing a retention catheter.

If a foreign body is lodged in the distal part of the urethra in the wide *navicular fossa* behind the narrow urethral orifice, *meatotomy* should be made (see page 791).

SUPRAPUBIC PUNCTURE OF THE BLADDER (PUNCTIO VESICÆ)

Puncture of the bladder is made in *retention of urine*, if, in spite of all endeavors, the operator does not succeed in introducing a catheter through the urethra into the bladder (especially in prostatic hypertrophy).

The largely distended bladder can be felt and is visible as a globular swelling over the symphysis pubis; its superior limit is ascertained by percussion. An injury to the peritoneal cavity, if the puncture is made closely above the symphysis, is almost excluded when the bladder is largely distended.

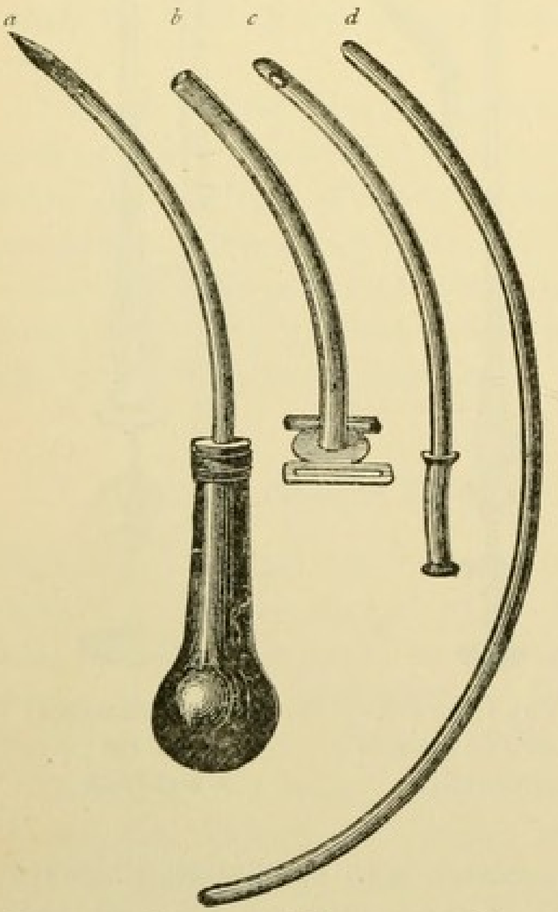


FIG. 1411. FLEURANT'S TROCAR FOR PUNCTURE OF BLADDER. *a*, stylet; *b*, external canula; *c*, internal canula; *d*, plug ("Docke")

1. The puncture of the bladder is made with the long curved *trocar* devised by *Fleurant* (Fig. 1411). Standing at the right side of the patient, the operator inserts the sterilized instrument through the (shaved) abdominal walls with a vigorous push closely *above the symphysis.* The handle is somewhat raised, whereby the point is introduced into the bladder behind the symphysis, and thereupon, while the stylet is withdrawn, the canula (*b*) is slowly pushed into the bladder as far as the shield.

2. The urine escaping in a stream is momentarily retained by applying the finger over the opening until the blunt-edged canula (*c*) has been introduced into the external canula (*b*). The rubber tube fastened to its end is placed into a vessel standing somewhat lower for the reception of the urine.

3. The canula is fastened by bandages conducted around the trunk or by small strips of adhesive plaster. The external canula must remain in position for six to eight days, to allow the punctured tissues to surround it; the internal canula, however, is often removed and cleansed from mucus, etc.

4. At the end of about a week the external canula must also be removed and cleansed from incrustations adhering to it. To prevent missing the punctured canal after the removal of the external canula, it is withdrawn over the *plug* ("Docke") (*d*) previously introduced. The latter remains in position in the canal until the external canula (*b*) has been introduced again. With this plug (or a catheter, bougie, etc.) the attempt may be made to enter from the punctured opening through the obstacle in the urethra, and thus to make the urethra passable from behind (*posterior catheterism, Brainard*).

Subsequently a permanent canula of hard rubber or an elastic catheter is introduced; sometimes a *sphincter-like closure* is formed by means of the muscular fibres of the recti muscles; this renders the wearing of the canula unnecessary.

In *very thick abdominal walls*, before the trocar is inserted, it is advisable to divide the skin and the adipose tissue down to the fascia by *a small incision;* the trocar can then be guided *more easily and more safely*.

The simple puncture with a fine exploring trocar and the puncture with a fine aspirator needle and *aspiration* (see page 660) can be easily made, and are successful; but neither is especially to be recommended, since infiltration of urine may take place, and since the operation must, in most cases, be repeated several times. On the other hand, as a substitute for the puncture of the bladder described above, in long-continued retention of urine *Poncet's* **cystotomy** can be made. This is easy of execution. With the pelvis elevated, a transverse incision 6 centimeters long is made closely above the symphysis through the abdominal walls, the exposed wall of the bladder is divided transversely for a distance of 3 centimeters, and the mucous membrane of its margins are sutured to the margins of the skin. During the first days the patient wears a short curved canula, for which a tin nail is subsequently substituted, until by cicatrization and the fibres of the rectus the closure is effected. A *Witzel's* oblique fistula (see Fig. 1254) can also be formed on the exposed vesical wall over an introduced little canula; this effects a safe closure in the same manner as in gastrostomy.

SUPRAPUBIC CYSTOTOMY

EPICYSTOTOMY (SECTIO ALTA), *Peter Franco*, 1561

Suprapubic cystotomy is made: —

(*a*) For the *removal of vesical calculi*, especially large and hard calculi (above all, in boys), calculi in diverticula, and other *foreign bodies* that cannot be well removed through the urethra.

(*b*) In *tumors of the bladder* and the prostate.

(*c*) In painful, tubercular ulcers and in irritable bladder.

(*d*) In *impassable strictures* of the posterior urethral portion as a preliminary step to posterior catheterism.

PREPARATIONS

After the bladder has, for several days, been irrigated with warm antiseptic solutions (boric, salicylic), on account of the catarrh generally existing, and after the rectum has been evacuated thoroughly, a metal catheter with a stopcock is introduced into the bladder at the beginning of anæsthesia, and remains in position during the whole operation.

In order to force the bladder and the duplicature of the peritoneum upward and out of the true pelvis ("kleines Becken"), first a well-lubricated cone-shaped rubber balloon, folded together (*Colpeurynter*, Fig. 1412), is introduced into the rectum as far as and above the sphincter, and filled with about 300 to 400 cubic centimeters of warm water. Next, by a gentle pressure, about 200 cubic centimeters of warm boric solution are allowed to enter the bladder from an irrigator; the duplicature of the peritoneum over the anterior abdominal wall is now raised at least 3 to 4 centimeters above the symphysis (*Garson*, *Petersen*, *Fehleisen*, *Strong*, Figs. 1413, 1414). A globular swelling is now seen over the symphysis, which elicits a dull sound on percussion; cystotomy can then be made without any danger of injuring the peritoneum. (Instead of water, air can be used for inflating the bladder and the rectal balloon.)

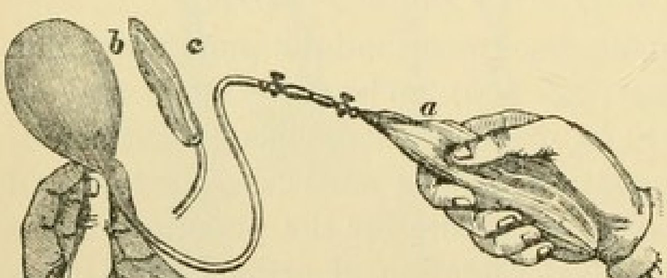


FIG. 1412. COLPEURYNTER. *c*, folded together; *b*, inflated by means of apparatus *a*

For this operation, *Trendelenburg's position* is now generally employed. By raising the trunk and the legs of the patient, his body is placed in an oblique, inclined position (45°). For this purpose, suitable arrangements are attached to operating tables (Fig. 1415). Tables have also been made for this special purpose.

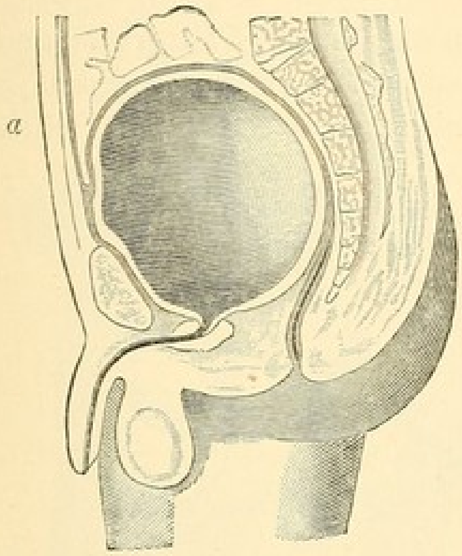


Fig. 1413. Bladder filled

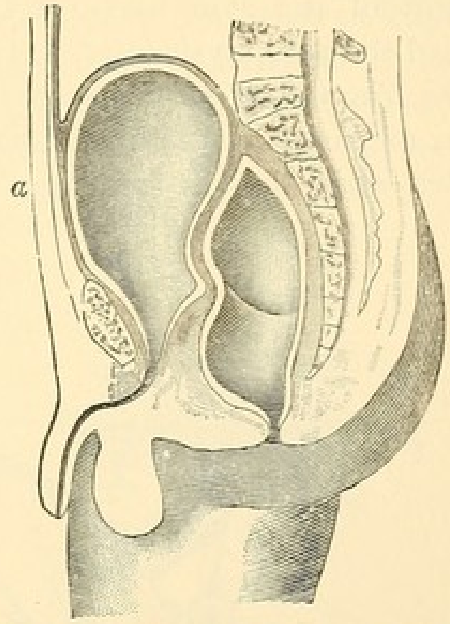


Fig. 1414. Bladder and rectum filled

Section of Pelvis. *a*, position of peritoneal fold (Fehleisen)

If such a table is not at hand, the patient may, during the operation, be held in the high pelvic position by a strong nurse (Fig. 1416).

With this position, the distention of the rectum and of the bladder is superfluous; the intestines gravitate toward the dome of the diaphragm, and the bladder is drawn up from the true pelvis by the simple force of gravitation. The entire operation can be made much more easily and safely in this position, and especially a free inspection of the interior of the bladder is obtained. This is of great value if cystotomy has been made for vesical tumors or hypertrophied lobes of the prostate. The tumors can then be extirpated clean with knife or scissors, or can be cauterized with the thermocautery or the galvanocaustic wire loop.

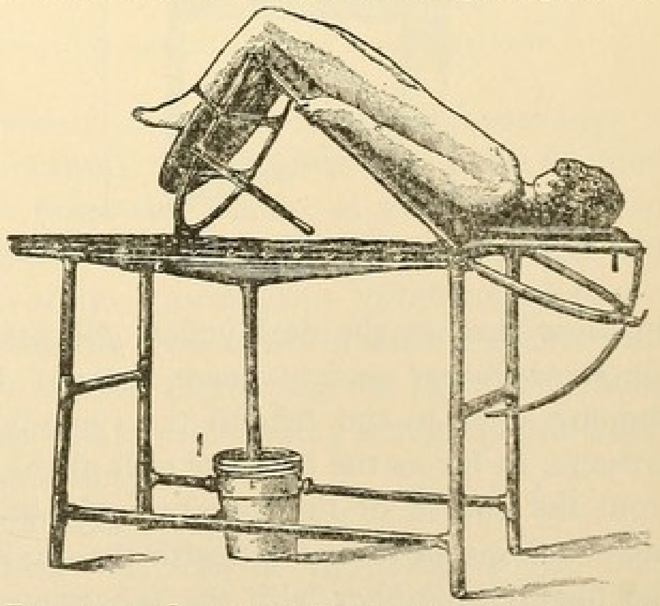


Fig. 1415. Operating Table with Arrangement for High Pelvic Position

1. *External incision*, either a *longitudinal incision* the length of a finger, exactly *in the median line* of the symphysis upward, or, better, a *transverse incision* (*Bardenheuer*) closely above and parallel to the superior margin of the symphysis, straight or slightly curved, with its convexity toward the symphysis (Fig. 1417).

2. The *superficial fascia*, *the pyramidales*, *the sheath of the rectus*, and the lower extension of the linea alba are detached closely at the superior pelvic border, while the left forefinger depresses and steadies the tissues; thus the

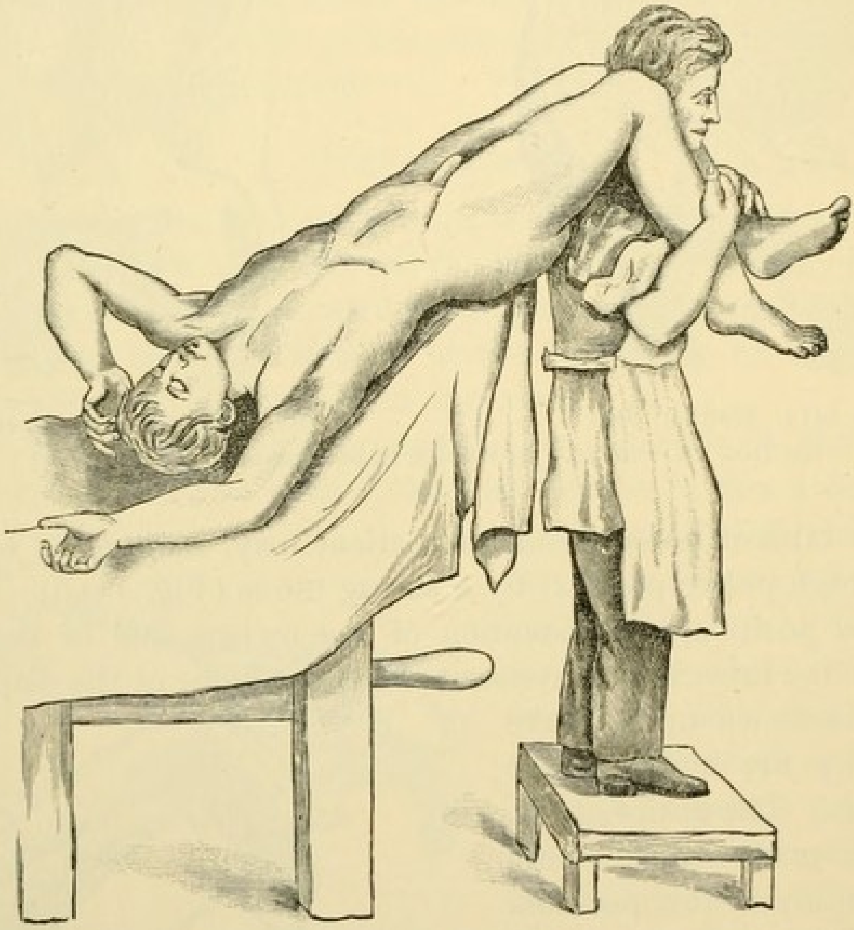
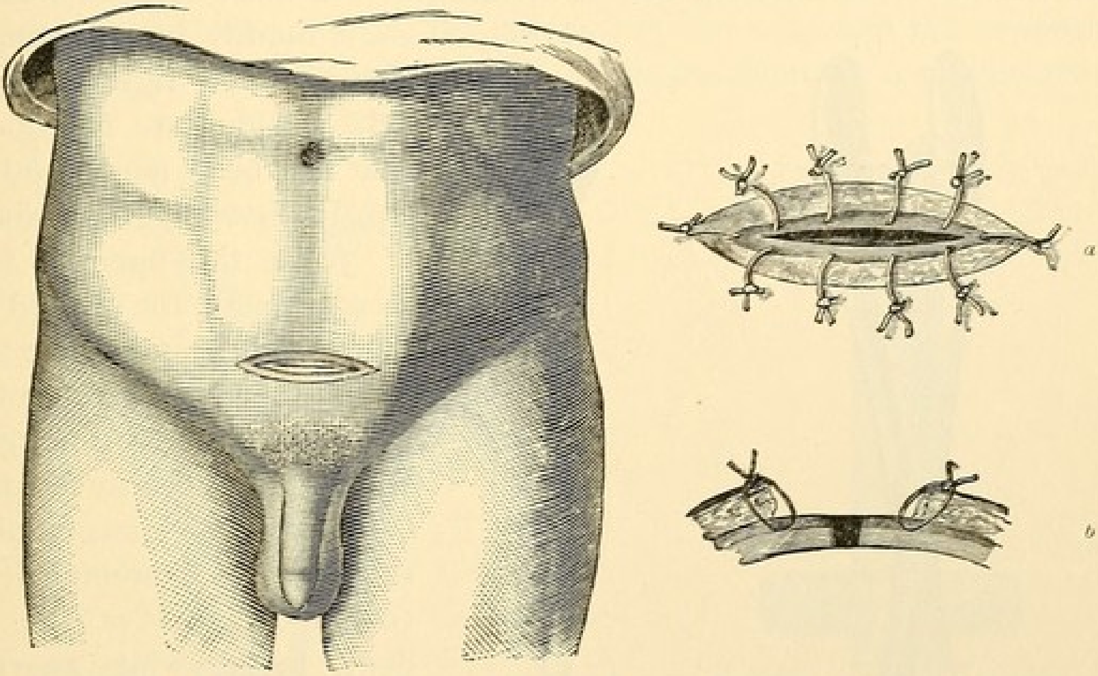


Fig. 1416. Trendelenburg's Position

operator reaches the dark yellow *prevesical adipose tissue* (rich in veins) of the *preperitoneal cavity* (*cavum Retzii*); in this he advances bluntly, always keeping close to and behind the symphysis, without any considerable hemorrhage, as far as the anterior wall of the bladder, which can be recognized from the course of the longitudinal fibres of its yellowish *muscles*. The upper margin of the wound with the duplicature of the peritoneum lying on the bladder, together with the subserous adipose tissue surrounding it, are drawn upward with blunt retractors or by the fingers of an assistant.

If cystotomy is to be made **in two stages** (**Vidal**) as an additional security against opening of the peritoneum, the bladder, which is held by a pair of forceps, is sutured all around to the margins of the skin (Fig. 1417 *a*), with silk sutures penetrating only as far as the submucous coat without entering the interior of the bladder; the ends of these sutures remain about as long as a finger. The wound is then tamponed, and the bladder is not opened until ten to fourteen days later, after firm adhesions have taken place all around.



Bardenheuer's External Incision FIG. 1417 Suturing Bladder to the margins of the skin

SUPRAPUBIC LITHOTOMY (Sectio Alta). *a*, seen from above; *b*, sectional view

(The editor has made, for a number of years, suprapubic cystotomy in two stages without making use of sutures, and believes that these do more harm than good. During the first stage the bladder is well exposed after free excision of the prevesical fat, and the wound is firmly tamponed with iodoform gauze. On the removal of the gauze prior to the completion of the operation (one week later), the anterior wall of the bladder presents itself as a granulating surface and can be incised without the use of an anæsthetic. This operation is of the greatest service in establishing a suprapubic fistula in the treatment of prostatic enlargement.)

If it is desirable to operate **at one time**, then follows:—

3. **Opening of the bladder**. After the wall of the bladder has been secured by toothed forceps, or, still better, by passing two ligature loops through at the extremities of the intended incision for preventing the bladder

from sinking backward, *the colpeurynter is evacuated;* next, the bladder near the forceps or between the ligature loops, as closely behind the symphysis as possible, is opened with the knife, lengthwise or transversely, to the extent of 4 to 5 centimeters.

4. At once, while its contents flow out, the right forefinger is introduced into the opening to ascertain the size of existing calculi, or the seat and nature of the tumor; on the size of the tumor depends the extension of the incision. The incision can be made with the knife or the scissors, or even bluntly by inserting the left and the right forefinger, side by side, into the opening that has been made, and then gently distending both fingers.

