# A MANUAL OF SURGICAL TREATMENT

# A Manual of Surgical Treatment

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In Six Parts

## PART II.

*The Treatment of the Surgical Affections of the Tissues, including the skin and subcutaneous tissues, the nails, the lymphatic vessels and glands, the fasciæ, bursæ, muscles, tendons and tendon sheaths, nerves, veins and arteries. Deformities*

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To

THE RIGHT HON.

LORD LISTER, LL.D., P.R.S.,

THE FOUNDER OF MODERN SURGERY,

WITHOUT WHOSE WORK MUCH OF

THIS BOOK COULD NOT HAVE

BEEN WRITTEN.

# AUTHORS' PREFACE.

## GENERAL PREFACE.

THE subject of Surgery has now become so extensive that any work attempting to deal with it in an exhaustive manner must necessarily be so large and unwieldy as to be suitable only for purposes of reference, or for the use of those who devote themselves exclusively to its practice. In any text-book of convenient size the information given in certain branches of the subject must therefore be considerably condensed, and, as the first essential for the beginner is to have the fullest knowledge of the nature and characters of the diseases that he has to study, special stress is usually laid upon pathology, symptomatology, and diagnosis. For the practitioner, on the other hand, who is already acquainted with these points, the great essential is full and detailed information as to the best methods of treatment.

We have ourselves frequently experienced the want of detailed information, especially as regards the after-treatment of our cases, and have had to learn the best methods of procedure from experience. Nothing can of course replace experience, but it is often of the greatest advantage to have a detailed record of that of others upon which to base one's work. It is this want that the present work is intended to supply. We have tried to put ourselves in the place of those who have to treat a given case for the first time, and we have endeavoured to supply them with details as to treatment from the commencement to the termination of the illness. We have assumed that the reader is familiar with the nature and diagnosis of the disease, and we only refer to the pathology and symptoms in so far as it is necessary to render intelligible the principles on which the treatment is based, and the various stages of the disease to which each particular method is applicable.

We have purposely avoided attempting to give anything like a complete summary of the various methods of treatment that have from time to time been proposed: to do so would merely confuse the reader. Only those plans are described which our experience has led us to believe are the best, but with regard to these we have endeavoured to state exactly and in detail what we ourselves should do under given circumstances. In some cases no doubt several methods of treatment are of equal value, and while we have only discussed at length that which we have ourselves been led to adopt, we have referred shortly to the others.

We have not mentioned all the exceptional conditions that may be met with, but we have endeavoured to include all the circumstances with which the surgeon is most commonly called upon to deal. The task has been one of some difficulty, the more so as we have had, to a certain extent, to break new ground. This must serve as our excuse for the many shortcomings in the work.

## PREFACE TO PART II.

In the reviews of the volume that has already appeared, some exception has been taken to what has been erroneously regarded as an attempt to deal with the subject of treatment independently of those of symptoms and pathology. We desire to take this opportunity of refuting this mistake; treatment, to be sound and scientific, must obviously be based upon pathology, and, to be intelligible, the pathological points on which it is based must be stated. We have attempted to give all the symptoms of each particular affection that seem needful to render the character and course of the disease intelligible, and we have introduced all the points in pathology which bear directly upon the treatment we recommend. In the ordinary text-books for students, symptoms and pathology are gone into most fully, and only the most salient points in the treatment are indicated; we, on the other hand, have endeavoured to give only the salient points in the symptoms and pathology, and have gone fully into the question of treatment. We venture to think that this is what the man in actual practice wants.

It will be noticed that no mention is made of Scoliosis in the section dealing with Deformities. We are of opinion that it will be better discussed in all its bearings in connection with the other affections of the Spine, and it will therefore appear in Part V.

Our best thanks are again due to Dr. J. Fredk. Silk for much help in seeing this volume through the press. For the majority of the illustrations of surgical instruments we are again indebted to Messrs. Down Brothers; for Fig. 15 we are indebted to Messrs. Krohne & Sesemann. Figs. 98 and 99 we owe to the kindness of Mr. C. A. Ballance, while to Messrs. Ferd. Enke & Co., of Stuttgart, are due our thanks for leave to copy or modify various illustrations (acknowledged in the text) from Prof. Hoffa's well-known *Lehrbuch der Orthopädischen Chirurgie*. Mr. Robert Jones has kindly given us permission to use Fig. 40, while Figs. 39 and 53 are, with the permission of Messrs. Longmans, taken from Erichsen's *Surgery*. With the above exceptions, the whole of the drawings in this volume have been made by Mr. T. P. Collings, from original sketches or actual preparations; to him our thanks are due for the care he has bestowed upon the work and the skill with which he has interpreted our ideas.

LONDON, 1899.

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## PART II.

# DIVISION I.—DEFORMITIES.

## CHAPTER I.

### DEFORMITIES AFFECTING THE FINGERS AND TOES.

VARIOUS deformities are met with in the fingers and toes, some of which are congenital and some acquired. Some are remediable by surgical treatment, others are not; we shall, of course, only consider those for which something can be done. Among the congenital deformities of the fingers and toes may be mentioned superfluous digits, and webbing or fusion of them. Another that is sometimes congenital and hereditary, but which is still oftener acquired, is hammer toe and the analogous condition in the little finger. Among the acquired deformities requiring mention are the various displacements of the great toe, such as hallux flexus, and more especially hallux valgus, bunion, Morton's disease or metatarsalgia, contraction of the fascia, especially of the palmar fascia (known as Dupuytren's contraction), and the deformities from cicatricial contractions after injuries, burns, etc.

#### SUPERFLUOUS DIGITS.

This is a congenital deformity which is not at all uncommon. The supernumerary digits may vary considerably in number; in some cases ten in all have been met with. The condition is usually more or less symmetrical and very frequently also it affects both hands and feet. In the foot it is commonest to find a supernumerary toe on the outer side, forming an accessory little toe. In the hand the most usual deformity is an accessory little finger, but the presence of an additional thumb is not at all infrequent. The degree of development of the supernumerary member varies very much; sometimes a complete digit is met with, that is to say, there are three distinct phalanges (or, in the case of the thumb, two) perfectly developed. It is very rarely that reduplication of a metacarpal bone also occurs, but if it does, the additional digit then articulates with the carpus or tarsus as the case may be. Generally the first phalanx of the supernumerary digit is attached to the side of the metacarpal bone, either with or without a proper articulation. In some cases there is no trace of a joint at all, the union between the surplus digit and the metacarpal bone being simply by means of fibrous tissue; in others there is a distinct well-formed joint on the lateral surface of the metacarpal bone, furnished with articular cartilage, ligaments, etc. In other cases again the condition is apparently that of bifid finger, and this is more especially the case in the thumb; the terminal phalanx may then be split and two phalanges may be present, each possessing a separate nail (see Fig. 1). Frequently, however, the division in the terminal phalanx does not extend completely through its whole length, but only affects the tip; the base of the phalanx is then single and undivided.