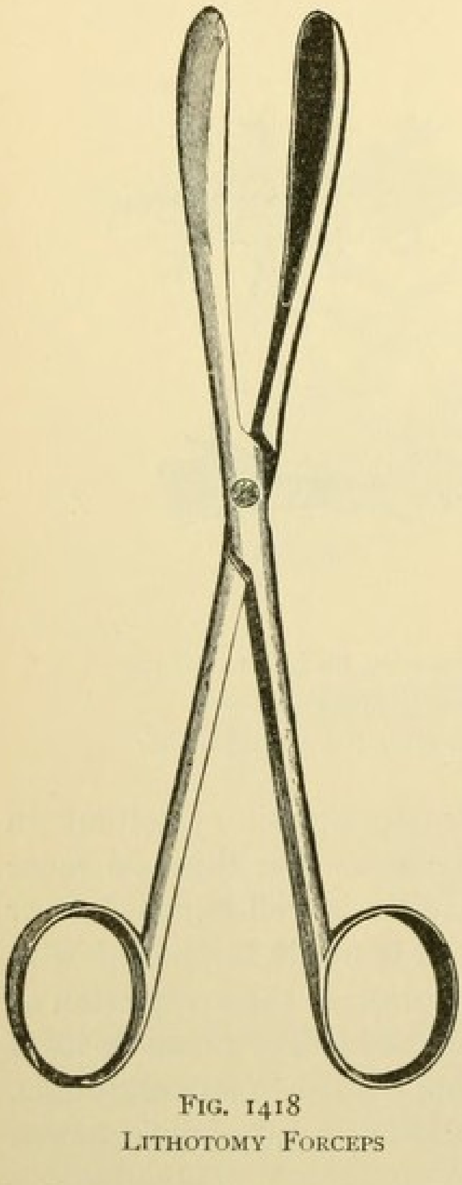


Fig. 1418
Lithotomy Forceps

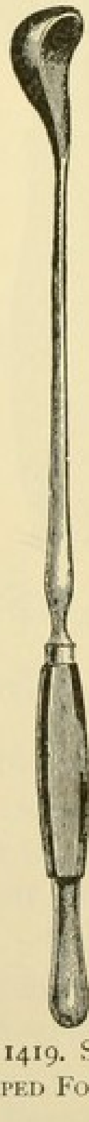


Fig. 1419. Spoon-shaped Forceps

5. If the opening seems large enough, the opened bladder is held gaping by the assistants, with blunt retractors, or the middle of the margin of each incision is stitched to the corresponding margin of the skin without piercing the mucous membrane of the bladder; for drawing apart the wound, the sutures remain long.

6. After a *thorough irrigation* of the bladder with warm boric water, the **removal of the stone** takes place with the *lithotomy forceps* (Fig. 1418) or *the spoon-shaped scoop* (Fig. 1419). Likewise, the two extended forefingers of the folded hands may be used like a pair of forceps (Fig. 1420); another irrigation is then made. If a sanious catarrh of the mucous membrane of the bladder is found, the wound of the bladder must not be immediately united; in such a case, the bladder is drained (see below) and tamponed with iodoform gauze. If the mucous membrane of the bladder is in a healthy condition,

7. **The suturing of the wound of the bladder** (**cystorrhaphy**) follows. The sutures, of fine catgut previously drawn through iodoform ether, are applied *very closely*, interrupted or continuous, in such a manner that they grasp the external two-thirds of the wall of the bladder; but they must not penetrate the mucous membrane; in tying the threads, *the surfaces of the vesical wound* are placed in exact apposition. It is expedient to apply all sutures first, and to tie them all at the same time. The ligatures can also be inserted *before* the bladder is opened (*Neuber*). *For a broad union* of the cystotomy wound, *Antal* bevels the margins of the wound at the expense of the outer layers; for a safe closure, *Thompson* recommends a quilted suture.

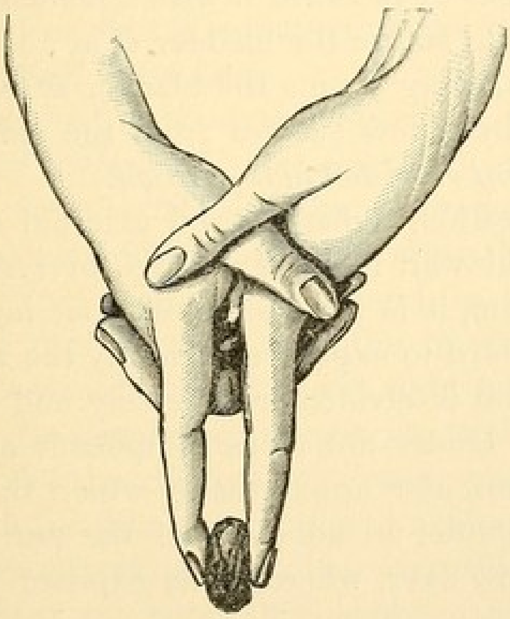


FIG. 1420

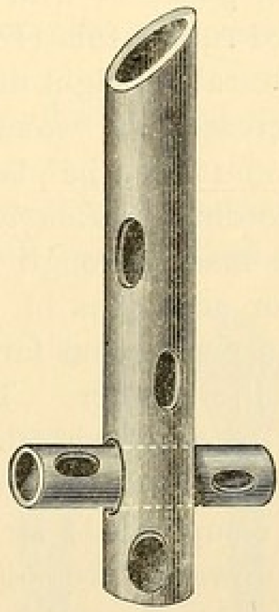


FIG. 1421. TRENDELENBURG'S T-SHAPED RUBBER TUBE

In most cases, however, a close superficial suture with silk or chronic catgut suffices; the latter is only slowly absorbed.

8. After the cystotomy wound has been thus sutured, the bladder is filled through a catheter under a strong pressure (up to 1 millimeter) with a warm boric solution, to ascertain whether the suturing has been done in a satisfactory and efficient manner; if the fluid oozes out at any weak places, more sutures must be applied to make the line of suturing water-tight. For greater safety, the sutured bladder may be stitched to the abdominal wound (**Cystopexy**).

9. *Tamponade* of the external wound or partial suturing and drainage; fastening of the dressings with a T-bandage. An elastic catheter is substituted for the metal catheter, and allowed to project only 1 to 2 centimeters

into the interior of the bladder. A tube is fastened to it and placed into a vessel with antiseptic solution, standing below the level of the pelvis.

If the operation is performed with a view of removing tumors in the interior of the bladder or the prostate gland, the opening of the bladder must be made as large as possible, and must be easy of access. Best adapted to this purpose is the transverse incision. To gain more space, *Helferich* chiselled away subperiosteally a portion from the superior border of the symphysis. It is advisable to detach, in addition to the pyramidal muscles, also the insertion of the recti from the symphysis. After such operations, it is always necessary to *tampon* the bladder loosely, first with iodoform gauze or with iodoform wick, or *to drain* it with *Trendelenburg's* T-shaped rubber tube (Fig. 1421), and to suture the bladder, if at all, secondarily after about eight days. *Trendelenburg* drains the bladder *in all cases*, and decreases the wound, if at all, by a few sutures from the sides; the patient must then be placed in *a lateral or abdominal position.*

According to *Langenbuch's* suggestion, a flap-shaped external incision may be made through the abdominal wall if, in rare cases of *very* large stones or adhesions of the peritoneum, it is impossible, without injury, to push the peritoneum far enough upward to expose sufficiently the anterior wall of the bladder. The peritoneum is divided transversely and pushed upward together with the skin flap. Under antiseptic tamponade and perfect rest of the intestines (and the muscular apparatus by which the abdomen is compressed), by the use of opium, an adhesion of the peritoneum pushed upward takes place after a few days, whereby the exposed surface for cystotomy is greatly increased.

For a drainage opening after suprapubic lithotomy and for palpating the bladder, especially in the region of the trigone, *Langenbuch* has devised **the subpubic incision** (sectio alta subpubica), for which a λ-shaped incision is made between the inferior border of the symphysis and the root of the penis. Surgeons, however, have employed this operation just as little as *Koch's* subperiosteal *resection of the symphysis*, in which only a small inferior portion of bone (lamen) remains in position.

Extirpation of the whole urinary bladder (*Küster*), which may become necessary for malignant tumors, is accomplished through a suprapubic incision; after as much space as possible has been created by a broad longitudinal division of the soft parts, and chiselling off the superior pelvic border, the bladder is detached bluntly all around; any peritoneal injuries are sutured at once. From a medial, perineal incision, the urethra is then detached transversely, the prostate gland is enucleated bluntly or with the scissors, the ureters are cut off obliquely, and after a complete enucleation of the bladder and the prostate gland are transplanted into the rectum.

PERINEAL CYSTOTOMY,

MEDIAN PERINEAL SECTION,

that is, opening the membranous portion of the urethra from the perineum, is made: —

(*a*) For removing *medium-sized* urinary calculi and *foreign bodies* that cannot be removed through the urethra.

(*b*) For removing *tumors* of the bladder and the prostate.

(*c*) For digital palpation of the bladder for diagnostic purposes (*digital exploration, Thompson*).

The first part of this operation has been described in the section on *external urethrotomy* (see pages 761–763, sections 1–3).

4. After incision of the membranous portion, a ~-shaped grooved director is introduced into the bladder along the grooved staff, which is then removed.

5. The urethrotomy wound is enlarged toward the prostate, until the operator can enter it with the point of the right forefinger.

6. *By slow boring movements with the finger* or by the dilators of *Simon and Hegar*, or with the dilating forceps or a blunt *gorget* (*Thompson*), *the prostate* is so far dilated that the finger can enter the bladder and palpate the calculus or the tumor.

7. If the operation is performed for the removal of a calculus, a pair of lithotomy forceps (Fig. 1422) is introduced, using the left index finger as a guide, and the stone is grasped. After the operator has convinced himself, by turning movements of the forceps, that the mucous membrane has not been included, and if the distance of the blades of the forceps indicates that the stone has been grasped *in its smallest diameter*, then follows

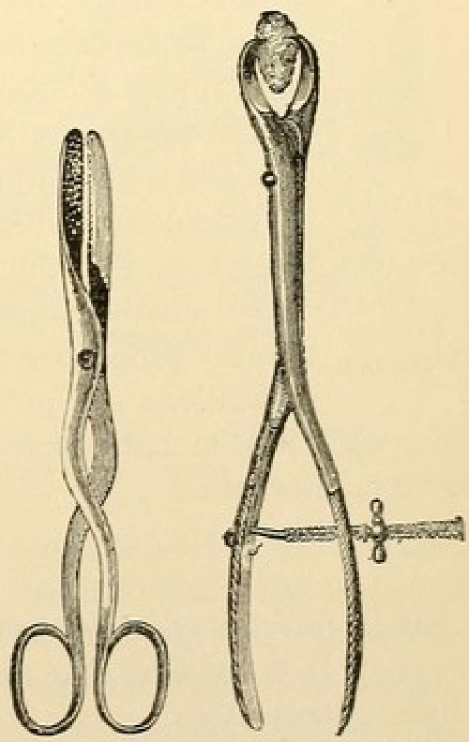


Fig. 1422 Lithotomy Forceps

Fig. 1423. Luer's Lithotrite

8. *The removal of the calculus* by making slightly lever-like movements during traction. If the stone is *too large*, the prostate can either be nicked

with a probe-pointed bistoury (see page 779) or with a *lithotrite* (Fig. 1423); the calculus may first be crushed into smaller fragments; the larger pieces are then evacuated with the forceps; the débris is scooped out with a dull spoon.

9. Finally, after the bladder has been *thoroughly irrigated* with a warm boric solution, a Nélaton catheter (as large as possible) is introduced through the penis into the bladder, and the wound is *tamponed* in its whole extent. The catheter (it slips out very easily) is best fastened, according to *Lauenstein*, by tying a silk thread around the catheter in the wound and by tying the ends of the thread over the tampon.

A better access, especially to *the prostatic part of the urethra* (by which procedure, also, an injury to the bulb is better avoided), is gained by a *curved transverse incision* between the anus and the bulb of the urethra (see Fig. 1427). The bulb is exposed and next drawn upward with retractors; the membranous portion of the urethra is carefully dissected free (*Nélaton, König*).

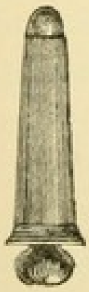


FIG. 1424 SIMON'S DILATOR FOR FEMALE URETHRA

In *women*, the extraction of calculi is considerably easier, on account of the *shortness and dilatability of the urethra*. Only in very large calculi, offering resistance even to lithotripsy, should suprapubic lithotomy be made; in general, however, **the dilatation of the female urethra** (*Simon*) is sufficient. The same is made with the dilators mentioned by Simon (Fig. 1424); these are introduced in gradually increasing sizes, until the forefinger can be inserted with ease into the bladder. In case of necessity, the external urinary meatus must be nicked by small incisions; this is a more gentle procedure than a dilatation made too violently. Thereby conditions are produced as in external urethrotomy in man (see above). The incontinence occurring during the next few days disappears after a short time.

PROSTATOTOMY,

that is, *incision of the prostate*, is indicated: —

(*a*) In a considerable *enlargement* of the same (hypertrophy, inflammation, abscesses).

(*b*) In *tumors and lithiasis*.

It is made in the same manner as *median perineal section* (see page 777). Through the incision of the membranous part of the urethra, the left forefinger is introduced into the bladder, and upon it the posterior side of the prostatic portion of the urethra is divided with a probe-pointed knife in the median line. Proceeding from this incision, it is sometimes possible to enucleate bluntly with the finger encapsulated circumscribed tumors (adenomata, fibromyomata), also to detach pedunculated tumors and swellings of the middle lobe with *Landerer's* cutting forceps or *Thompson's* forceps (Fig. 1425).

After the hemorrhage has been arrested, a thick rubber tube, wrapped with iodoform gauze, or a *Watson hard rubber drainage tube* (Fig. 1426) is introduced into the bladder, and left in position for six to eight weeks, until the swelling of the prostate has been reduced by pressure (atrophy from compression).

It is better to expose the entire posterior surface of the prostate by *Zuckerkandl's perineal prerectal incision* (Figs. 1427, 1428). The left forefinger is

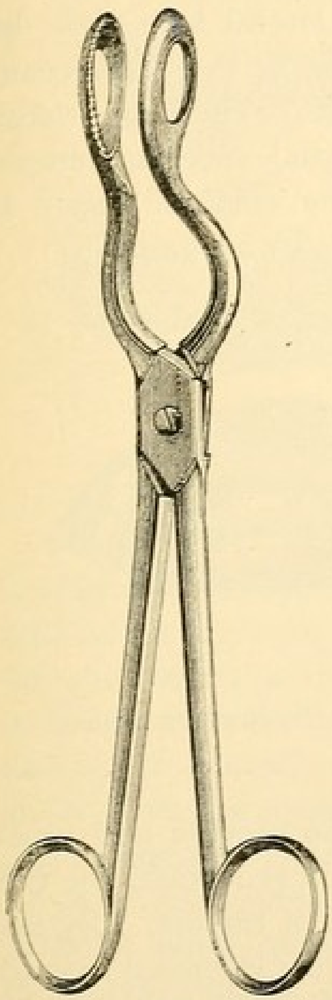


FIG. 1425. THOMPSON'S FORCEPS

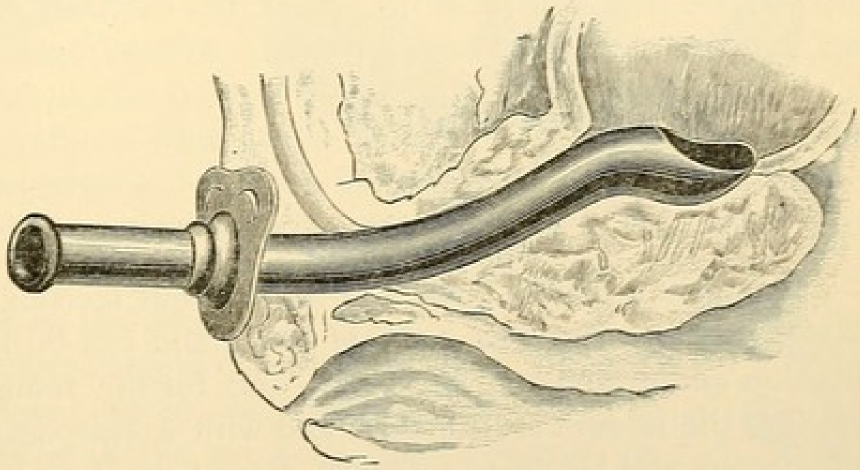


FIG. 1426. WATSON'S HARD RUBBER DRAINAGE TUBE FOR HYPERTROPHY OF PROSTATE

introduced into the anus to prevent injury to the anterior wall of the rectum. Next, 3 centimeters above the anus, a slightly curved transverse incision, 7 centimeters long, is made across the perineum, if necessary, as far as the tuberosities of the ischium. After division of the *superficial fascia* and separation of the connection between *the bulbo-cavernosus and the sphincter ani externus*, the insertions of the levator ani are separated on both sides from the rectum. The stumps recede toward the pelvis. Next, the operator penetrates bluntly into the connective tissue between rectum, prostate, and bladder, as far as the reflection of the peritoneum. The exposed membranous portion of the urethra is then opened upon a lithotomy staff. The finger penetrates through the urethra into the bladder. A probe-pointed knife, introduced upon the finger, splits the posterior wall of the prostate exactly in the median line, close to the peritoneal duplicature. With sharp retractors, the two halves of the prostate are then drawn apart, and the median lobe, if enlarged, as well as portions of the lateral lobe, may be excised from the bisected prostate with knife, scissors, or the thermocautery; any existing calculi can be removed with ease. After the hemorrhage has been arrested, the incision is diminished by partial suturing, ample space being left for a drainage tube (as above). The external wound is likewise sutured in part, and the remaining space packed with gauze.

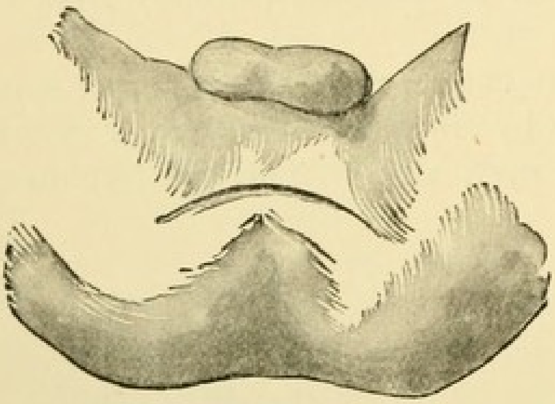


FIG. 1427. External Incision

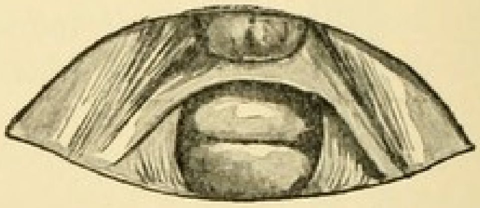


FIG. 1428. Cavity of the Wound

ZUCKERKANDL'S PRERECTAL INCISION

From the perineal incision, even without incising the urethra and prostate gland, *the posterior wall* of the gland can be made accessible for the incision and drainage of abscesses, and for the removal of tumors. By detaching the rectum still farther, and with a temporary displacement toward the coccyx and by deepening the wound, even the *seminal vesicles* and the fundus of the bladder can be reached.

Kocher's prerectal pointed arch incision (Figs. 1429, 1430) creates similar conditions of the wound, and a still better access to the organs mentioned.

Recently, moreover, all these operations on the prostate have been made through a *suprapubic incision*, the patient being placed in Trendelenburg's position (**suprapubic prostatectomy**). For this purpose the bladder is opened in a more upward direction (at the apex). The cystotomy wound is drawn apart with strong retractors, so that the interior of the bladder can be well inspected. If a catheter is then introduced, the operator can see and determine with the wound the location of the obstruction to the escape of the urine (nodules, lobes, wall-like elevations, etc.). *All projections are removed* (*MacGill*). A marked *sacculation* at the fundus behind the prostate can be removed by *deep, wedge-shaped excisions of the wall of the bladder* with subsequent suture.

Lateral prostatectomy (*Dittel*) exposes the prostate gland and its surroundings from behind.

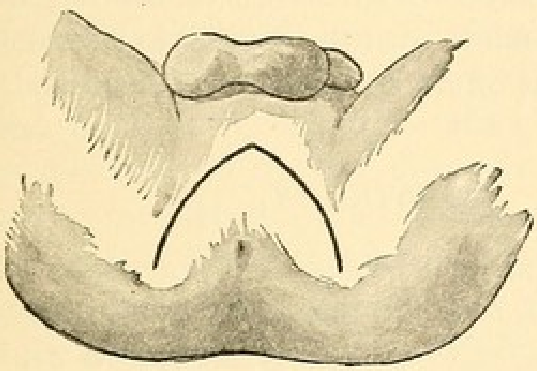


FIG. 1429. External Incision

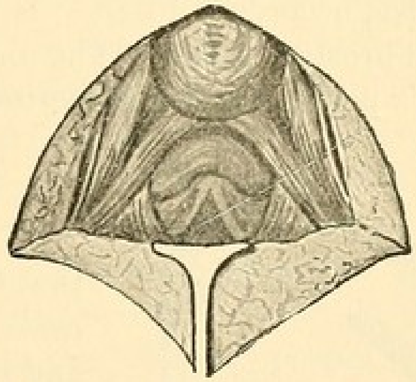


FIG. 1430. Cavity of the Wound

KOCHER'S PRERECTAL POINTED ARCH INCISION

The patient, into whose urethra an elastic catheter has been introduced, is placed in the right lateral position. The *external incision* extends in the anal notch from the point of the sacrum to the right, around the margin of the anus as far as the raphé in front of the anus. In penetrating into the ischiorectal fossa, the rectum is detached bluntly from the prostate gland and drawn laterally until first the right lobe of the prostate and, finally, its entire posterior surface are exposed. More space, if necessary, can be gained by removing the coccyx.

A procedure that deserves more consideration than it seems to have found until now (*Czerny*, *Kümmell*, *Freudenberg*) is the **galvanocaustic excision** of the prostate gland (*Bottini*) in hypertrophy.

It is made with a lithotrite-like instrument, the movable arm of which consists of a little platinum knife about $1\frac{1}{3}$ centimeters high; this knife is made to project from the slit in the beak of the instrument by screw action (Fig. 1431), the beak serving at the same time as a cooling tube. After the introduction of this instrument through the urethra previously anæsthetized (5 cubic centimeters of a 1% cocaine solution), the knife, rendered red-hot by closing an electric current, is *slowly* drawn from behind forward through the prostate gland. In most cases it is necessary to make several linear cauterizations in various directions, for instance, upward, downward, and at the side of

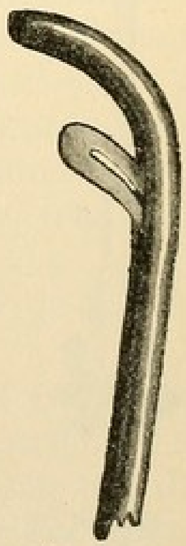


FIG. 1431
BEAK OF
PROSTATIC
INCISOR

the greatest hypertrophy. The operation is completed in a few minutes; in most cases, the patient can urinate spontaneously after a few hours. Up to this time but few if any failures have occurred.

Likewise, *the ligation of the different arteries* and of the hypogastric arteries, according to Bier, is often followed by shrinking of the hypertrophied prostate gland. The operation is made with the patient in Trendelenburg's position and transperitoneally, but offers considerable difficulties.

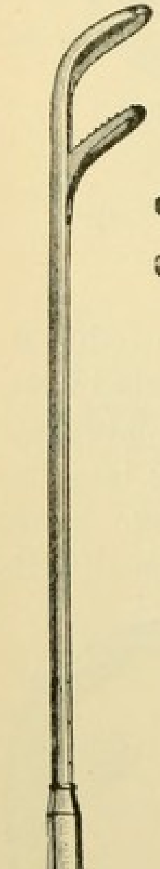


FIG. 1432
CIVIALE'S LITHOTRIPTOR

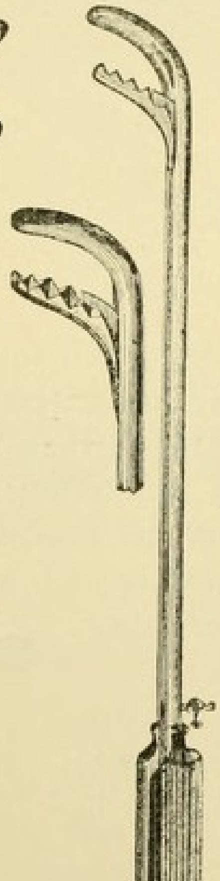


FIG. 1433
BIGELOW'S LITHOTRIPTOR

LITHOTRIPSY,

that is, *the operation of reducing to fragments a calculus in the bladder* without injuring the bladder and the urethra, can be made *if the calculi are not too large and not too hard,* and if the urethra is of sufficient caliber (strictures, especially at the external urinary meatus, must be removed previously by dilatation or incision). To obtain good results with the operation, **great practice and dexterity in manipulating** the necessary instruments are required.

The crushing is made with the *lithotrite,* a catheter-like metal instrument with a short, broad beak, consisting of two arms. One of them (the male) can be slid in a groove of the other (the female) like a sledge. The former has a strongly denticulated anterior end fitting into the fenestrated end of the female blade. By screw power or strokes with a hammer the stone grasped by the arms is crushed (Figs. 1432–1433).

For the operation, the patient is placed upon a low table, with his pelvis raised and his legs flexed. He is then anæsthetized. The bladder is several times washed out with boric acid solution, and finally about 50 to 100 cubic centimeters of the solution are left in the bladder. Thompson prefers to operate with the bladder empty.

If it is desirable to operate without anæsthesia, the bladder can be rendered anæsthetic by injecting 40 to 50 cubic centimeters of a 2% to 5% cocaine solution.

1. *Introduction of the lithotrite* exactly in the same manner as described in catheterization; the weight of the instrument facilitates its insertion, provided the urethra possesses the required width.

2. The operator stands at the right side of the patient, holding the cylinder-like shaft of the instrument with his left hand, the handle at the end (wheel, ball) with his right hand. When the handle is raised, the beak of the instrument is gently pressed against the fundus of the bladder, and in this position the operator waits quietly for a few seconds; when the sliding (male) arm of the instrument is withdrawn, its beak is opened so far that the operator feels it touch the neck of the bladder; the handle is then pushed back again. From the firm resistance distinctly felt, the operator knows that the stone has fallen between the blades of the instrument. If this is not the case, the blades are opened again; and the operator probes toward the right or the left, repeatedly opening and closing the instrument until the stone has been grasped.

3. Next, by bringing together the halves of the screw concealed in the handle, the "interrupted screw" becomes locked; and by slowly rotating the handle around its axis, the beak is made to operate, and is very forcibly screwed together until the crushing of the stone is felt and heard; since the fragments fall toward both sides, the instrument can be completely closed again. During this procedure, the cylinder-like shaft is held firmly and steadily in its position with the left hand.

4. The instrument is at once opened again, and an attempt is made to grasp one of the fragments and to crush it in the same manner; this procedure is repeated until all of the larger fragments have been crushed; it can then be taken for granted that the stone has been entirely crushed into small pieces. For grasping even the last portions, the beak is turned *downward* toward the neck of the bladder, so that it can grasp any fragments concealed behind the prostate.

5. If the stone is too hard to be broken by screw power, it may be broken by striking the handle with a hammer.

If, in this manner, the stone has been broken into small fragments, another lithotrite is introduced, the female arm of which is not perforated at the end, but scooped out like a spoon (*e.g.* Fig. 1432). With this the fragments are grasped again, one after another, and ground to a fine gravel. After this has been accomplished, a large *evacuation catheter* with a large opening at its beak-like end is introduced (Fig. 1434, 3). Through it, the fluid present in the bladder generally flows out with a portion of the fragments of stone.

6. The *evacuation of the fragments of stone* is then made at once (**litholapaxy,** *Bigelow*).

For this purpose is used the *evacuator* (*Bigelow, Otis,* Fig. 1434), a suction pump, the end of which is screwed into the opening of the catheter. The whole apparatus is filled with boric solution; and by compressing the elastic bulb a portion of the solution is forced into the bladder, from the bottom of which it whirls up the débris. If the pressure is discontinued, the bulb aspirates the fluid, bringing with it some of the fragments of stone; these fall at once into the glass receiver (2) filled with glycerine and screwed

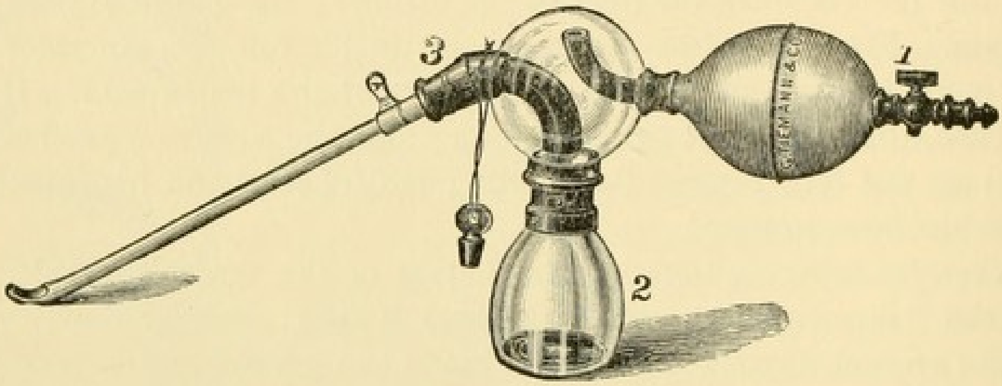


Fig. 1434. Otis's Evacuator for Litholapaxy

to the apparatus. The compression and suction by the elastic bulb are now slowly but rhythmically continued until no more fragments can be removed from the bladder. The interruption of the current of fluid in the glass receiver by means of a tube opening above and another opening below, prevents the fragments of stone withdrawn from returning into the bladder.

If fragments of stone are no longer evacuated, the evacuator is removed, and the lithotrite is introduced once more, to search for any fragments that may have remained. If any are found, they are removed in the manner described before.

OPERATIONS FOR CONGENITAL CLEFT FORMATION OF THE ANTERIOR PELVIC REGION

(*a*) **In ectopia vesicæ,** *that is, exstrophy of the bladder.*

The congenital defect of the abdominal wall and the bladder exists nearly always in connection with a cleft of the pubis, with epispadias and inguinal hernias.

For relieving to some extent the pitiable condition of the patient suffering from these defects, — the continuous trickling of urine from the vesical apertures of the ureters freely exposed in the protruding posterior wall of the bladder, — the urine is collected in a suitable *receptacle* made of soft rubber (Fig. 1435).

The operative closure, however, offers exceedingly great difficulties, and the operator can feel satisfied when he has covered the vesical defect so far that some urine may collect in the bladder, which has been forced back. The urine is retained by a trusslike appliance, and is evacuated at pleasure by removal of the truss.

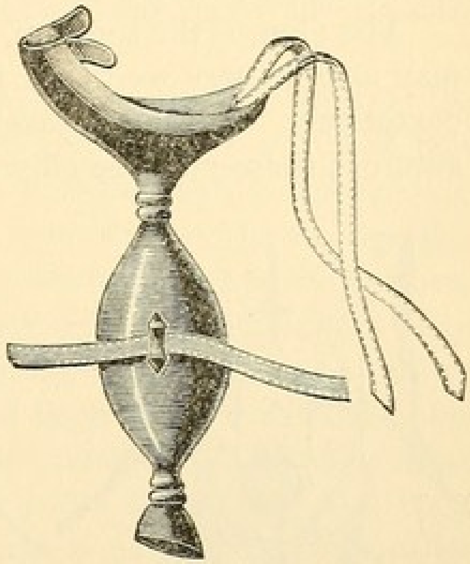


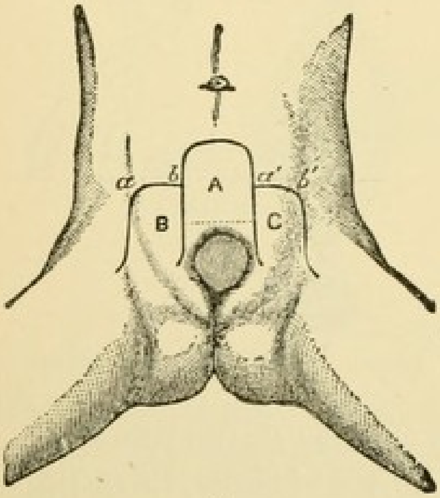
FIG. 1435. RECEPTACLE FOR URINE

Covering the protruding posterior wall of the bladder (**cystoplasty**) has been attempted by the **formation of flaps** (*Wood*, *Thiersch*).

The flaps of skin must be taken from the immediate neighborhood, that is, from the abdominal wall. They can be stitched directly with their fresh wound surface to the vivified margins of the vesical defect. For this purpose, either *one* large flap (*Hirschberg*) can be employed, or several, simultaneously, or one after another (*Thiersch*). *Underlining* by turning over a sufficiently large flap (attempted by *Nélaton*) is not practical, because the epidermis side turned into the interior of the bladder furnishes the cause for obstinate stone formations by deposition of phosphates on the hair. It is sufficient to fasten over the cleft a large flap, with the wound surface toward the bladder. If its healing succeeds, it is true, the flap subsequently contracts considerably; but during cicatrization it partly draws the mucous membrane of the bladder toward its inner surface. *Wood and Thiersch* closed the cleft by lining it *with three flaps* (Figs. 1436–1438). First, from the skin of the abdomen over the bladder, a large flap (*A*) was excised, turned downward, its epidermis side toward the bladder, and sutured to the vivified margins of the bladder; this flap was then covered by sliding and turning two pedunculated flaps (*B* and *C*), obtained from the lateral inguinal regions. The annoying condition mentioned above — the formation of concretions — might perhaps be removed by grafting (according to *Wölfler*) the large flap with mucous membrane, as a preliminary step to its transplantation (*A*), after a superficial removal of the epidermis, or by destroying the several hair follicles by electrolysis or galvanocautery.

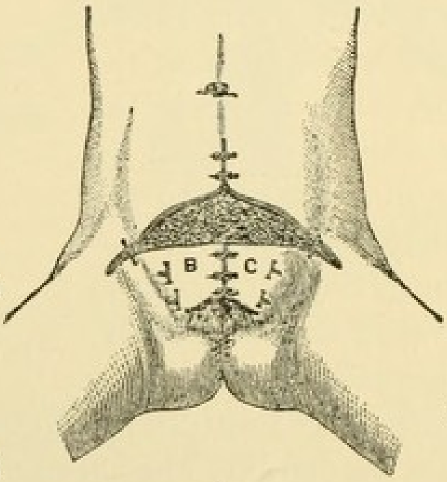
Thiersch afterward proceeded as follows: He detached two *lateral flaps*, having an upper and a lower bridge, near the margin of the bladder, and allowed them to granulate upon a plate of tinfoil, ivory, or glass, placed under them. When the flaps began to contract and fold, he divided the upper bridge, and sutured first one lap over the inferior portion of the bladder; after it had healed, he closed the superior portion by means of the flap of the other side, treated in the same manner; by a final operation, he closed the transverse cleft remaining between the two flaps.

The skin of the scrotum, often considerably enlarged by inguinal hernias, may also be very well used for such flaps; the healing hardly ever succeeds completely. In most cases, small fistulas remain between the several sutures; these must be closed subsequently.



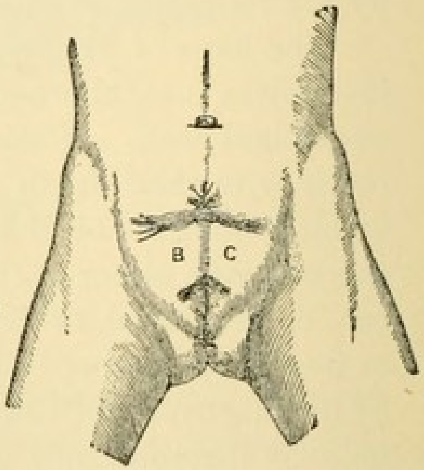
a

Fig. 1436



b

Fig. 1437



c

Fig. 1438

Wood's Cystoplasty. Fig. 1436, forming flaps; Fig. 1437, suturing lateral flaps over inverted middle flap; Fig. 1438, healing of wound

Czerny succeeded in directly suturing the margins of the defect by dissecting off, all around, the prolapsed mucous membrane of the bladder with the exception of a portion in the middle about as large as a ten-cent piece, and by turning it over and suturing the margins of the wound in the median line. *Battle* proceeded in a similar manner. Suturing of the margins of skin, however, must be effected by a plastic operation.

Schlange and Rydygier sutured the margins of the vesical cleft by including the recti muscles and portions of the pubes; *Pozzi* proceeds in a similar manner.

Miculicz sutures two bridge flaps, containing the recti and their chiselled-off pubic insertions, with silver wire over the bladder, previously detached and sutured to form a hollow sphere; he subsequently forms the urethra and the penis by uniting the margins of the cleft vivified longitudinally, and finally occludes the neck of the bladder by circumscribing it with the knife and inversion suture of the fistula.

Poppert, after the bladder had been sutured, effected a rather good continence by allowing the posterior portion of the urethra (which contains the sphincter) to extend for a short distance into the lower wall of the bladder. Stretching of the ring of the sphincter muscle by intravesical pressure cannot then take place.

Passavant advantageously employed *Demme's* suggestion, that is, to remove first the *cleft of the pubes;* having the patient wear a rubber belt or a steel belt provided with screws, or having him lie upon a wooden log with a cuneiform excision , he tried *very gradually* to force together the gaping margins of the pubes, so that they almost touched each other. Meanwhile, by suitable apparatus, he forced back into the abdominal cavity the wall of the bladder (elastic bulb with gutta-percha plate and rubber bandage). When the margins of the cleft had been approximated by this treatment (after several months), he sutured the cleft of the bladder after vivifying broadly; next, *he approximated the pubes by sutures*, and then attempted the formation of a *sphincter ring*, which in its original position forms only a straight muscular band. Finally the groove of the urethra, open in an upward direction, was closed by suturing the corpora cavernosa of the penis, which had been turned upward.

Trendelenburg effected reduction in the size of the cleft of the pubis *in a much shorter time* **by dividing the sacroiliac articulations.** For this purpose, the left forefinger is introduced into the rectum of the child lying on the abdomen, and the sciatic notch is sought for. Then the skin over the articulations is divided from without, and the operator penetrates in the same line through the posterior masses of ligaments, until the connection has been sufficiently loosened to enable a vigorous lateral pressure upon the two pelvic halves to rupture it, so that the stumps of the symphyses touch each other. The wounds are closed by skin sutures. The child is then placed for four to six weeks into an apparatus which keeps the pelvis laterally compressed. Then, after a broad vivifying, the approximated margins of the cleft are sutured with silver wire in a vertical line. If too great a tension is caused thereby, the skin can be made more movable by lateral incisions parallel to the margins of the cleft (as in Fig. 1404).

Koch obtained good success with a similar procedure. He decreased the cleft of the symphysis by *forcibly rupturing* the articulations.

König approximates the divided symphysis after chiselling through the horizontal and the ascending ramus of the pubis on both sides.

In exstrophy, with very marked protrusion, *Sonnenburg* removed the whole bladder, after having detached it carefully from above from the peritoneum (**extirpation of the urinary bladder**), and sutured the dissected-off ureters into the groove of the penis at the lower sutured extremity of the cavity of the wound covered by sliding lateral flaps. *Langenbuch* proceeded in a similar manner.

After extirpation of the bladder, *Maydl* and others implanted the ureters, together with a portion of the vesical mucous membrane, into the sigmoid flexure.

Even in healthy kidneys, *Harrison* extirpated the left one, implanted the ureter of the right kidney into a small skin-incision of the right lumbar region, and closed the bladder by a plastic operation.

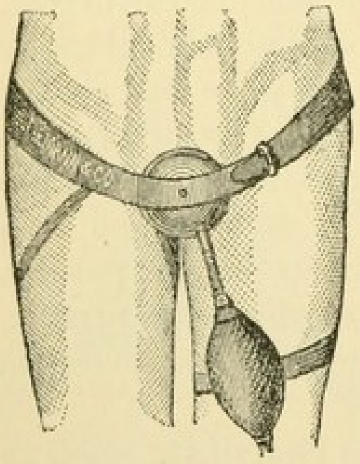


Fig. 1439. Portable Urinal after Cystoplasty

The success of all these operations consists in reducing the defect and thus in obtaining a smaller opening at the lower extremity of the covered defect, after the mucous membrane of the bladder, which, owing to its inflammation, is exceedingly painful, has been covered or removed. The small opening resulting from the operation can be closed by the stump of the penis turned upward, and by a *suitable* pad; or, at least, it is *better adapted* for applying a *portable urinal*, which is fastened laterally to the patient's leg (Fig. 1439). Finally, by removing the epispadias, which nearly always exists, the urine may also be evacuated through the thick stump of the penis, whereby approximately normal conditions are produced; or, at least, the continuous irrigation of the scrotum and the perineum with decomposing urine is lessened.