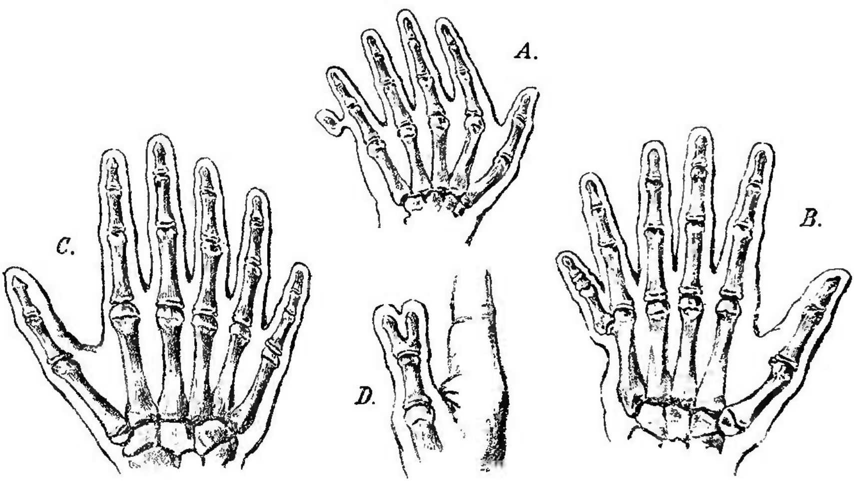



FIG. 1.—DIAGRAMS TO ILLUSTRATE THE DIFFERENT FORMS OF SUPERFLUOUS DIGITS. *A*, The simplest form, in which the connection between the digit and the rest of the hand is of skin and fibrous tissue only. *B*, The form in which there is a distinct articular surface on the lateral aspect of the metacarpal bone. *C*, The one in which there is a supernumerary metacarpal bone as well as the phalanges. *D*, One form of bifid terminal phalanx. Here the bone is only partially cleft, and it will be noticed that neither of its component parts is in a straight line with the first phalanx.

**TREATMENT.**—The removal of the surplus digit is of course the only remedy for this condition. In the case of the toes it is not usually a matter of any great consequence if the offending member be retained, but in the hand the additional finger is very unsightly and ought, if possible, to be taken away. The operation should be carried out in early life, as otherwise the ultimate result will not be nearly so satisfactory.

(*a*) *When the digit is quite separate* from its neighbour and is only connected with the side of the metacarpal bone by fibrous tissue (see Fig. 1, *A*) the result of amputation is quite perfect; it is only necessary to make an elliptical incision around the digit where it springs from the metacarpal bone, and then to remove it and the fibrous band connecting it with the bone. With a nicely planned incision and primary union, a perfectly level surface will be left, showing no trace of the additional finger.

(*b*) *When there is an actual articulation* between the digit and the metacarpal bone (see Fig. 1, *B*) it is not sufficient merely to remove the finger. If the articular surface be allowed to remain, a very marked swelling is left upon the side of the metacarpal bone, and the deformity tends to increase as time goes on from growth taking place beneath the articular surface; so that, by the time adult age is reached, a very unsightly projection is to be seen. Hence it is necessary to remove both the superfluous digit and the articular surface upon the metacarpal bone to which it is attached. Formerly, an operation of this kind was considered dangerous because of the risk of suppuration and osteomyelitis; nowadays, of course, this point need not be considered. The procedure to be adopted is quite simple. The flaps are so planned that there shall be no excess of tissue left when they are brought together; after the finger has been disarticulated and removed, the articular surface on the metacarpal is exposed, and enough bone is chiselled away to render the shaft of the bone uniform in thickness throughout.

(*c*) *When there is a supernumerary metacarpal bone articulating with the carpus* (see Fig. 1, *C*), the amputation must remove it as well as the finger; when that has been done, enough bone must be chipped off the side of the carpus by a chisel to make the outline of the hand resemble that of the opposite side. This, of course, involves opening the wrist joint, and therefore the most minute attention must be given to the antiseptic precautions; in fact, the operation is not one that ought to be undertaken unless the surgeon be quite certain of his ability to keep the wound aseptic. The results, however, from the point of view of the symmetry of the hand are very satisfactory, as, with a little care, it is easy to obliterate the unsightly projection at the side of the wrist and so to leave little or no trace of the deformity.

(*d*) *In the case of a bifid finger*, especially a bifid terminal phalanx of the thumb (see Fig. 1, *D*), the result of treatment is not nearly so satisfactory. Usually the two portions of the phalanx diverge from each other so that whichever be removed, the one remaining is out of line with the rest of the limb, and it is very difficult to bring it properly straight; that, however, must be the aim of the operation. In the first place, the phalanx which deviates most from the axis of the finger (usually the smaller of the two) should be amputated by an elliptical incision over the corresponding side of the digit. When the phalanx is not completely bifid it should be split down to its base with bone forceps and the desired half removed. After this has been done, the lateral ligaments on the opposite side of the joint will usually require division, so that the part of the phalanx left may be brought into line with the rest of the finger; any other structures that are tense and resist reposition must also be divided. Suitable dressings and splints should then be applied to keep the phalanx in its proper position, and the retentive apparatus must be worn for a considerable time; usually three or four months must elapse before it can be left off.

Immediately after the operation a narrow wooden splint may be applied along the side of the finger opposite to that on which the deflection is, and the phalanx drawn outwards towards it, but as soon as the wound has healed it is best to fix the digit and the wrist in a silicate bandage, which, while very efficient, is smaller and interferes less with the movement of the rest of the hand than the wooden splint does. This casing may be split along one side and should be removed from time to time and massage

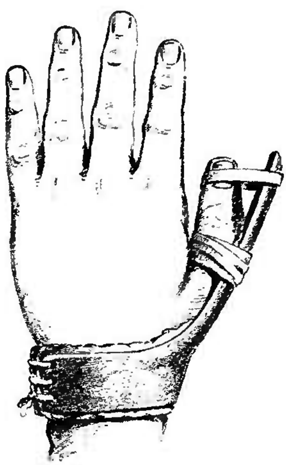


FIG. 2.—SPLINT FOR AFTER-TREATMENT OF BIFIO FINGER. This is applied after the redundant portion of the phalanx has been removed, and is employed to bring the tip of the finger straight. The splint, which takes its purchase from the wrist, is made of metal padded, and the finger prolongation can be bent out to any required degree, so as to get a good pull upon the tip of the finger after the first phalanx bas been firmly secured; the method of applying it is shown in the figure. Additional traction on the tip of the finger can be got, if required, by inserting a thick pad between tbe first phalanx and tbe splint.

and passive movement practised. This should be done at first about once a week, and oftener later, until finally it is done every day; the joint may otherwise become very stiff. About six weeks after the operation the silicate case may be left off entirely, and a suitable moulded metal splint, nicely padded, adapted to the wrist and forearm, and prolonged down to one side of the digit; to this the terminal phalanx is strapped so as to keep it in proper position (see Fig. 2).

## WEBBED DIGITS.

This condition affects both toes and fingers, but in the former case it does not usually cause any inconvenience, and no treatment is necessary. The presence of a web between the fingers, however, is a great disadvantage; it is unsightly, it prevents the proper separation of the digits, and it thus interferes greatly with the usefulness of the hand; moreover, fingers so united do not develop nearly so well as those which are free. In almost all cases, therefore, it is necessary to take steps to get rid of the deformity.

The cases of webbed finger vary considerably, both as to the extent of the web in the downward direction, and the closeness with which the fingers are bound together. In some cases (Fig. 3, *A*) there is merely a slight extension downwards of the natural web between the fingers, which may only reach as low as the first inter-phalangeal joint. This web is usually quite loose and does not really inconvenience the patient, whose chief reason for seeking surgical advice is rather to have an unsightly deformity removed than to have the usefulness of the hand increased. In others, again, the web extends right down to the terminal phalanges and these cases may be divided into three groups: (1) those in which the web is quite broad and allows considerable play to the fingers (Fig. 3, *B*); (2) those in which the fingers are closely bound together by a very narrow web, but without any actual fusion of adjacent bones (Fig. 3, *C*); and (3) those in which the bones of the adjacent fingers are more or less completely welded together (Fig. 3, *D*).