(*b*) EPISPADIAS

The operation for epispadias consists in transforming the gutter on the upper surface of the penis into a closed urethral canal. This is done preferably by

THE METHOD OF THIERSCH,

who proceeded at various sittings as follows:—

1. **Formation of the glans portion of the urethra:** By two incisions, extending along the margins of the canal of the glans, obliquely inclined toward each other and penetrating deep into the substance of the glans, the latter is divided into three flaps (Fig. 1440, *a*, *b*). After the hemorrhage has

been arrested, the median flap, containing the mucous membrane of the canal, is depressed with a grooved director; and the two elastic lateral flaps

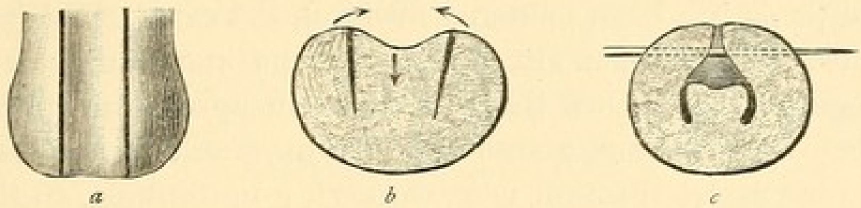
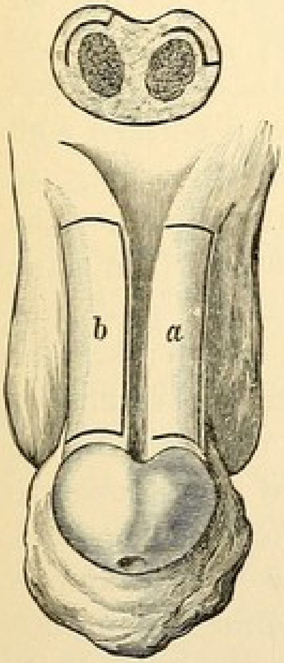


FIG. 1440. FORMING GLANS PORTION OF URETHRA

are folded over it and united with deep interrupted or continuous sutures (Fig. 1440, *c*). After the wound has healed successfully, the attempt is made

2. **To close the penile portion of the gutter.** On both sides of the gutter two oblong rectangular flaps (Fig. 1441) are excised from the skin of the dorsum of the penis. One of these flaps, the broader, is turned with its free



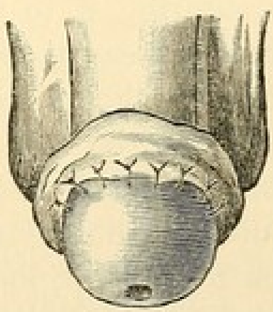


FIG. 1442. CLOSURE OF OPEN SLIT BETWEEN GLANS AND PENIS

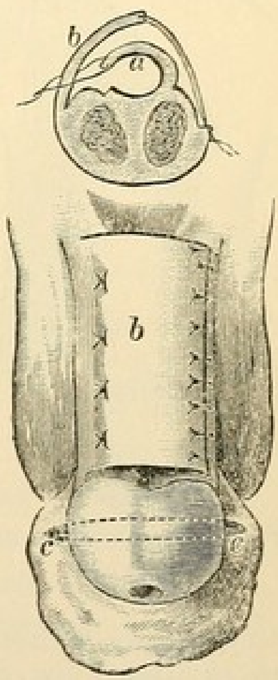


FIG. 1441 CLOSURE OF PENILE PORTION OF GUTTER FIG. 1443

margin (*b*) toward the gutter. The smaller of these two flaps with its base (*a*) (like the leaves of a door) is turned over the gutter in such a manner that its outer (epidermis) surface is directed toward the canal; the other, the broader flap, is turned over the smaller flap, so that its wound surface comes to lie upon the wound surface of the smaller flap, which has been turned over. After the position of the two flaps has been secured by a few quilt sutures, the margin of the larger flap, serving for a cover, is united by superficial sutures with the opposite margin of the wound of the wall of the penis (Fig. 1443). When, in this manner, after the healing of the flaps, the groove of the penis has been changed into a closed canal, then follows: —

3. **The closure of the open slit** between glans and penis, for which the prepuce, hanging down below the glans like an apron, may be used. The same is slit below the corona glandis by a transverse incision (Fig. 1443, *c*), and the glans is passed through it as through a buttonhole, so that the prepuce comes to lie on the slit in the form of a ridge. After the margins of the prepuce have been vivified, they are stitched to the corresponding vivified margins of the glans and the penile tube (Fig. 1442). There remains now: —

4. The closure of the *funnel* existing at the root of the penis. This must be done by pedunculated flaps taken from the neighboring skin of the abdomen (Fig. 1444).

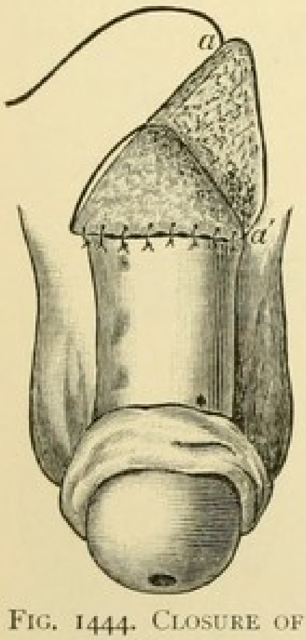


Fig. 1444. Closure of the Funnel

Thiersch formed two lateral flaps, — a triangular and a rhomboidal flap, — which he placed over each other in a similar manner as in forming penile portion of the urethra (Fig. 1442). It is better to form only one flap, and before suturing it to graft its wound surface with mucous membrane by transplantation according to Thiersch, in case the existing mucous membrane of the funnel should not be sufficient for grafting (see page 765). *Küster* effected transformation of the groove of the penis into a canal by dividing the inferior surface of the penis by a deep, longitudinal incision extending between the corpora cavernosa. He then turned the two halves upward. *Helferich* divided even down to the mucous membrane. The deep incision wound is left to granulation. If the penis is very small and in very young subjects, *Rosenberger* proceeded in such a manner as to turn the penis (having been sutured to the scrotum) upward toward the abdomen, after having vivified the groove broadly; here it healed into two vivified margins (Fig. 1445). The penis directed upward was subsequently turned downward by excising a flap from the abdomen (Fig. 1446). The wound on the dorsal surface was covered with this flap, and the thin defect of the abdominal wall closed by suturing.

(*c*) HYPOSPADIAS

The operator proceeds according to the methods just described; or he covers the defect according to the methods given in the operations for *urethral fistulas* (see page 765).

By a simpler method and in considerably less time, **Landerer's** (**Rosenberger's**) **Procedure** seems to bring about the desired end.

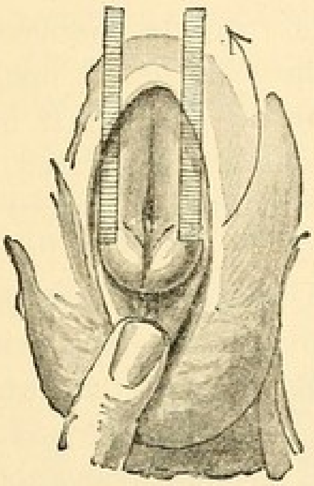


Fig. 1445

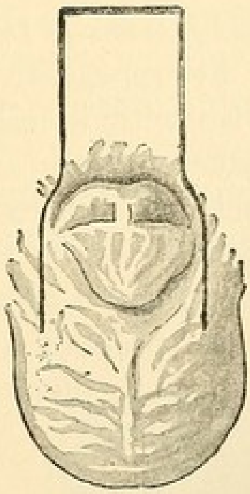


Fig. 1446

Rosenberger's Operation for Epispadias

He restores the missing lower urethral wall from the *skin of the scrotum.*

First two strips about 3 to 4 millimeters wide are vivified on both sides of the groove of the penis as far as and into the scrotum; the penis is turned down upon the scrotum, its glans portion is sutured to the deepest point of the scrotal wound, and the remaining portion of the penis is fastened on both sides to the scrotum by three superficial sutures (similarly as in Fig. 1445).

After the penis has become completely embedded in this position (after six to eight weeks), it is liberated from the scrotum and covered with skin on its lower surface. For this purpose, from the external urinary meatus of the penis drawn upward at the glans, two lateral incisions are made into the scrotum, a little longer than the penis is intended to be, and the rhomboidal defect caused thereby is closed by suturing it longitudinally.

OPERATIONS ON THE PENIS AND THE SCROTUM

OPERATION FOR PHIMOSIS

The *abnormal stenosis of the preputial orifice* can be removed: —

1. **Bluntly**, by repeatedly *stretching* the contracted opening of the prepuce crosswise with dressing forceps, or by pushing it back forcibly several times, whereby any existing adhesions are separated at the same time. This procedure suffices nearly always in *little boys*, and gives better results than incision.

2. **By incision, Roser's dorsal incision.** Upon a grooved director, introduced between the prepuce and the dorsum of the glans, with a pair of scissors, the prepuce is divided longitudinally beyond the anterior half of the glans (Fig. 1447). (The division can also be made with a curved tenotome from within outward.) By drawing back the external layer of the prepuce, the internal layer remains still lying on the glans, its wound angle lies in front of the angle of the external layer. By two lateral incisions with the scissors from this angle of the wound, a triangular flap is formed (Fig. 1448, *a*), whose point turned over in an upward direction is united by suture with the angle of the wound of the external layer (*b*).

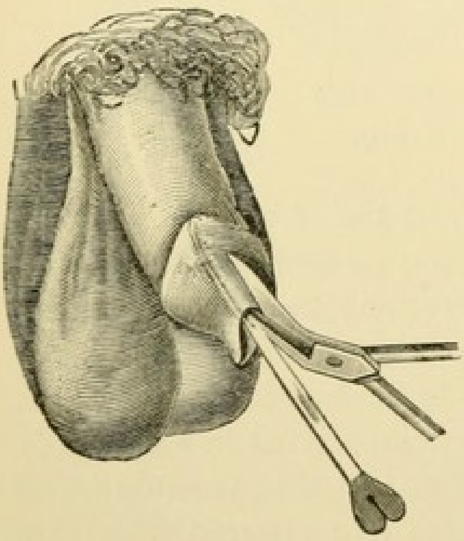


Fig. 1447

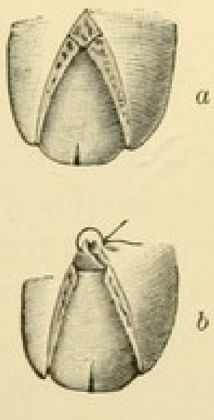


Fig. 1448

Operation for Phimosis (Roser's dorsal incision)

Finally, the two surfaces of the lateral margins can also be united by suture. The two flaps formed by the incision then hang down like a small apron.

A better form of prepuce is obtained if similar but smaller incisions are made *at both sides* of the prepuce, and if the margins of the wound are united *transversely* by fine sutures (Fig. 1449); or, in less serious cases, the prepuce is divided by a simple incision only to such an extent that it can be retracted as far as the corona glandis. There it remains until the wound has healed, which then extends in a transverse direction. In order not to soil the dressings, the patient may urinate through a wide tube (broken-off test-tube).

Likewise, by several very shallow *nickings*, the opening of the prepuce may be enlarged until it can be retracted as far as the corona glandis.

3. **By circumcision**, especially if the length of the prepuce is excessive. The prepuce is steadied by two forceps grasping its margin, and held tense. Next, it is cut off with a pair of scissors parallel to its margin in front of the glans without injuring the latter. Still simpler is the procedure if the portion to be removed is grasped transversely with forceps, and cut off on the outer side of the same as along a ruler; the internal and external layers are then united by a few sutures.

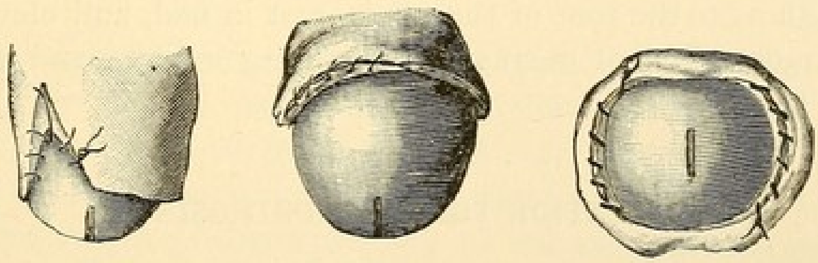


FIG. 1449. OPERATION FOR PHIMOSIS BY SUTURING TRANSVERSELY TWO LATERAL INCISIONS (von Esmarch)

The removal of the whole prepuce is rarely required. It is made for *malignant disease or for elephantiasis.* The dorsal incision is made as far as the corona glandis, and from the angle of the wound the prepuce is removed with the scissors by cutting on both sides close to the sulcus coronarius as far as the frænulum; the internal layer is united by suture with the external layer.

In children, sometimes, the whole internal surface of the glans is adherent by epithelium to the prepuce. This can be removed easily soon after birth by retracting the prepuce or by using blunt instruments. But if this is not done, the internal lamella adheres so firmly to the glans that it cannot be detached from the same in this simple manner. If the adhesion were removed with the knife, the former condition would still recur from cicatrization. In such cases *Dieffenbach* formed a new prepuce by a plastic operation (**Posthioplasty**).

He removed the proboscis-like anterior margin of the prepuce and separated the external layer, which had been forcibly retracted from the internal layer by superficial incisions, as far as 1 centimeter behind the corona glandis; next, he carefully dissected off the whole internal lamella from the glans, and cut it off all around along the corona glandis.

Then he inverted the free margin of the external layer as far as the sulcus coronarius, and fastened the thus doubled external layer in this position by a few sutures. A reunion by adhesion could not occur after that, and the surface of the glans became cicatrized after a short time.

Probably it is better *not* to remove the firmly adherent internal layer, but to graft the wound surface of the internal lamella at once with epidermis.

The *œdema* of the prepuce and skin of the penis frequently occurring after all these operations should be prevented by immediately dressing the whole penis with fine gauze or rubber bandages.

(Dressing the wound with carbolated vaseline, elastic compression from the tip of the glans to the root of the penis, rest in bed, and elevation of the penis are the most efficient means in preventing œdema and in expediting the healing of the wound.)

OPERATION FOR PARAPHIMOSIS

If the glans is strangulated by a retracted tight prepuce, œdema and gangrene of the prepuce and glans soon occur, unless the strangulation is removed. Since the chief obstacle to reduction consists in *œdema*, which quickly develops, its removal must always be first attempted. This is accomplished in most cases by wrapping a small **elastic rubber bandage** around the whole penis. Commencing at the tip of the glans, slowly envelop the whole penis as far as its root under moderate traction of the bandage. The compression should be strongest over the glans and diminish gradually in the direction of the root of the penis. After a few minutes the bandage is removed; then the **reduction of the prepuce (taxis)** can generally be made without difficulty.

1. The penis is held with the left hand so as to be encircled by the forefinger and the thumb behind the incarcerated swelling, while with the first three fingers of the right hand pressure is made against the glans in the direction of the constricting ring (*Desruelles*, Fig. 1450), or

2. While the forefinger and the middle finger of each hand encircle the penis behind the swelling, and push the prepuce over the glans anteriorly,

the two thumbs lying together upon the glans, press the same through the incarcerating ring (*Coster*, Fig. 1451).

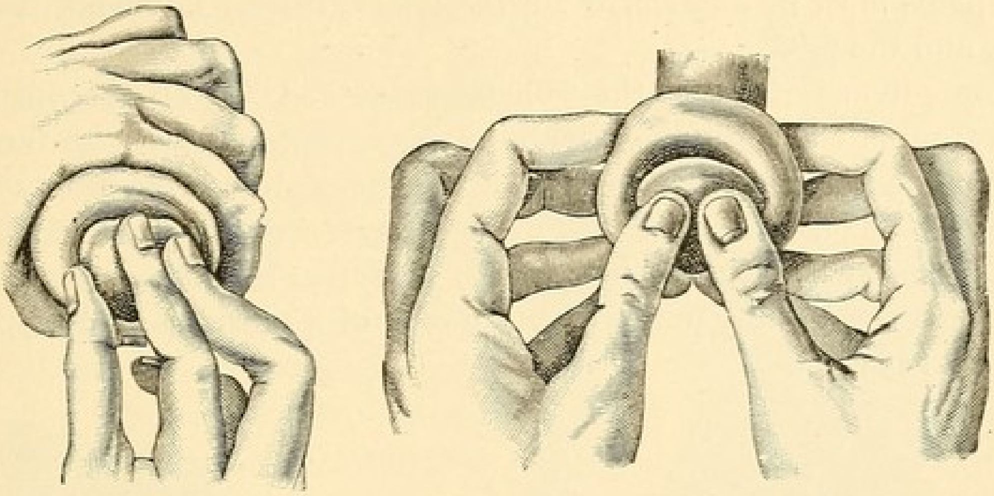


FIG. 1450 FIG. 1451

REDUCTION OF PREPUCE (TAXIS) IN PARAPHIMOSIS

If these attempts do not succeed, or if gangrene of the prepuce has already set in, it is preferable to **incise the strangulating ring** (Fig. 1452). Into the middle of the dorsum of the penis a pointed grooved director is pressed from behind beneath the strangulating ring (groove due to compression *between* the two swellings corresponding to the anterior margin of the prepuce), and the same is divided with the knife. If the strangulating ring can be exposed by drawing apart the two ridge-like swellings (œdematous internal and external layer of the prepuce), it is completely divided in layers from without inward.

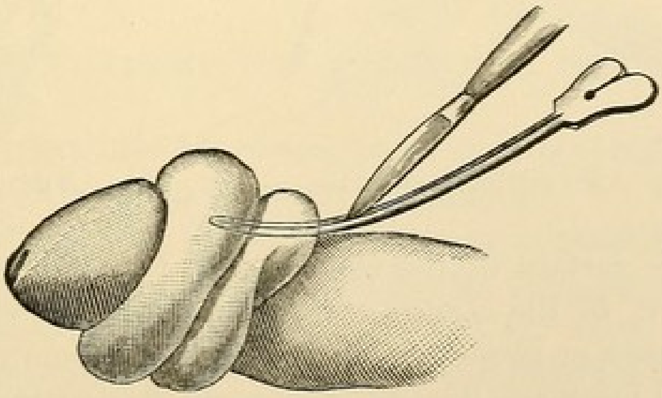


FIG. 1452. INCISING STRANGULATING RING

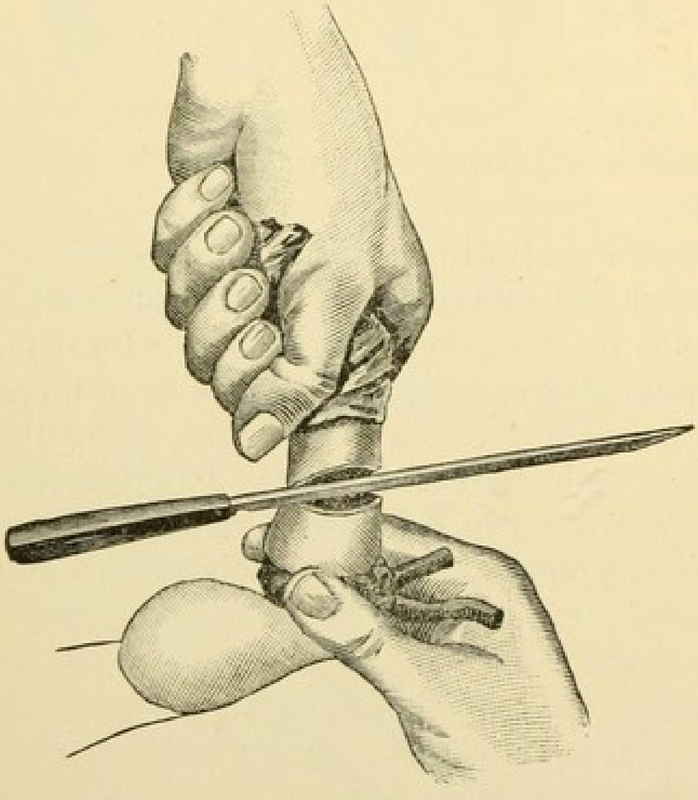
After a subsequent reposition of the prepuce, it is sometimes desirable to remove the existing phimosis a few days later.

AMPUTATION OF THE PENIS

The penis must be *amputated* for *malignant disease* involving the glans, prepuce, and the penis.

The operation is made by the "bloodless method" by elastic constriction, either in front of the scrotum or behind it, according to the seat of the tumor.

1. While an assistant securely holds the root of the penis, the portion to be detached, which is covered with gauze, is grasped with the left hand; the penis is drawn away from the body under moderate traction of the skin, and amputated in the healthy part with *one* sweep of a medium-sized amputation knife (Fig. 1453).



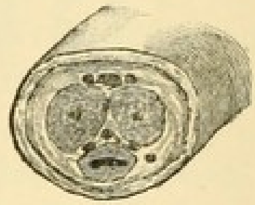


FIG. 1454. WOUND SURFACE

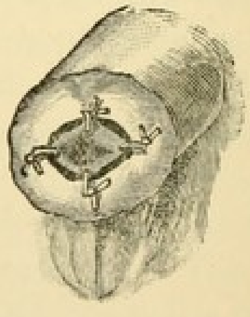


FIG. 1453. AMPUTATION OF PENIS

FIG. 1455. SUTURE

2. Next, on the surface of the wound (Fig. 1454), the dorsal arteries of the penis, the artery of the corpus cavernosum, and the artery of the bulb are sought for, ligated, or twisted. The hemorrhage from the corpora cavernosa is arrested by ligatures "*en masse*," or by closing the surface of incision by drawing over it the albuginea, which is sutured over it.