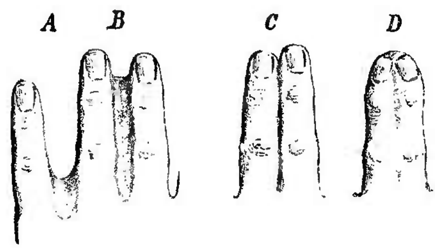
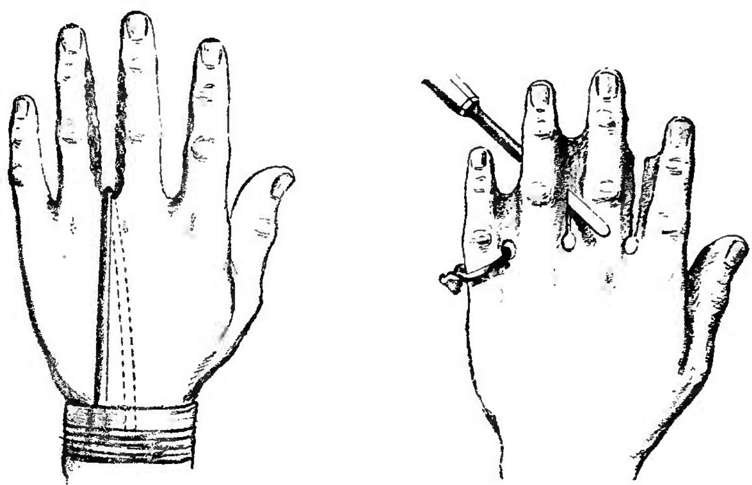



FIG. 3.—DIAGRAMS TO ILLUSTRATE THE VARIOUS DEGREES OF WEBBED FINGERS. *A* and *B* show the two forms of the broad and extensile web; in *A* it is merely a slight prolongation downwards of the normal web, while in *B* it reaches almost to the finger-tips. *C* shows a common form of the affection; the fingers are bound together throughout their whole length so closely that there is practically no proper web between them. In *D* is shown the most exaggerated type of the deformity; here tbe bones of the adjacent fingers are actually fused together.

**TREATMENT.**—(1). **Where the web is broad.**—A great many operations have been introduced for the separation of webbed fingers, but it must be confessed that none of them are completely satisfactory for cases other than those in which the web is broad and quite extensile. The chief difficulties in the operative treatment are, on the one hand, the constant tendency to the re-formation of the web after division, and, on the other, the tendency to contraction of the finger or fingers (especially in the direction of flexion) after they have been separated. If, for example, the web be simply divided down the centre it will be found that, as the wound heals, the web re-forms, and no sort of mechanical arrangement seems to be able to prevent this.

Various methods have been employed for the purpose of preventing this re-formation of the web. Thus by some an elastic tube or band is stretched across the cleft between the fingers after the web has been divided, and attached to a band around the wrist, in the hope that the continuous pressure of the elastic will prevent reunion at the roots of the fingers (see Fig. 4, *A*). These attempts, however, always fail; the power of contraction of the granulations is so great that any elastic pressure that the patient can tolerate is powerless to prevent it. It is quite clear that if re-formation of the web is to be prevented, rapid healing of the wound must be obtained at the cleft between the fingers. The re-formation of the web is then less likely to occur. Two methods are employed with this end in view: in the one a perforation is made at the cleft of the fingers through the base of the web, and this is allowed to cicatrise completely before the latter is divided; in the other a flap is turned into the cleft so as to get immediate union there.



*A* *B*

FIG. 4.—OPERATIONS FOR WEBBED FINGERS BY SPLITTING THE WEB.

*A*. THE EMPLOYMENT OF THE ELASTIC BAND AFTER SIMPLE SPLITTING. After the web has been split from its free edge to its base, a piece of india-rubber (*e.g.* a drainage tube) is fastened by one end to a bandage round the wrist, put on the stretch and then carried across the cleft, and its other end fastened to the wrist bandage on the opposite side. The dotted line in the figure indicates the elastic band in front of the palm.

*B*. THE EAR-RING PERFORATION. The figure shows the three stages of the operation. On the left is the ring of stout silver wire *in situ*; in the centre is shown the method of splitting the web by a tenotome introduced through the perforation which has been allowed to cicatrize previously, whilst on the right the splitting is complete and the redundant edges of the split web are ready to be trimmed off.

(*a*) **The ear-ring perforation.**—In the perforation method the plan adopted is practically identical with that employed in perforating the ear for ear-rings (see Fig. 4, *B*). A hole is made through the base of the web and a piece of stout silver wire is inserted through it, bent loosely round one of the fingers into a ring, and kept in position until cicatrization is complete. This requires some two or three weeks, at the end of which time a knife is introduced into the hole and the web split down to the free edge. Should the flaps left by splitting the web be at all redundant, the requisite amount may be removed on each side and the cutaneous edges united by suture, so as to get union by first intention throughout.

Even then, however, a considerable amount of contraction may still take place.

(*b*) **The V-shaped flap.**—A more satisfactory method is to turn a flap into the cleft after the web has been divided. The best way of doing this is to make a triangular flap with its apex downwards upon the dorsal surface of the base of the web (see Fig. 5). A triangular flap, the apex of which is in the centre of the web sufficiently low down to enable the flap when cut to fold into the cleft and be readily stitched to the skin of the palm, is marked out by carrying an incision upwards on each side from this point to one a little to the side of the corresponding phalanx and opposite the base of the web. This flap, consisting of skin and fat, is turned upwards, and then the web is split down the centre. The flap is now folded downwards between the fingers, its apex is stitched

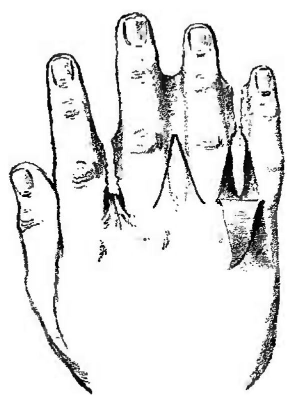


Fig. 5.—The V-Shaped Operation for Webbed Fingers.—The three stages of the operation are here depicted. In the centre is shown the flap marked out upon the web; on the right, the flap has been dissected up, and the web split to its free margin; while on the left is shown the flap sutured in position in the cleft between the fingers, the redundant portion of the web only requiring removal before tbe operation is complete.

to the palmar edge of the cleft, and its sides to the adjacent skin edges. The result is that immediate union takes place and no contraction occurs. The raw surface on each finger left by splitting the web is then trimmed so that all redundant tissue is removed, and the edges stitched accurately together so as to obtain union by first intention. It will usually be found that the granular fat projects between the edges of the skin, and prevents their accurate apposition; where this is the case, it is well, before putting in the stitches, to press the skin edges together and clip away all the projecting fat. This operation may be employed not only for a web that is partial, but also for one that is complete, provided always that it is sufficiently broad to leave plenty of room between the fingers; in these cases it is the best procedure that can be adopted.

(2) **Where the web is narrow.**—This is a much more difficult condition to deal with successfully. Under these circumstances the operation

just described is unsuitable, for if it were done the result would be that, while healing would be obtained at the cleft (for it is usually easy to get enough skin to form the flap to fill the cleft), a large, raw surface would be left along the side of each finger, which, if allowed to heal by granulation, would contract and lead to lateral bending and flexion of the fingers; the patient would finally have the fingers flexed and bent to one side, with a strong rigid scar running along the front of the finger on that side. This contraction may, to some extent, be prevented by immediate skin-grafting, a single long skin-graft being applied to the raw surface on each side, with a piece of protective over it, and the fingers being bound together and left undisturbed for ten days. The results of skin-grafting in these cases are, however, as a rule, very far from satisfactory, as some contraction

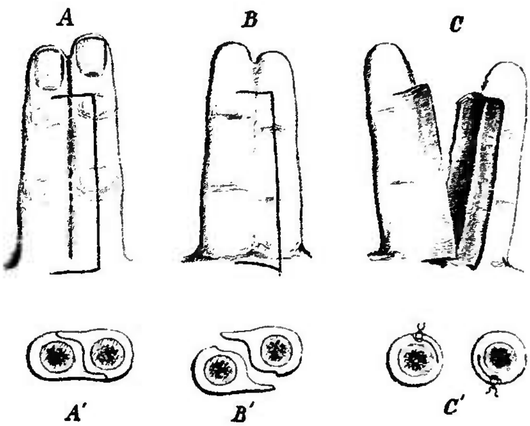



FIG. 6.—DIDOT'S OPERATION FOR WEBBED FINGERS. *A* and *B* show the lines of incision on the dorsal and palmar surfaces of the fingers respectively. In *C* the flaps are raised and the union between the fingers divided; *A'* and *B'* show the method of effecting the separation between the webbed fingers, while *C'* illustrates a section of the two fingers as they should be when the flaps are wound round them and sutured in place.

occurs in spite of it. Simple splitting and skin-grafting is therefore not a method to be recommended.