3. After the constrictor has been removed, and any secondary hemorrhage has been arrested, the mucous membrane of the urethra is drawn forward (if necessary it is nicked somewhat at its lower margin), and its

margin is united with the external skin by four interrupted sutures (Fig. 1455) to guard against stenosis of the new opening. Between the deep sutures a few superficial sutures may be added, according to necessity.

In a very high amputation the stump, before its complete division, must be grasped with a hook or with tenaculum forceps, so that the corpora cavernosa cannot retract underneath the skin in case the elastic constriction should not prevent this.

If the amputation must be made as far as and into the scrotum, the latter is divided in the median line into two halves, and the carefully dissected-out urethral stump is sutured downward into the slit of the skin (Fig. 1456), or the urethral stump is drawn out through a wound made on the perineum (perineal *urethrostomy ;* see also page 763). By this operation the constant wetting of the scrotum with urine is prevented.

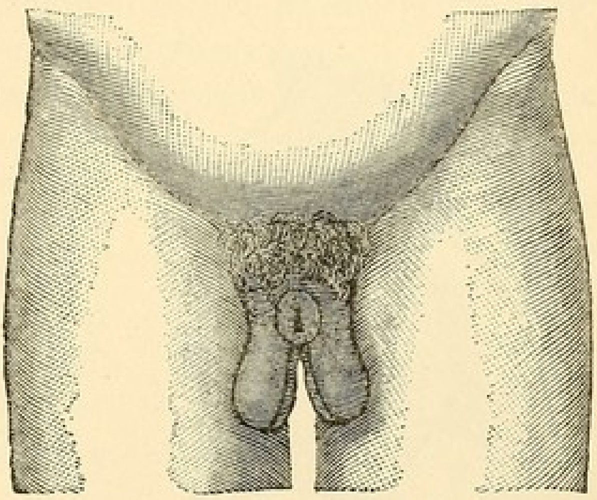


FIG. 1456. HIGH AMPUTATION OF PENIS DIVISION OF SCROTUM

For dressing, a small piece of iodoform gauze is used. This is applied on the surface of the wound, removed in urinating, and at once renewed.

It is not necessary to introduce a catheter permanently, but sometimes during the first days the evacuation of urine by means of a catheter may be necessary.

OPERATIONS FOR HYDROCELE TESTIS

The simplest procedure for removing an ordinary *hydrocele* is : —

1. **Puncture and injection of solution of iodine.**

After the position of the testicle, which in most cases lies at the posterior side of the swelling, has been ascertained, the operator with his left hand grasps the scrotum from behind, and stretches it. With his right hand he inserts a moderately strong trocar through the anterior wall in an upward direction at a point where there are no visible veins ; the depth to which the instrument is to be inserted is fixed by applying the point of the forefinger upon the canula (Fig. 1457). Puncturing the testicle should be avoided.

In extracting the stylet, the canula is inserted at the same time as far as its shield, and the contents are then allowed to flow out ; during this procedure the internal opening of the canula must be prevented by skilful manipulations from coming in contact with the opposite wall.

After all of the fluid has been drained off, the point of the syringe, fitting exactly into the opening of the canula and filled with 5 to 10 grams tincture of iodine or *Lugol's* solution (iodine, 1; kali jodat. 2; aq. 24), are injected into the canula, and its contents are slowly emptied into the cavity. While the syringe remains inserted in the canula, the assistant, by kneading massage movements, tries to bring the iodine solution in contact with the whole wall of the sac. Then, by drawing the piston of the syringe, the larger portion of the fluid is removed by aspiration.

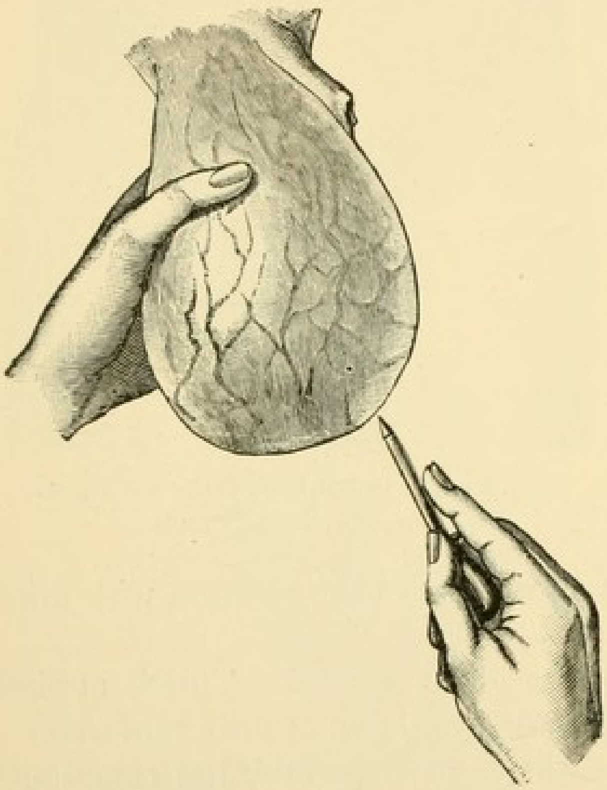


FIG. 1457. PUNCTURE FOR HYDROCELE TESTIS

After removal of the canula, the puncture is sealed with iodoform collodion, adhesive plaster, etc. The patient remains in bed for eight days with his scrotum slightly elevated; he then receives a suspensory, and is dismissed with a request to report about the success of the operation after six months; for it frequently takes this length of time for the interior of the sac to become obliterated by the irritation of the iodine after a renewed (inflammatory) extravasation. Recurrence occurs after this operation only in rare cases. Hence, in its simplicity, it can be considered the normal procedure, especially in children that do not keep themselves clean.

(In this country iodine is seldom used in the radical treatment of hydrocele, owing to the uncertainty of the results and the violent inflammation which occasionally follows this procedure. The favorite treatment consists in injecting carbolic acid (pure) after puncture and evacuation of the sac (*Levis*). The amount of carbolic acid injected varies, according to circumstances, from a few drops to half a drachm.)

Incision with suturing of the tunica vaginalis to skin (*von Volkmann*). This operation is indicated in *hæmatocele, pyocele, and hydrocele*, when the puncturing, with iodine injection, has proved unsuccessful.

After a careful disinfection, the scrotum is held tense with the left hand from behind, as for puncture, and is incised *at its anterior external side by an incision* 5 to 10 centimeters long down to the tunica vaginalis.

After the hemorrhage has been arrested, the exposed *tunica vaginalis propria* is punctured with the knife, and the opening is enlarged to correspond with the external incision, while the contents escape.

Next, the margins of the tunica vaginalis are grasped with forceps, somewhat drawn forward, and *stitched to the margins of the skin* by a few interrupted sutures (Fig. 1458). (The tunica vaginalis should be united with the skin by a continuous fine catgut suture.) If the testicle has prolapsed, it is replaced into the sac; and beside it, a short drainage tube is introduced, and the sutured margin of the wound is inverted and held in place by a few deep sutures.

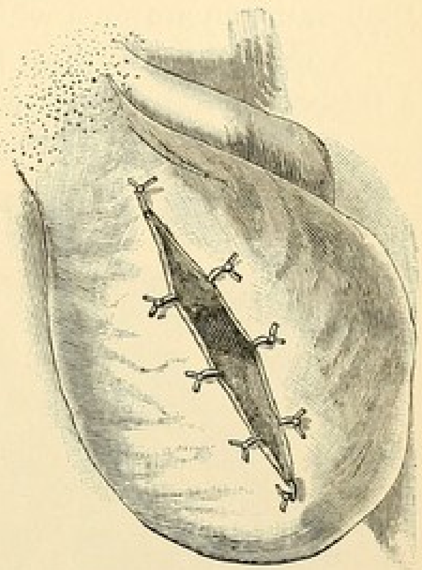


FIG. 1458. VON VOLKMANN'S INCISION FOR HYDROCELE

The rest of the wound is tamponed with iodoform gauze, and finally a typical pelvic dressing or a pair of bathing drawers are applied. König incises the tunica vaginalis to the extent of the external incision, inspects the cavity, irrigates it thoroughly, and sutures the wound by a continuous suture, with the exception of a small opening into which a strip of iodoform gauze is introduced.

(The editor has always placed great stress on the importance of bringing in contact with every part of the parietal and visceral tunica vaginalis iodoform gauze (one strip), which is allowed to remain for at least six to seven days in order to transform the endothelial into a granulating surface.)

Sometimes, especially in thickened walls of hæmatoceles of long standing (*vaginalitis proliferans*), it is necessary to *resect* corresponding portions of the parietal tunica vaginalis, and to line the remainder with skin. But, since the healing always occupies some time, **the total extirpation of the internal tunica vaginalis** (*von Bergmann*) is a method that effects a thorough healing in a shorter time. From a skin incision sufficiently large, the whole tunica vaginalis propria is enucleated bluntly as far as and close to the testicle and the spermatic cord, and detached near the testicle with the scissors, leaving in position only a small portion; the wound of the skin is sutured in its whole extent; an introduced drainage tube is removed after two days. In a similar manner, the sac is excised in hydrocele *of the spermatic cord.*

The *folding together* of the divided tunica vaginalis, which *Storp* places around the testicle (as a soldier folds his cloak around his knapsack), can be employed only for milder cases, and can probably be dispensed with.

OPERATIONS FOR VARICOCELE

The largely distended veins of the *pampiniform plexus* are *extirpated* if they cause symptoms which cannot be removed by wearing a *suspensory.*

After the scrotum of the patient, while standing, has been constricted by a rubber tube in such a manner that the veins greatly swell from stasis by the first (gentle) constriction, while the next tour effects a complete arrest of the circulation, after anæsthesia has taken effect, a correspondingly long incision exposing the bundles of the veins is made through the skin of the scrotum. Any incised lumina or veins are closed at once by hemostatic forceps. The dilated veins are then dissected off from the surrounding loose connective tissue for a distance of a few centimeters; and after double ligation they are divided near the testicle, dissected off in an upward direction, and also cut off centrally after another double ligation (Fig. 1459). The extremities of the resected veins can be tied together by means of the ligature threads, also a piece can be cut off from the skin of the scrotum, if the same is much elongated; or, still better (according to *Köhler*, *Parker*, *Senn*), the longitudinal wound of the scrotum can be sutured transversely, whereby the scrotal half becomes considerably shortened.

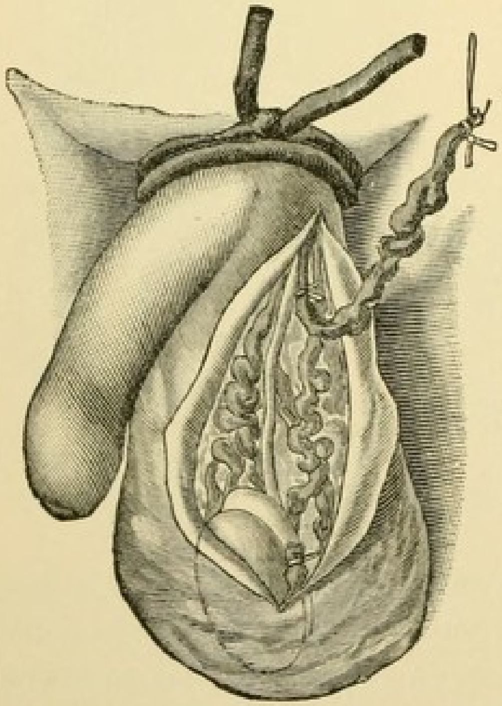


FIG. 1459. OPERATION FOR VARICOCELE

(Elastic constriction at the base of the scrotum is of no special value in the enucleation of varicose spermatic veins. The operation is performed almost bloodlessly by careful dissection. The vein stump should be sutured together with a fine catgut suture enforced by tying the ligature ends together. Excision of the scrotum is superfluous if the scrotal wound is sutured transversely.)

One or two veins, however, must remain uninjured; likewise an injury to the arteries must be avoided, else atrophy or necrosis of the testicle easily ensues.

The wound of the skin is closed by suture as far as the lower angle, and finally an antiseptic dressing is applied.

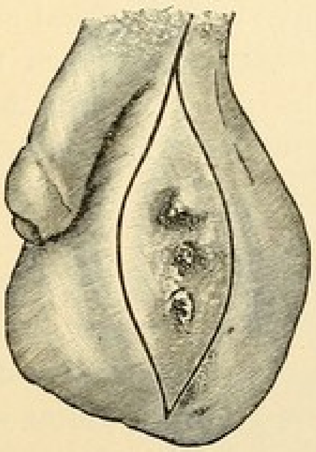
After the healing of the wound, the patient must wear a suspensory.

Ricord's subcutaneous ligation is less safe, and has probably been displaced completely by the aseptic extirpation. But the double ligation and subsequent division of the exposed veins may be attempted.

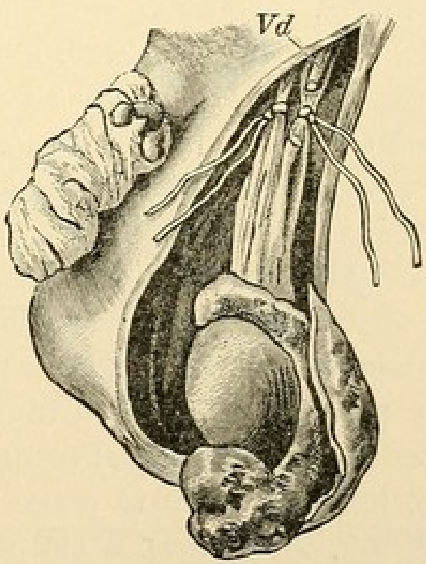
CASTRATION

The removal of the testicle is indicated in the treatment of *malignant tumors* and *tuberculosis* of an advanced degree.

1. After the application of the elastic constriction tube around penis and scrotum, the scrotum is seized with the left hand and drawn tense; *external incision* over the most prominent part of the tumor or swelling by dividing



a
Fig. 1460



b
Fig. 1461

Castration. *a*, external incision; *b*, ligating spermatic cord; *Vd*, vas deferens

the different layers separately down to the *tunica vaginalis.* In existing fistulous openings, and in very large tumors, it is desirable to cut away a corresponding (elliptical) portion of the diseased or superfluous skin (Fig. 1460).

2. **Incision of the tunica vaginalis**, rendering the diagnosis certain by a careful inspection of the testicle. Next, the testicle is enucleated as bluntly

as possible from its envelopes, until it is connected only with the spermatic cord. If, in firmer adhesions, the knife must be used, the operator should always cut toward the tumor of the testicle, and guard against opening the scrotal cavity on the other side by an injury to the septum scroti.

3. The *vas deferens*, which can easily be felt, is sought for, isolated from the loose connective tissue, and *divided*.

4. The spermatic cord is *pierced through* in its middle portion with a pair of forceps or a similar instrument; a double strong catgut thread is passed through the opening, and each half is *very firmly* ligated and *cut off* about 1 centimeter below the ligature (Fig. 1461). To prevent the stump from slipping back into the abdominal cavity, the threads of these ligatures "*en masse*" are allowed to remain about the length of a finger in the upper angle of the wound, where they serve at the same time for drainage.

5. The large wound is kept patent by retractors, and each bleeding vessel is grasped and ligated; next, after any superfluous skin has been removed with scissors or knife, the surfaces of the wound are sutured by buried sutures, and its margins by interrupted sutures. Drainage in most cases is superfluous. To avoid suturing of the rugous scrotal skin, which is difficult to disinfect, the spermatic cord can also be exposed first beneath the inguinal canal by a longer oblique incision, and then the testicle can be luxated out from this opening (as in post mortems). In a *double castration*, a curved ⌣ external incision is made *across* the raphé, and the greater part of the scrotum is extirpated.

Recently, in old men, the *double castration* has been made (*Ramm*, *White*), to relieve the obstructive symptoms incident to **hypertrophy of the prostate gland**; it is claimed that this operation results in progressive diminution in the size of the prostate gland, and thus relieves the symptoms caused by it. Since, however, serious psychical disturbances are not rarely resulting from this operation, it is advisable to make instead **resection of the vas deferens, vasectomy** (*Mears*, *Helferich*), a simple and harmless operation, which, in case of necessity, can be made without narcosis under *Schleich's* anæsthesia.

From an external incision 3 to 4 centimeters in length across the round cord of the vas deferens, which can be distinctly felt between two fingers in the region of the inguinal opening, or deeper, the vas deferens is liberated from the other spermatic strictures, drawn forward somewhat, cut off centrally, and torn from the epididymis. The removed portion often measures from 8 to 10 centimeters. *Von Büngner* recommended *evulsion*, whereby, through a gradually increased traction on the exposed vas deferens, a large portion of it in the abdominal cavity is also torn out.

OPERATIONS ON THE RECTUM AND THE ANUS

EXAMINATION OF THE RECTUM

For *an external examination*, the patient is requested to stoop over a table or a bed, while the coccygeal region is turned toward the light; still better is the knee-elbow position. Next, the buttocks are drawn apart, and the patient is told to strain so that the anus is made more prominent.

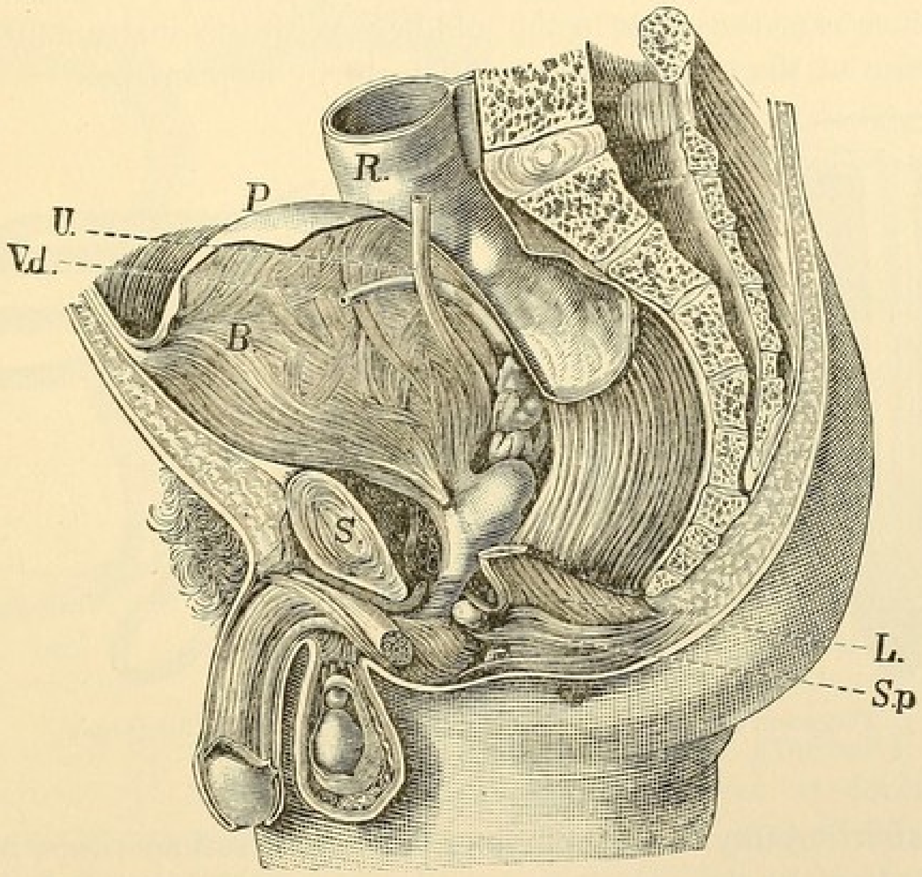


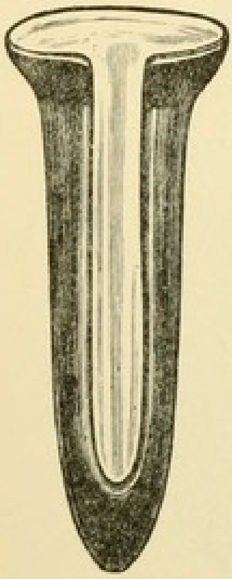
FIG. 1462. ANATOMY OF PELVIC ORGANS. *S*, symphysis; *R*, rectum; *B*, bladder; *U*, ureter; *P*, peritoneum; *Vd*, vas deferens; *L*, levator ani; *Sp*, sphincter

For *internal examination*, the forefinger, well lubricated with antiseptic salve (boric vaseline), is introduced into the rectum, previously cleansed by an enema. By slow and gentle turnings, the finger is advanced far enough to palpate the internal surfaces of the rectum. In order to palpate also the higher sections of the rectum with the tip of the finger, the patient is requested to force or to press, or the surgeon himself presses with his other hand upon the abdomen of the patient in a backward and downward direction.

But, if it is necessary to *inspect* the internal surface of the rectum, the resistance of the sphincters must be overcome; for this purpose **a rectal speculum** (*speculum ani*) is used.