(*c*) **Didot's operation.**—The operation most commonly adopted for this particular form of the affection is that known as Didot's, and is illustrated in the accompanying figure (Fig. 6). It is performed as follows: two incisions are made, one along the middle line of the dorsum of one finger, and another along the middle line of the palmar surface of the other, from a point opposite the free end of the web down to the knuckle. At each end of these two vertical incisions a transverse one is carried across to the adjacent border of the other finger, and thus two flaps are marked out; these are carefully dissected up, and, when the interval between the bones is reached, the soft structures are split into two halves, one half forming part of the posterior flap, and the other, part of the anterior. When the flaps are turned aside, the separation between the fingers is of course complete, and there is then a flap attached to each of the separated fingers, formed partly by the skin of the front or back of the corresponding fingers respectively, and partly by half the thickness of the web between them; the base of these flaps is on the palmar surface of one finger, and on the dorsal of the other. The flaps are then wrapped round the side of the finger and stitched in place, the one along the back, the other along the front. It is but seldom, however, that the flaps can be made of sufficient length to actually meet the line of incision in front or behind, and generally an interval, sometimes even a considerable one, is left between the edge of the flap and the edge of the skin to which theoretically it should be stitched. In these intervals the fat protrudes, and ultimately a narrow line of granulation tissue forms; this contracts, and may give rise to considerable deformity. In order to obtain as rapid healing of the raw surface as possible, skin-grafts, cut by Thiersch's method (see Part I., p. 50), should be laid on it at the time of the operation, but in this operation, as in the one referred to in the last paragraph, the grafts do not prevent the occurrence of a certain, and in some cases a considerable, amount of contraction. The final outcome of the operation is generally that in one finger the result is perfect, while in the other it is not so good. The one that has the palmar flap is usually quite satisfactory, as the narrow scar which forms along the dorsum of the finger does not interfere with movement; the patient can always flex the finger, and thus any undue contraction is prevented. On the other hand, the finger which has the dorsal flap, and in which the line of the cicatrix lies along the palmar surface, generally becomes contracted, the narrow scar causing flexion of the finger, and consequently an imperfect result. This tendency of the finger which has the dorsal flap to become contracted must be carefully borne in mind, and in order to remedy it as far as possible, skin-grafting should be employed over any portion that is left raw, and besides this, a splint must be worn for a long time, so as to keep the finger extended and prevent contraction. The best splint (see Fig. 7) is one applied to the dorsal surface, taking purchase from the lower part of the forearm and back of tbe hand; opposite the knuckles there is a single prolongation extending downwards along the back of the finger, and to this the latter is strapped. This splint should be worn day and night, being only left off at intervals to permit of passive movement; at the end of a couple of months it may be left off during the day, but it should be worn at night for at least six months, and generally for about a year. In spite of the splint there is a strong tendency to the formation of a cicatricial ridge along the palmar surface of one finger and consequent contraction.

When several fingers are united it is well to separate only two fingers at a time, and to allow some weeks, or even months, to elapse before proceeding to separate a second pair. There is a distinct advantage in doing the operation at as early an age as possible, because the webbing of the fingers undoubtedly seems to interfere with their growth; a finger which has been freed grows much faster than one that is still webbed. At the same time, the hand in infants is so small and so difficult to fix that it will generally be found best to wait until the child is a year or two old, and the fingers have attained a length and size more suited for the application of splints.