Fergusson's speculum (Fig. 1463) consists of a tube closed anteriorly, whose internal surface is coated with mirror glass. The portion of the rectum to be inspected is placed in the longitudinal opening of the tube. Of similar construction is *Gowlland's* speculum.

Allingham's speculum (Fig. 1464) consists of four blades; its arms can be separated by compressing the handles, and can be held in position for any width by means of the screw in the middle. With this instrument, the entire lower section of the rectum can be satisfactorily inspected.



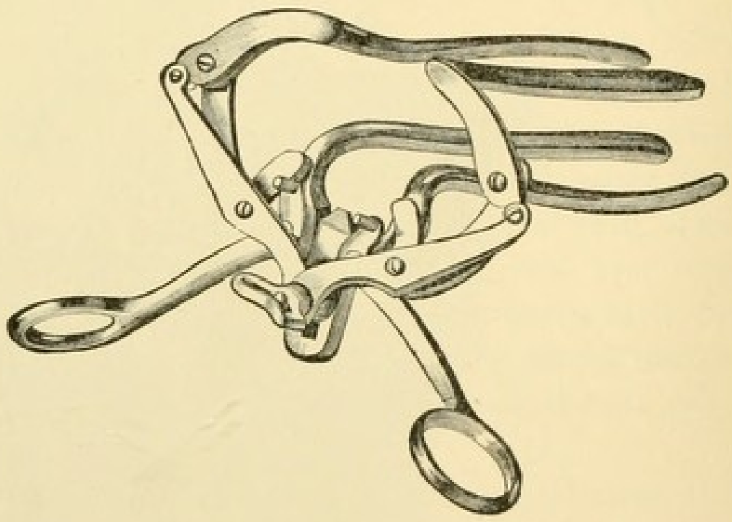


FIG. 1463. Fergusson's FIG. 1464. Allingham's
RECTAL SPECULA

In great irritability of the sphincter, and in all serious cases, however, it is advisable to make the *examination under anæsthesia*. After the sphincter has become relaxed from the effects of the anæsthetic, *Sims's* (Fig. 1465) or *Simon's* (Fig. 1466) *groove-shaped vaginal specula* can be introduced without any trouble; with this, the whole internal surface of the rectum can be inspected. In the knee-elbow position, after the introduction of these specula, the rectum becomes inflated with air, and can be well inspected. **The forcible dilatation of the anus according to Recamier**, made by stretching the sphincter during deep anæsthesia, likewise greatly facilitates the inspection of the lower section of the rectum; it is made, also, as a preliminary procedure for removing diseases of the rectum. First, both thumbs are introduced into the anus, while the four fingers rest on the buttocks (Fig. 1467). Next, the thumbs are slowly removed from each other until the stretching of the anal ring becomes very extensive. The same procedure is then repeated in various directions until the whole anal ring is sufficiently stretched. The sphincter becomes lacerated subcutaneously during this procedure, and finally feels like a well-beaten steak. After the operation very little blood flows from the anus.

In difficult cases (in high carcinoma, foreign bodies, ileus) it may become necessary to introduce **the whole hand** (and the forearm) into the rectum under anæsthesia (*Simon*). Into the anus, previously dilated, the operator introduces first one finger, then several fingers, then half the hand, and finally the whole hand into the rectal cavity, with careful turning movements and a pressure gradually becoming more effective. If the folded hand is not more than 25 centimeters in circumference, it can generally be forced through the anus of an adult without lacerating the mucous membrane.

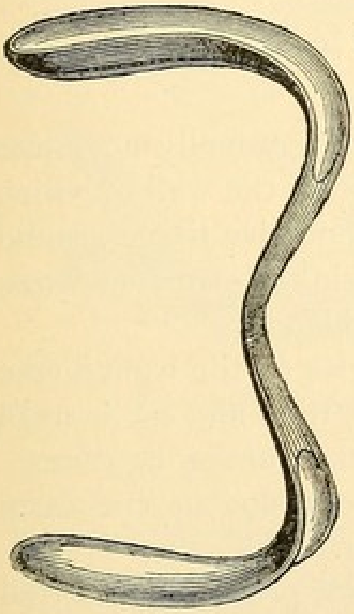


FIG. 1465
SIMS'S SPECULUM

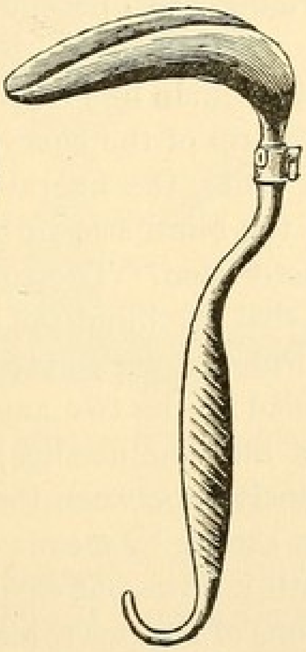


FIG. 1466
SIMON'S SPECULUM

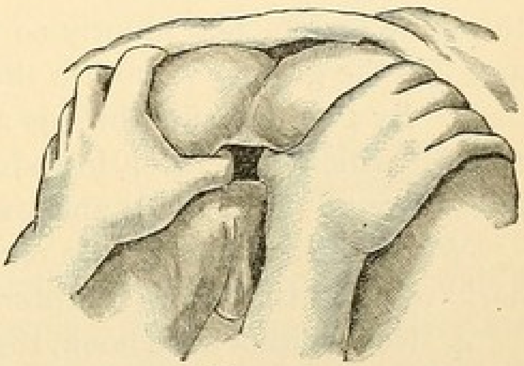


FIG. 1467
FORCIBLE DILATATION OF ANUS

(Manual explorations should be undertaken only by surgeons with small, delicate hands.)

Posterior sphincterotomy, *the posterior raphé incision*, is rarely necessary for the purpose of an examination, but it facilitates many operations on the posterior wall of the rectum. With a probe-pointed knife introduced upon the finger as a guide, the whole sphincter is divided in the raphé in a posterior direction as far as the tip of the coccyx. The latter may be displaced downward and outward, or be extirpated completely (*Verneuil*).

Fecal incontinence, caused by this operation, disappears, as a rule, after eight to fourteen days.

PROCTOPLASTY

The formation of an opening of the anus is required in the various forms of congenital imperforate anus (*atresia ani*), to create a sufficient exit for the collected intestinal contents, and to establish thereby the natural conditions as far as possible.

The child is placed in a dorsal sacral position, and is but slightly anæsthetized, since the pressing forward of the perineal region, caused by its crying, essentially facilitates performing the operation. The bladder must be previously evacuated.

1. *External incision* exactly in the median line from the scrotum (posterior commissure of the labia) as far as the tip of the coccyx.

2. With careful sweeps of the knife, the operator gradually advances deeper as far as the prominence of the blind sac, through the wall of which the shining meconium can be distinctly seen. The connective tissue around the same is detached bluntly so far that the blind sac sinks down somewhat, and fills the gaping wound in the form of a dark blue bladder.

3. By two fine silk threads applied at the two angles of the wound (the ends of which have been introduced into fine needles), the blind sac is fixed in the wound (Fig. 1468) and then incised between these traction ligatures.

While the contents of the rectum escape by means of a douche, the warm boric solution is allowed to enter until it flows out clear.

4. Now, with a little hook, the loops of the two threads previously inserted are drawn from the cleft, divided in the middle (Fig. 1469, *E*), and employed for four interrupted sutures, by which, anteriorly and posteriorly, the divided blind sac is stitched to the external skin (Fig. 1469).

5. Next, the remaining portion of the margins of the incision of the rectum is sutured to the external skin all around with interrupted sutures (*Dieffenbach's* labial suture, similar as in Fig. 999), whereby an anal stenosis, which otherwise might occur, is permanently prevented.

Even if the atresia extends very high, the attempt should always be made to reach the blind sac by a courageous deepening of the perineal incision if necessary, by opening the perineal sac and by extirpating the coccyx, to gain better access to the deeper layers. In case of necessity, a loop of the large intestine hanging down low may also be drawn forward and sutured to the margins of the wound and opened. *Macleod* recommends, in difficult cases, even opening the abdominal cavity anteriorly in the median line, searching for the blind sac, detaching it from its connections, and forcing it from above toward the perineal incision. To prevent the escape of meconium, the same is stroked from the lower extremity toward the colon while the child is in Trendelenburg's position.

If the rectum terminates in the bladder, urethra, or vagina, the rectum is likewise exposed by a perineal incision; next, the cellular tissue around the place of inosculation is detached bluntly, and the intestine is cut off

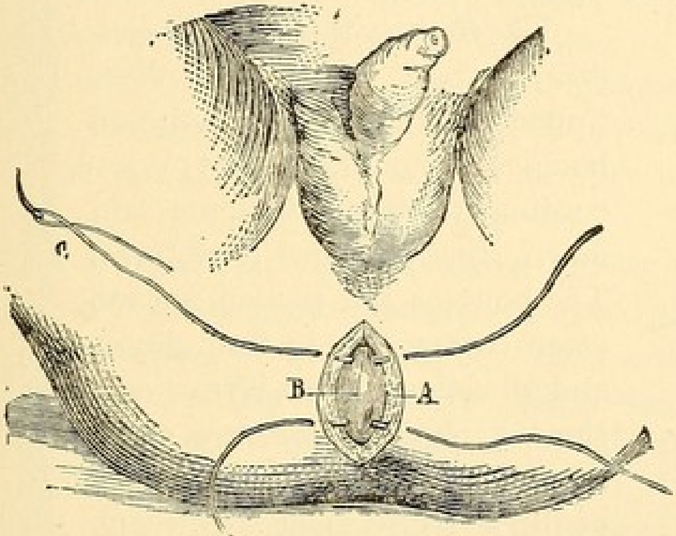


FIG. 1468. Fixing blind sac in the wound

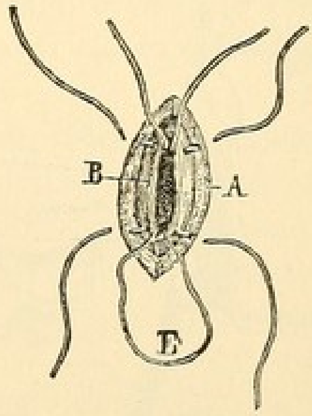


FIG. 1469. Opening blind sac
Tying sutures

PROCTOPLASTY

transversely with the scissors. The opening thereby produced in the wall of the vagina or the bladder is sutured immediately; the portion of the rectum, however, is drawn downward into the perineal wound, and fastened there (*Rizzoli*).

If the anus cannot, in any manner, be formed in its natural place, an *inguinal anus* must be established (see page 700) in order to preserve the life of the child.

STRICTURES OF THE RECTUM

Strictures of the rectum are *recognized most readily* by digital examination; if they are located very high, bougies (similar to those described on page 756) must be introduced. If any pass through the stricture, the operator, on withdrawing them, feels their points *arrested.* Still better are the *ivory-olive* points fastened to a whalebone rod (Fig. 1470, see also Fig. 1219), in the employment of which the operator has distinctly the sensation of a resistance suddenly overcome, when they have passed through the stricture. Moreover, they do not relax the sphincter so much, when left in position for some time.

During these examinations, the patient is best placed in the knee-elbow position or Trendelenburg's position, in order to displace the intestines as much as possible from the true pelvis; else the operator is very easily deceived by the formation of folds, etc.

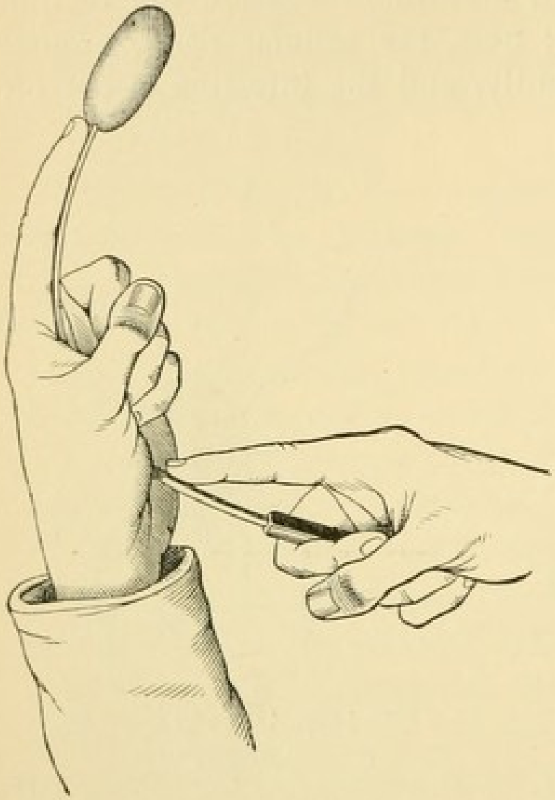


FIG. 1470. BUSHE'S OLIVE-POINTED BOUGIE

The slow dilatation with bougies is best made with olive-tipped bougies or glass-tipped bougies (Figs. 1470, 1471), according to the principles laid down for urethral strictures. The bougies are passed not too often (every two to four days), and all violence must be avoided, since a *slight momentary pressure* influences the firmer tissue of the stricture most effectively.

The *forcible dilatation* must be made only with the tip of the forefinger, which has been introduced slowly and carefully; if the tissue prove to be very firm, its margin can be nicked very superficially and in several places with a herniotome (as hernial ring in herniotomy, **rectotomia interna**).

After *deeper incisions*, — which might divide the entire wall of the rectum thereby opening the cavity, — progressive phlegmon with fatal termination easily ensues.

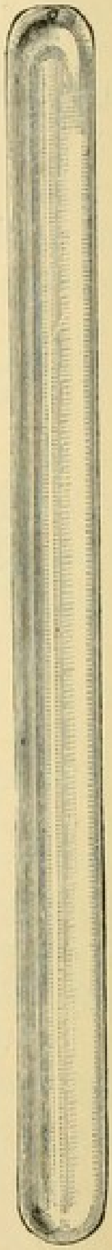


FIG. 1471
GLASS BOUGIE

In strictures seated very high, the **external rectotomy** (*Sonnenburg*) is to be recommended. After the posterior surface of the rectum has been exposed by resection of the coccyx and sacrum (see page 819), the stricture is divided from without inward; *the sphincter remains intact.* The wound is tamponed, and heals very slowly (after the manner of external urethrotomy); the cicatricial contraction gradually draws all healthy intestinal portions downward.

In very serious cases, *colostomy*, or if there is no hope whatever of improving the stricture, an artificial *anus* must be made.

STRICTURES OF THE ANUS

can be removed permanently only in rare cases, by a tedious bougie treatment.

It is better, in milder cases, to divide the anus *longitudinally*, and suture the wound *transversely*. In very narrow strictures, it is better to divide the anus *longitudinally* in front and behind *in the median line*, to detach the mucous membrane of the rectum all around so far that it can be drawn down to the external wound when it is sutured to the skin, especially at the angles of the wound (as described on page 526 in the discussion of *stomato-plasty*).

If the cicatricial tissue extends far into the rectum, while the external skin is in a normal condition, *two tongue-shaped flaps*, after a median division, are formed from the latter; their point is turned toward the anus. These flaps are detached, drawn across the gaping clefts into the rectum, and fastened here with fine sutures (*Dieffenbach*).

OPERATION FOR RECTAL FISTULA

consists in *division* of the wall of the entire fistulous canal from one end to the other; this is the simplest, most rapid, and safest method of curing a fistula radically.

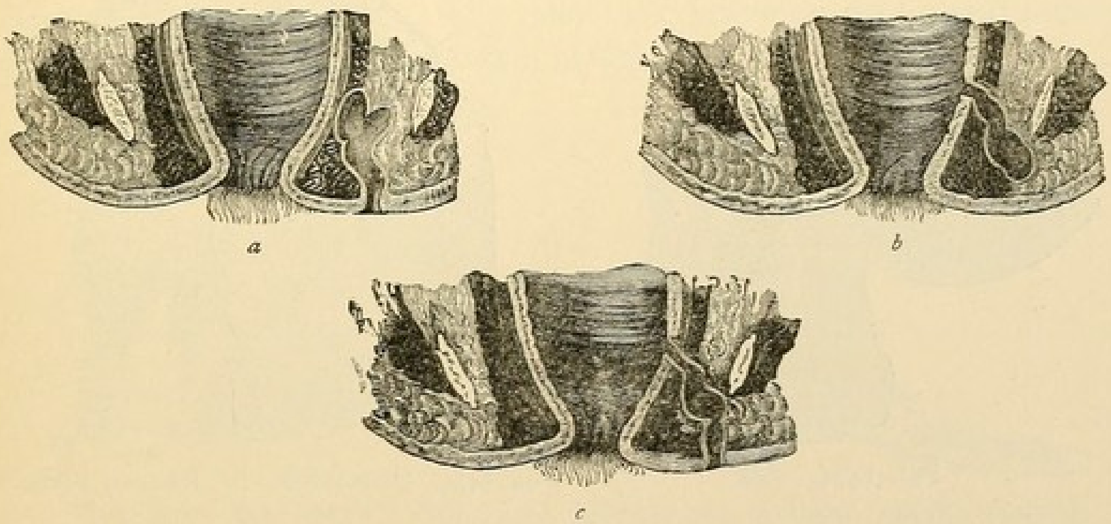


FIG. 1472. FISTULA ANI. *a*, externa incompleta; *b*, interna incompleta; *c*, completa

After the patient has been subjected to a thorough evacuation for several days, he is anæsthetized and placed in a lateral or lithotomy position.

1. The *internal orifice* of the fistula must be searched for.

The latter is often located near the sphincter, as a small, hard swelling, toward which a probe can be pushed through the external opening (Fig. 1473).

FIG. 1473. PROBE FOR RECTAL FISTULA

Very small internal openings, located very high, are found in the most satisfactory manner by injecting milky solutions (milk, creoline); while a rectal speculum (*e.g.* Fig. 1463) is introduced, the solution is injected under moderate pressure with a small syringe, through the external fistulous opening; generally the fluid escapes in a fine spray from the wall of the rectum; in this manner also the existence of *several* internal openings is ascertained.

(The most reliable diagnosis of the resources in determining the existence of a complete fistula is to inject through the external opening peroxide of hydrogen. If the fistula is incomplete, tension and pain will follow. If it is complete, foam will escape from the anus.)

2. Next, a flexible metal probe-pointed sound, with grooved shaft, is carefully introduced, without great violence, toward the rectal cavity through the external opening; the narrow internal opening, if necessary, is

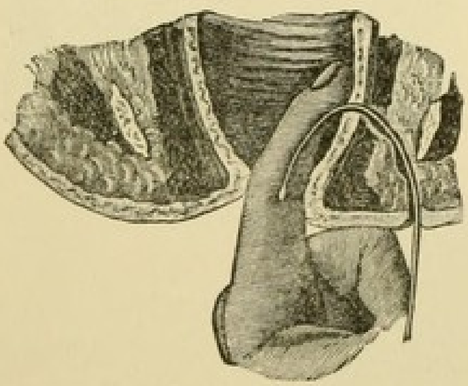


FIG. 1474

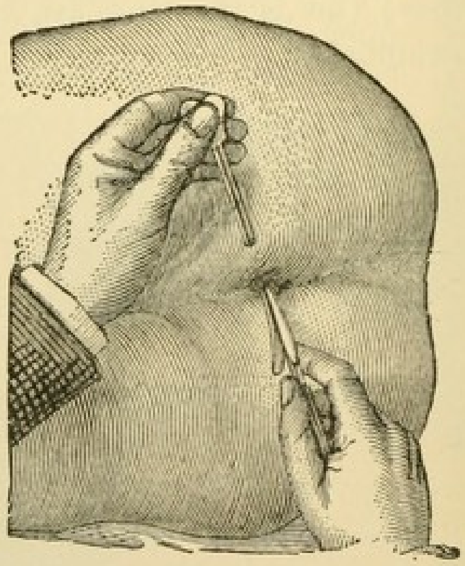


FIG. 1475. OPERATION FOR RECTAL FISTULA

enlarged by pressing the probe-pointed sound forward, so that it becomes visible in the rectum. While the point of the probe is bent downward (Fig. 1474), and forced out of the anus with the introduced forefinger, the probe is pushed through farther. *All soft parts lying between the two openings are now lying as a thick fold upon the probe in front of the anus*, and may easily be *divided* with a pointed knife pushed along the groove of the probe (Fig. 1475); or they are incised with the thermo-cautery, or with the galvano-caustic loop.

3. The walls of the divided fistulous canal are thoroughly scraped with the sharp spoon; for a dressing, a thick tube wrapped with iodoform gauze (Fig. 1476) is introduced; this, by means of its pressure, arrests the hemorrhage, in most cases inconsiderable; likewise it forces apart the margins of the wound and prevents their premature union; for it is desirable *that the wound should heal from its bottom by granulation.*

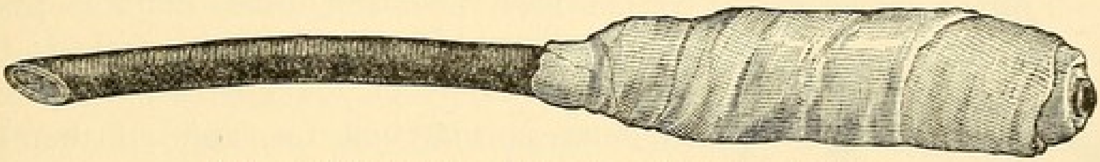


FIG. 1476. TUBE FOR DRESSING IN RECTAL FISTULA

If the *internal opening* is located very high, and surrounded by indurated tissue in such a manner that the probe point cannot be brought out of the anus, either a wooden gorget (Fig. 1478) may be introduced into the rectum for protecting the wall lying opposite to the same, when the operator is cutting with a long-pointed knife along a grooved director; else *Allingham's* scissors may be used, one blade of which, provided with a probe-point, glides along a deeply grooved director (Fig. 1477). If there are several external or several internal openings, they must all be divided, and again united with one another; undermined livid skin-bridges are *cut away.*

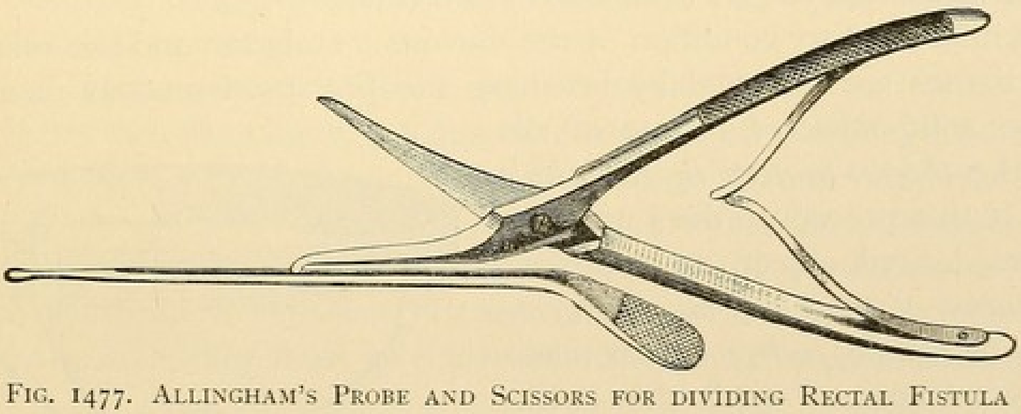


FIG. 1477. ALLINGHAM'S PROBE AND SCISSORS FOR DIVIDING RECTAL FISTULA

Incomplete fistulæ (Fig. 1472, *a*, *b*) must be transformed into *complete* fistulæ.

If no internal opening can be found, the wall of the rectum is *pierced* with the point of the probe at its thinnest place, and the probe is caught with the introduced finger or in the groove of a gorget (Fig. 1478); all the portions lying between are divided.

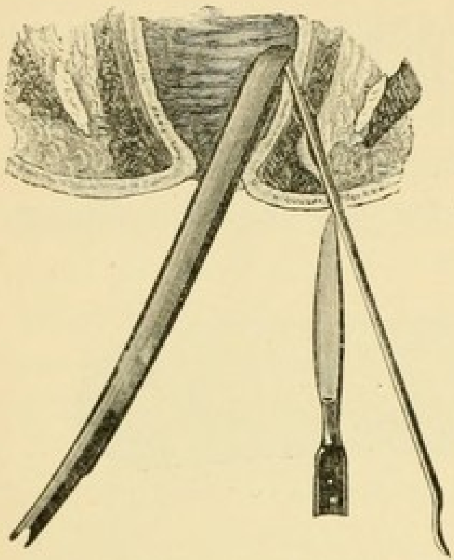


Fig. 1478. Dividing Incomplete Rectal Fistula

If the external opening is absent, and if only a hard place, sensitive to pressure and slightly prominent, indicates that the abscess will break through at this place, it is often possible to push the point of a hook-shaped probe through the internal opening as far as the skin, and to make an incision upon the same; else a sharp-pointed knife is pushed into the hard place until pus is reached; then, from the cavity of the abscess, the internal opening is searched for, and all the tissue intervening is divided.

The division of the fistula by silk or elastic *ligatures* is tedious and not without danger.

But after laying open the fistula, the indurated tissue of the fistulous canal can be *extirpated* completely, and the surfaces of the wound can be at once united completely by *suture* (*Stephan*, *Smith*, *Lange*).

PROLAPSUS RECTI

is often permanently reduced *in children*, if they are prevented from violent straining and if the prolapsed rectum is carefully pushed back into position with the lubricated fingers after each evacuation.

The inflammatory condition of the mucous membrane and the relaxation of the tissues are removed by brushing the prolapsed mucous membrane with the solid stick of nitrate of silver or the *thermo-cautery in radiating lines*. If this procedure does not produce the desired object, an energetic *cauterization of the whole mucous membrane with fuming nitric acid* is made under anæsthesia. With this (without touching the skin of the anus) the carefully dried mucous membrane is touched, until a dry green eschar has been formed; next, the prolapse is reduced with a tampon, and the buttocks are drawn together over the same by a broad strip of adhesive plaster.

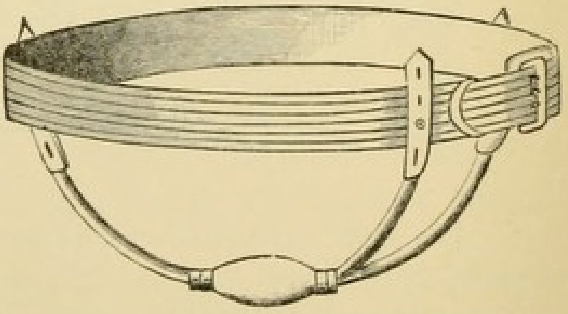


Fig. 1479. Rectal Supporter

Adults may use *a rectal supporter* (Fig. 1479), that is, an elastic rubber ball which is pressed against the opening of the anus by belts. By a thorough cauterization or the excision of a large *myrtle-leaf-shaped portion* with subsequent suture (*Dieffenbach*), sometimes a not too large prolapse can be removed permanently. The anal orifice can also be diminished by a *purse-string suture* or by a ring of thick silver wire applied subcutaneously, which has often yielded good results (*Thiersch*). *Gersuny* detached the lower part of the rectum, *turned* it around its longitudinal axis until the lumen was just passable for a finger, and sutured it in this position.

In obstinate cases, however, **resection of the entire prolapse** is the best and safest procedure, especially when reduction is impossible or dangerous on account of incipient or existing gangrene.

Into the intestine, pressed forward as much as possible, a wooden cylinder provided at its superior extremity with a shallow transverse groove, a rectal bougie, or something else, is introduced so far that the prolapse can be constricted with a thin rubber tube around the groove closely in front of the anus (*von Esmarch*). Any intestinal loops present in the prolapse must first be reduced. Next, under the *bloodless method*, the whole intestinal wall is carefully divided, cutting through the several layers separately, 2 centimeters in front of the elastic constrictor; and, after ligation of all visible blood vessels, first the serous coats and, then (after removal of the tube), the muscular and the mucous coats are sutured together. Instead of the bougie, a tampon tube is introduced, and thereby the sutured intestine is returned.

In obstinate cases, however, the resection of the whole prolapse is the best and safest procedure.

Miculicz proceeded in a similar manner as follows: —

1. After two deep ligature loops have been inserted through the summit of the prolapse, to hold the intestine in position, first the *anterior circumference of the external visceral canal* is divided transversely in layers about 1 to 2 centimeters in front of the anal fold until the serous surface of the internal intestinal is exposed. If any intestines are found in the opened peritoneal pouch, they must be returned, if necessary, after dilatation of the anus.

2. By interrupted sutures, two intestinal sutures with their peritoneal surfaces facing each other are united on the *peritoneal side* as carefully as possible, until the peritoneal cavity at this place has been closed completely.

3. Next, the *anterior circumference of the internal intestinal tube* is divided in layers, and the two visceral canals are united in the entire line

of incision by deep interrupted sutures, including all layers; the ends of the ligature remain long.

Finally, the *posterior* circumference of both intestinal tubes is divided in layers, the vessels of the mesocolon lying between them are ligated, and following the line of division the margins of the incision are united step by step by deep interrupted sutures (see also page 702, enterorrhaphy).

5. After all threads have been cut off short to the knot, the stump, lightly dusted with iodoform, is pushed back carefully into the anus. Tubular tampon and dressing are not required.

If the external intestinal tube has a much longer circumference than the inner, a wedge-shaped cleft is left open in the most posterior portion, into which a strip of iodoform gauze is inserted.

Helferich makes this resection more rapidly and more easily by longitudinally dividing the entire anterior and the posterior wall of the prolapse; at the ends of these incisions a suture is applied through all layers; the base of the formed *flaps* is pierced with quilt sutures, and cut off transversely before them.

In prolapse which cannot be returned, *Bogdanik* and others obviate resection by drawing back the invaginated intestinal portion after having opened the abdominal cavity, and by fastening it in its normal position to the parietal peritoneum with a few sutures, which do not pierce the mucous membrane (**colopexy**, *Bogdanik*). The inferior portion of the rectum can be sutured to the coccyx with a few silk sutures after a longitudinal division of the skin from the anus to the coccyx (**rectopexy**, *Verneuil*). In the knee-and-elbow position *Lange* exposed the posterior surface of the rectum by a longitudinal incision of the anal depression and resection of the coccyx, and by buried quilt sutures he formed a deep *longitudinal fold* of the rectum projecting inwardly (**rectoplicatio**). After the divided fibres of the levator and sphincter ani have been sutured, the wound of the skin is likewise closed, and the cavity formed by excision of the coccyx is tamponed.

For *narrowing the dilated anus* cauterization with a cautery iron and the *radiate excision* of several folds (*Dupuytren*) are successful only in rare cases. More effective is *the excision of a large wedge* from the prolapsed mucous membrane, the anus, and the external skin, with subsequent suture (*Dieffenbach*).

OPERATION FOR HEMORRHOIDS

When the phlebectases (varicosities) of the *hemorrhoidal plexus*, as well by their size and number as by their tendency to hemorrhages, have become troublesome, it is advisable to remove them; this is best and most thoroughly effected by **extirpating the hemorrhoidal swellings** in the following manner: —

After the bowels have been evacuated thoroughly for several days, directly before the operation an enema of very warm water is given, which, by straining, is evacuated into a chamber filled with hot water, whereby all varicosities (intermediary and internal) usually appear to view.

The patient is then deeply anæsthetized and placed in the lithotomy position. Milder cases may also be operated upon under *Schleich's* anæsthesia.

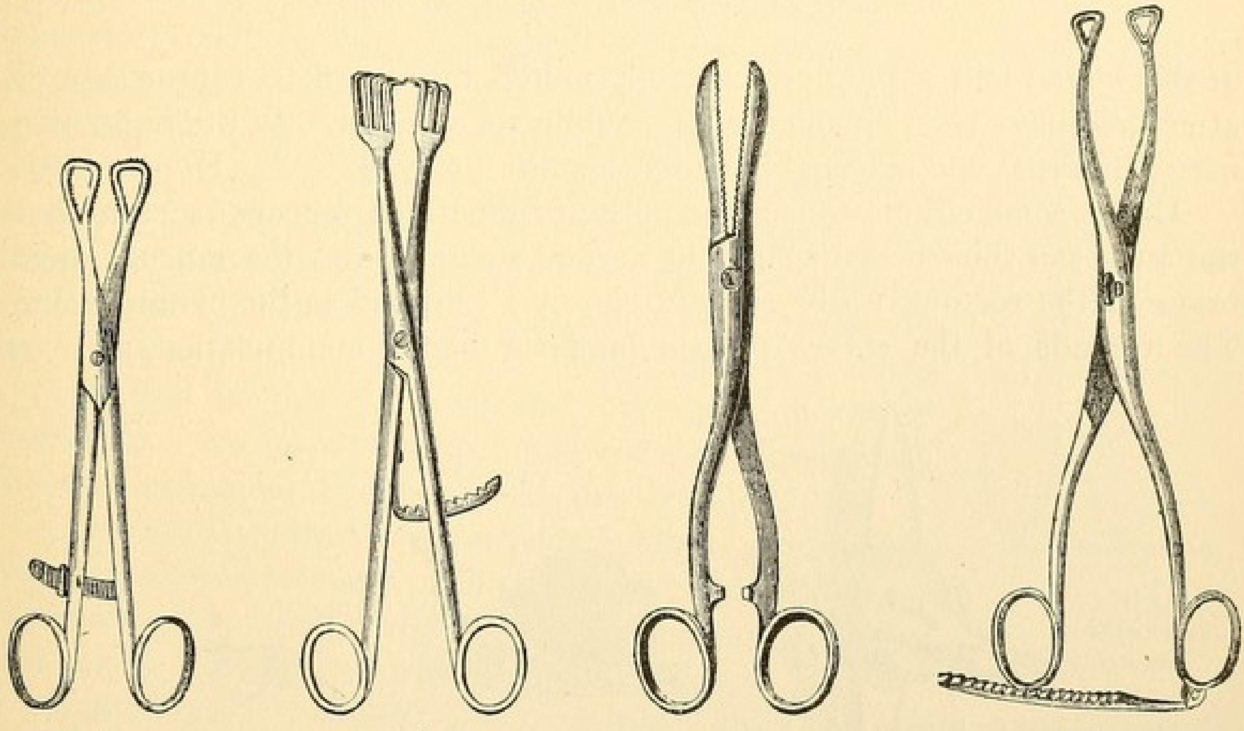


FIG. 1480. CLAMP FORCEPS. *a*, Smith's; *b*, Curling's; *c*, Hahn's; *d*, Luer's

1. The anal ring is forcibly *dilated* (see Fig. 1467), and a large sponge, fastened with a strong silk thread, is introduced high into the rectum; the latter is thoroughly irrigated with a warm antiseptic solution (boric or salicylic).

2. Next, all the large external swellings, as well as the internal, are grasped with clamp forceps (Fig. 1480) and drawn forward; by the weight of the hanging forceps they are prevented from slipping back.

3. One after the other the base of each hemorrhoid is detached on its internal side, first from the sphincter muscle by a deep incision with a pair of good cutting scissors (*Allingham's* hemorrhoidal scissors, Fig. 1481), or with the knife. It is then drawn forcibly forward, and the mucous membrane

above the base is drawn to the external skin with a quilt suture (Fig. 1482). Next, the mass is cut off in front of the suture, all spurting vessels are ligated, and the wound is closed by tying the quilt suture. The margins

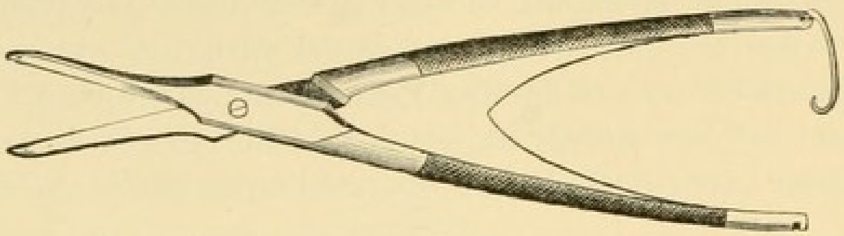


FIG. 1481. ALLINGHAM'S HEMORRHOIDAL SCISSORS

of the wound still gaping are carefully united by superficial catgut sutures, after they have been sponged with a sublimate solution. In the same manner all internal and external hemorrhoids are removed.

Under some circumstances the entire degenerated mucous membrane of the anus can thus be extirpated in several sections, and the mucous membrane of the rectum can be sutured closely all around to the external skin. The threads of the suture remain long for better manipulation, and are

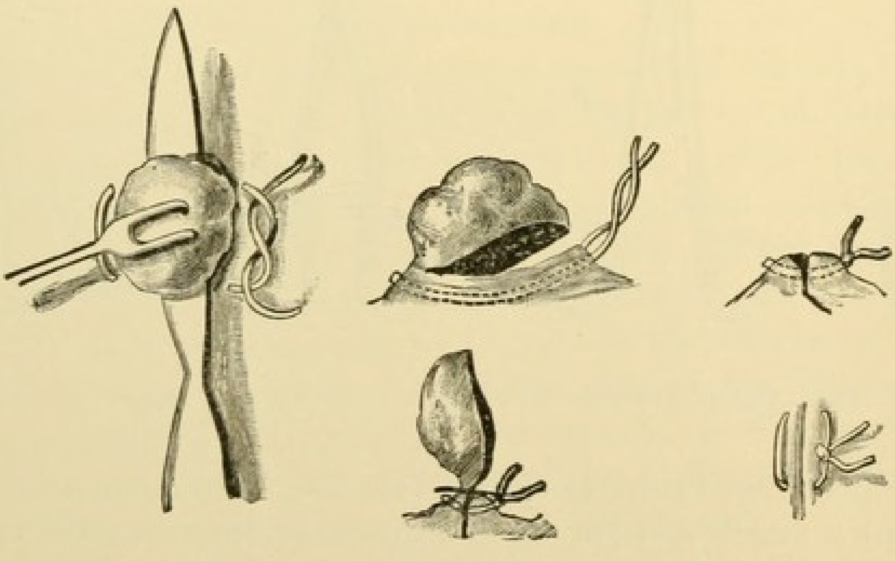


FIG. 1482. EXTIRPATING HEMORRHOIDAL SWELLINGS

spread in a radiate manner around the anus. For preventing, however, cicatricial contractions occurring subsequently, it is advisable to leave a few small mucous membrane bridges uninjured between the extirpated nodules.

After the operation, the sponge introduced into the rectum is removed, and a thick *rubber tube* wrapped with iodoform gauze (Fig. 611) is introduced. This remains in position until the next evacuation, which is postponed to the sixth or eighth day by opiates.

The spasmodic retention of urine occurring mostly during the first days after the operation (*spasmus urethræ*) is removed by opium and warm compresses over the pubic region, or more quickly by a careful introduction of a catheter, which must not be too small.

The removal of hemorrhoids by ligation, a favorite method in England, and their destruction by the actual *cautery* after grasping them with *von Langenbeck's clamp forceps* (Fig. 1483), have indeed met with just as good success, but they bring about the desired end considerably more slowly, since the ligated or cauterized nodules must slough off before healing can take place by granulation, while by *extirpation* the wound generally heals by primary intention. Also *cauterizations* with nitric acid (*Houston*) and pure carbolic acid are used. Recently *Pooley*, *Lange*, and others have favorably mentioned the *parenchymatous injection* of carbolic acid glycerine ($\overline{aa}$) with a *Pravaz* syringe — a convenient procedure by which one to two drops can be injected with a fine syringe into the nodules protected by some lubricating substance. No carbolic acid should come in contact with the mucous membrane, else it becomes necrotic.

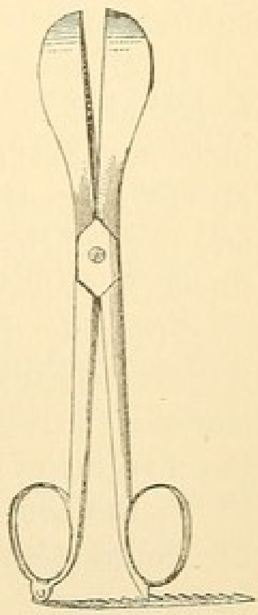


Fig. 1483
Von Langenbeck's Clamp Forceps

(The old-fashioned hemorrhoidal clamps are all too heavy and cumbersome. The delicate curved clamp devised by *Dr. Charles Adams* of Chicago is very useful and can be manipulated with the greatest ease.)

Hemorrhoidal nodules that are not too large not rarely disappear after a forcible dilatation of the anus (*Verneuil*).

OPERATION FOR CANCER OF THE RECTUM

is made variously, according to the seat and the extent of the disease.

Smaller or well-defined pedunculated tumors of the rectal wall are removed by **simple excision**. If they occupy *the anal portion*, they are drawn forward with tenaculum forceps; after a forcible dilatation of the anus, the operator circumscribes them with the knife in the healthy parts, and sutures the surface of the wound completely; after the hemorrhage has been arrested, if possible,, the wound is closed in *a transverse direction*, in order that no harmful constriction may follow the operation.

If, however, the tumor is located so high *above the anal portion* that it cannot be drawn outside of the anus, the latter is incised through the *pos-*

terior raphé as far as the tip of the coccyx (*Dieffenbach*). The margins of the deep wound are now drawn apart with sharp hooks, and the tumor drawn downward is circumscribed with the knife by two semilunar incisions. If the tumor occupies *the anterior rectal wall*, the anus is divided in the median line toward the perineum (*anterior sphincterotomy*), and the anterior wall of the rectum is carefully dissected off from the prostate and the bladder. After the removal of the tumor, the wound is reduced in size by a few sutures, and the remainder is drained.

If *the anus is the starting point* of the trouble, and if the entire anal ring is included in the carcinoma, the anus is circumscribed by two semilunar incisions through healthy tissue; next, with rapid sweeps of the knife, the operator penetrates into the cellular tissue surrounding the rectum as far as and beyond the limit of the disease, which is determined with the left forefinger introduced into the rectum. The detached portion of the rectum is now forcibly drawn forward with tenaculum forceps, and the intestine is transversely divided above the limit of the disease. After the hemorrhage has been arrested, the rectum, which has been drawn down, is sutured to the margins of the skin (**extirpatio ani**, *according to Lisfranc*).

In the course of time *the wound heals by granulation and cicatrization;* the contraction following the operation is sufficient to prevent total rectal incontinence. With a view of preventing rectal prolapse, which frequently follows, it is advisable to make use of pressure by *a ball of common cotton* applied over the new anal opening, and to hold it in place by a suitable bandage.

If the tumor occupies the *larger portion of the circumference or even the whole circumference of the rectal wall* (**annular**), the whole rectum must be removed as far as and beyond the upper limit of the disease (**resectio recti**). If the tumor, springing from the *anal portion*, has not yet invaded the sphincters, the anus, according to *Dieffenbach*, is divided first anteriorly in the raphé as far as the bulb of the urethra, and then posteriorly as far as the tip of the coccyx; but the mucous membrane is divided transversely on both sides at the junction with the anal integument; it is then detached from the internal sphincter.

After the two halves of the anus have been drawn apart with large sharp retractors (*Simon*) by an assistant, the rectum is divided below the tumor transversely on both sides, and detached from its surrounding tissues as far as, and at least 4 centimeters above, the upper limit of the tumor.

First, the anterior wall is dissected off carefully from the prostate and the bladder; next, all around and close to the external wall, the operator penetrates carefully upward, *pressing* more with the fingers and blunt instruments than cutting with the knife, and thus dividing the tense bands of connective tissue, and securely ligating every vessel, if possible, before its division. Farther upward, and within reach of the tumor, the operator avoids the rectal wall as much as possible.

If the upper limit of the tumor, palpable through the intestinal wall, is situated so high that *the lower duplicature of the peritoneum* must necessarily be opened, the peritoneum is incised transversely; it is then easy to draw the rectum downward. Sometimes the surgeon also succeeds by blunt dissection in pushing the peritoneum carefully upward; at each inspiration, it bulges like a fish bladder in the large wound cavity; after a thorough disinfection, smaller rents are closed immediately by the suture. As soon as the surgeon has reached a part of the bowel at a safe distance above the tumor, he penetrates with his forefinger through the loose cellular tissue to the other side, and now tries, by curving the finger like a hook, and by grasping the tumor with the whole hand, to draw the intestine forcibly downward, and to detach it on all sides until it has been made freely movable, when it hangs down in front of the gaping wound.

Next, the intestine is divided transversely at least 4 centimeters above the demonstrable proximal limits of the tumor; all bleeding vessels are ligated.

Then the margin of the resected intestine is united with the anal integument by sutures, at least at its anterior surface, for it is better to tampon the posterior surface for effective drainage for the secretions and the fæces. The wounds in the perineum and in the gluteal furrow are somewhat reduced by suturing, and drained.

In very high carcinoma, if the *coccyx* is in the way, it is detached from the sacrum (*Kocher*).

The largest space for the removal of tumors seated *very high* in the rectum is obtained by

RESECTION OF THE SACRUM (*Kraske*)

in the following manner: —

1. While the anæsthetized patient lies on his right side, a *skin incision* from the posterior margin of the anus is made in the median line *as far as the middle of the sacrum.*

(The patient should always be placed in the ventral position, the pelvis well elevated for the purpose of facilitating the technical part of an operation, and to minimize the hemorrhage. A cot is preferable to an operating table) (Fig. 1485).

2. Penetrating layer by layer, the operator detaches the insertion of the *gluteus maximus* from the left side of the sacrum and *disarticulates the coccyx*.

3. Next, the lowest portion of the *great sacro-sciatic* and of the *lesser sacro-sciatic ligament* is detached from the sacrum; by this means the superior portion of the posterior wall of the rectum becomes much more accessible.

4. With strong *bone-cutting forceps, the lower portion of the left border of the sacrum is excised* in a line beginning from the left margin at a level with

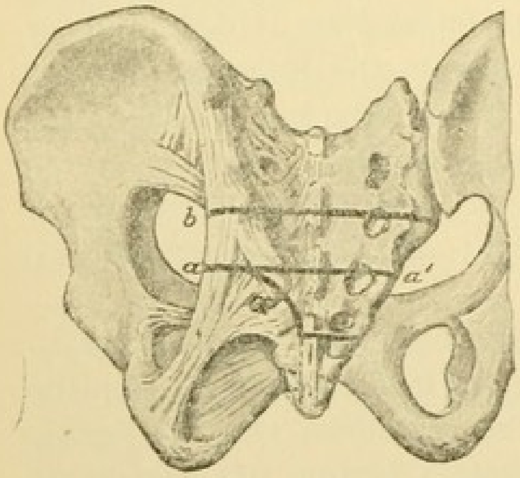


FIG. 1484. RESECTION OF SACRUM. *a*, according to Kraske; *a–a′*, according to Bardenheuer; *b*, according to von Volkmann and Rose

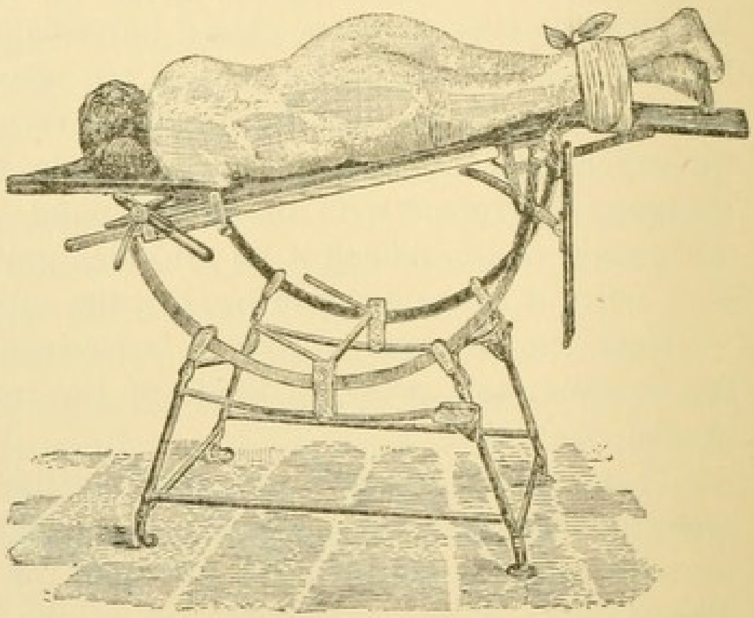


FIG. 1485. POSITION OF PATIENT FOR OPERATIONS OF THE SACRUM

the third posterior foramen of the sacrum, and extending in a curve inward and downward around the fourth sacral foramen as far as the left inferior sacral cornu (Fig. 1484, *a*).

The spinal canal is not injured; the sacral nerves, however, are divided as far as the third.

5. The patient is then placed in the *lithotomy position* with his pelvis elevated; first, the whole rectum is detached from its adjacent tissues in the manner described before, beyond the limits of the tumor, to such an extent that the diseased portion can be drawn down as far as the anal margin, without great tension. If the operator finds any diseased lymphatic glands

in the pelvic connective tissue of the sacral cavity, he enucleates them as bluntly as possible.

6. At the posterior wall of the rectum, always advancing as closely to the same as possible, it is comparatively easy to detach the rectum all around, — in part, bluntly; in part, with scissors (see page 819).

7. If the anal portion is *not* invaded by the disease, it can be preserved uninjured by excising the diseased intestinal portion by two transverse incisions in the healthy parts, and by suturing the upper end, after it has been drawn down to the posterior vertical incision of the anal portion. For this purpose, it is best to suture only the anterior half of the intestinal circumference, and to leave the posterior half open.

8. The whole wound and the posterior raphé incision are *tamponed;* subsequently the latter can be closed by suturing the two lateral flaps of skin; a tampon tube is introduced high up into the rectum.

It is just as good to draw the rectal portion, temporarily closed by a rubber ligature or completely closed by a silk ligature, through the anal portion stripped of its mucous membrane, and to fasten it in this invaginated position (*Kocher*, *Hochenegg*). *Nicoladoni* sutured the proximal end drawn downward to a ring 3 to 4 centimeters wide, wrapped with iodoform gauze to prevent it from slipping back.

Rehn proceeds according to *Kraske's* method **in two sittings**, by amputating first the diseased rectum; after about ten days he sutures the stumps.

(The editor has had a somewhat extensive experience with Kraske's method of rectal extirpations, and he has come to the conclusion that the additional space secured is but an inadequate compensation for the increased risks incurred to life by the operations. For a number of years he has limited pelvic resection to excision of the coccyx as a preliminary step to excision of the rectum for malignant disease.)

If the anal portion has also to be removed, a narrowing to the requisite extent of the rectum, which has been drawn down, is effected by *rotating* it around its longitudinal axis (*Gersuny*).

A still more convenient access to the true pelvis from behind than by *Kraske's* method is obtained *by the transverse resection of the sacrum according to Bardenheuer*. He removes the whole lower portion of the bone as far as the third sacral foramen (Fig. 1484, *a–á*), advances then toward the rectal wall, and detaches the same as bluntly as possible from the surrounding tissue. Without any evil consequences, the bone may be chiselled off transversely even as far as the second sacral foramen (*von Volkmann*, *Rose*, **posterior cœliectomy**).

Von Heineke makes the resection of the sacrum *osteoplastically*.

The posterior sphincter incision is extended in the median line as far as the fourth sacral foramen, the coccyx and the sacrum are divided longitudinally in the median line with the broad amputating saw, and the sacrum is then chiselled off transversely and a little obliquely downward along the lower border of the fourth sacral foramen (protection of the fourth sacral nerve). The flaps of bone and soft parts are turned over laterally, Fig. 1489).

By a somewhat similar procedure, *W. Levy* protects the levator ani and its sympathetic nerve originating from the fourth sacral nerve, by dividing the sacrum transversely below the fourth sacral foramen, a finger's breadth above the cornua of the coccyx. From the extremities of this incision, two longitudinal incisions are made 8 centimeters downward, and the skin-bone flap is forcibly drawn downward (Fig. 1490). *Schlange* proceeded in a similar manner — only the extremities of the lateral incisions divide below the skin alone (protection of the inferior hemorrhoidal nerves), but above they detach the gluteus maximus and the ligaments from the border of the sacrum.

Hegar turned the sacrum over in an upward direction, after he had circumscribed it by two incisions extending from the inferior posterior spine of the ilium to the tip of the coccyx; below the second sacral foramen, he divided it transversely (Fig. 1491).

Rydygier makes the incision through the soft parts obliquely, a little distant from the border of the sacrum, from the superior posterior spine of the ilium as far as the tip of the coccyx, and then in the median line toward the anus. Having detached the soft parts from the sacrum, he chisels through the latter transversely below the third sacral foramen and turns it over to the right, so that the sacral nerves of the right side remain uninjured (Fig. 1493).

O. Zuckerkandl created a passage to the pelvic organs according to *Hueter's* method, *on the anterior side* of the rectum, by a large horseshoe-shaped *incision* (Fig. 1494), from which he penetrated between the prostate and the bladder on one side and the rectum on the other as far as the peritoneal reflection. The retraction of the divided levator ani facilitates the operation considerably. After the diseased intestine had been resected, he united the sigmoid flexure with the anal portion by circular enterorrhaphy. It is still better to incise the anus in front and to tampon the wound temporarily.

Similar is *Hueter's* operation by a horseshoe incision (Fig. 1495), in which a musculo-cutaneous flap is turned downward, exposing the anterior rectal wall.

E. Zuckerkandl suggested, from an anatomical point of view, the **parasacral incision,** for the exposure of the pelvic organs.

RESECTION OF SACRUM

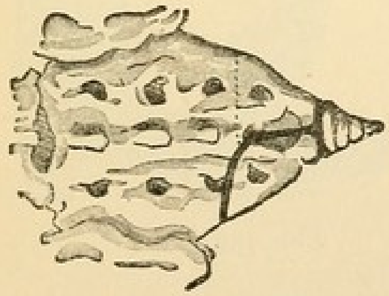


FIG. 1486
Kraske's

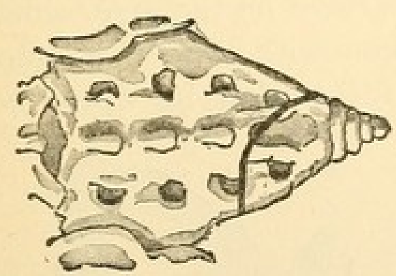


FIG. 1487
Hochenegg's

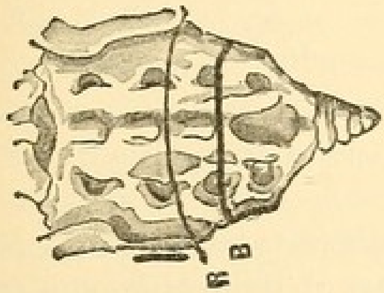


FIG. 1488
Rose's, Bardenheuer's

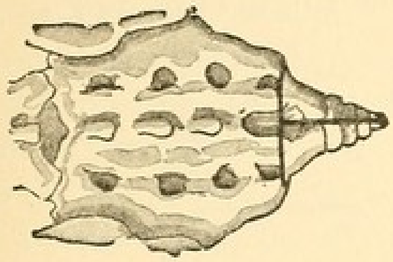


FIG. 1489
Von Heineke's

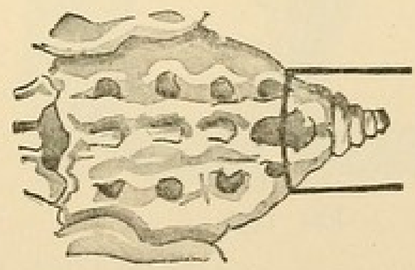


FIG. 1490
Levy's, Schlange's

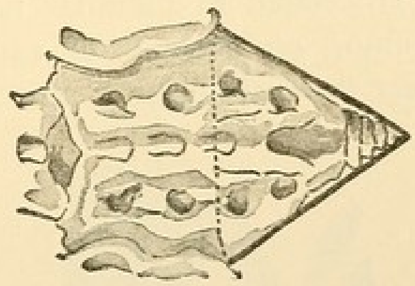


FIG. 1491
Hegar's

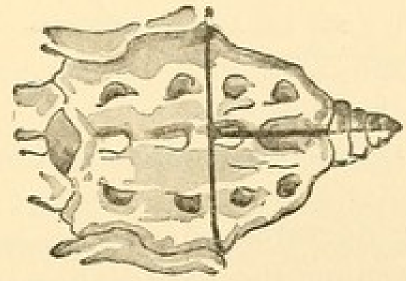


FIG. 1492
Gussenbauer's

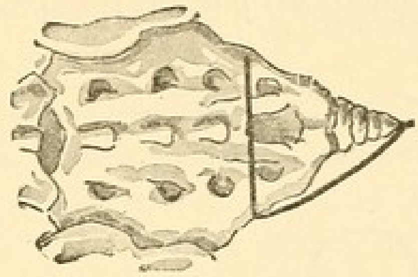


FIG. 1493
Rydygier's

1. The patient is placed in a right lateral position ; the incision extends from the *left* tuberosity of the ischium in a slight curve close to the sacral border as far as the ischiorectal fossa in the middle between the tuberosity of the coccyx and the rectum.

2. The gluteus maximus, the great sacrosciatic and the lesser sacrosciatic ligament, the coccygeal muscle, and, if necessary, also a portion of the levator ani, are cut off close to the sacrum and the coccyx, whereby the extraperitoneal rectal portion is exposed in its whole length (Fig. 1496).

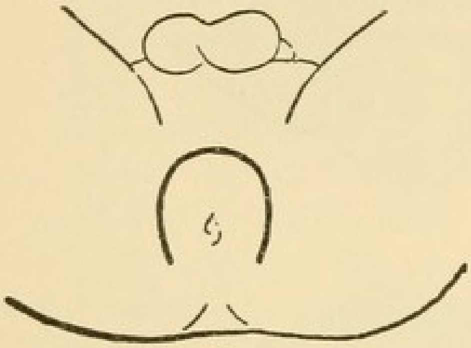


FIG. 1494

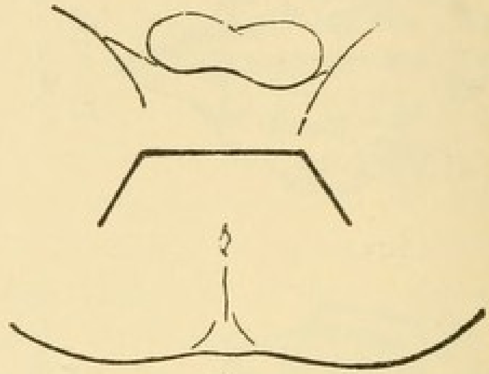


FIG. 1495

PERINEAL EXTIRPATION OF RECTUM. *a*, Zuckerkandl's; *b*, Hueter's

3. If the operator now advances toward *Douglas's* fossa, he can reach also, after opening the peritoneum, the superior part of the rectum and the sigmoid flexure.

Wölfler proceeded in a similar manner, but operated on the *right* side.

If the tumor, on account of extensive adhesions with the surrounding parts, can *not* be excised, or if the patient is so feeble that he would not

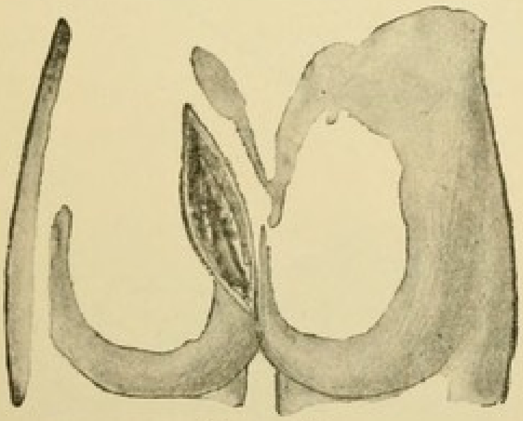


FIG. 1496

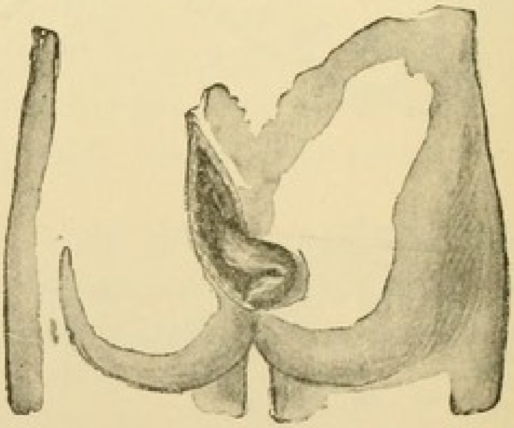


FIG. 1497

ZUCKERKANDL'S PARASACRAL INCISION

survive a major surgical operation, at least a passage must be created for the fæces accumulating above the stricture. This is effected either by removing as much as possible from the tumor mass with the sharp spoon and the thermo-cautery, or by incising the entire posterior wall of the rectum as far as and beyond the superior limit of the tumor, with the thermo-cautery (**linear rectotomy**, *according to Verneuil*).

In most cases, however, it is advisable to form an *artificial anus*, for the escape of the fæces, and by doing so any irritation of the ulcerated surfaces by fæces is prevented (see also page 700).

To provide this anus with *something like a sphincter*, the central extremity may be sutured into the sacral incision (**sacral anus**, *Hochenegg*); and the peripheral rectal end, containing the carcinoma, can be sutured; or the intestinal end, cut off in healthy tissue, is pushed through a transverse opening, made four to five fingers' breadth at the side of the sacral incision between the fibres of the glutei (**gluteal rectotomy**, *Witzel*).

But if the disease extends so far in an upward direction that the sigmoid flexure or the colon must be used for the new anus, an inguinal anus is established, as described on page 700. *Witzel* obtains with this a better closure, by drawing the upper end of the intestine through an incision along the left crest of the ilium under the skin as far as the superior lateral gluteal region (**colostomia glutealis**). Here, by the fibres of the gluteus maximus, a sphincter is formed; the portion of the intestine in the extrapelvic tissues can easily be made to serve as a sphincter by making pressure against the ilium.

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