(3) **Where the bones are united together.**—The cases in which the neighbouring phalanges are more or less completely welded together by bony union are very much more difficult to deal with, and in many

FIG. 7.—SPLINT FOR USE AFTER DIDOT'S OPERATION FOR WEBBED FINGERS. This is only shown applied to one finger, as generally after Didot's operation the result in one finger is so good that a splint is not required for it, and is only called for in the one where the result is not so satisfactory; it can however be made with two finger prolongations if desired. The splint is made of well padded metal, and the dorsal finger part can if necessary be bent backwards to any extent that may be thought desirable, in order to counteract any tendency to flexion.

instances it is doubtful whether it is advisable to interfere with them at all. Where the deformity is very marked, and the finger is not so useful as it might be were the deformity overcome, an attempt may be made to remedy it. The only proceeding which offers any prospect of success is, however, not to attempt to separate the fingers, for then there would be no covering for the opposed surfaces, but to remove a portion of the welded bones so as to obtain one good finger instead of two bad ones. The skin covering the portion of the finger taken away will be sufficient to cover over the raw surface left, and a satisfactory result, not only in the way of less deformity but also of greater mobility, may be obtained. The precise steps to be adopted in operating must, however, depend on the condition present, and cannot be described here.

## HAMMER TOE.

By the term 'hammer toe' is understood a deformity of which the essential element is flexion of the first inter-phalangeal joint of the toe, accompanied, secondarily, by hyper-extension of the first phalanx on the metacarpal bone. The terminal phalanx usually retains its normal position, but in bad cases it may be in the same straight line with the second, so that the last two phalanges have their long axes directed vertically downwards, and the tip of the toe comes into contact with the ground. In acquired cases, on the other hand, this flexion of the terminal phalanx may not be present, the result being that the toe resembles the letter Z (see Fig. 8). This deformity usually affects the second toe, but it may affect others.

The condition is a very troublesome one on account of the development of corns upon the points exposed to pressure. There is generally a large and tender corn over the first inter-phalangeal joint where it rubs

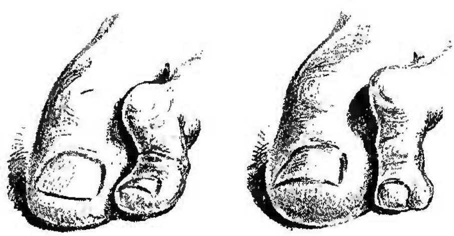


FIG. 8.—HAMMER TOE. The figure illustrates the two varieties of the affection. On the left-hand side is the Z-shaped deformity, in which there is, besides hyper-extension at the metatarso-phalangeal joint, flexion at the first and hyper-extension at the second interphalangeal articulation. In the other figure the deformity is similar, except that the terminal phalanx, instead of being hyper-extended upon the second, is in the same straight line with it.

against the boot, and also on the free end of the toe, especially when the terminal phalanx looks straight downwards; the corn is then very often situated just behind the free edge of the nail, which is somewhat recurved, and causes intense pain when the patient walks. Corns also form on the inner aspect of the toe at the point where the great toe comes into contact with it. Another trouble in the cases in which the terminal phalanx is directed vertically downwards and the patient walks upon the tip of it, is that, unless the nail be kept very closely cut, there is a tendency for it to be separated from the matrix in walking, and great pain is thus occasioned.

Hammer toe may be congenital and is often hereditary; in the latter case it is not usually marked until the patient begins to walk. In most cases it is acquired, and the chief cause is the presence of the condition known as hallux valgus; the great toe is abducted, over-rides the second toe, and causes flexion of the second phalanx of the latter and the typical deformity just mentioned.

**PATHOLOGICAL CHANGES.**—The ligaments of the first inter-phalangeal joint, in particular the lateral ligaments and the anterior or glenoid ligament, are very markedly shortened when the deformity is once established. This is accompanied by secondary contraction of the flexors of the toes (which, however, does not occur until a late period), and by alterations in the articular surfaces. In bad cases the second phalanx is actually drawn up under the first, leaving the articular surface of the latter entirely uncovered. Hence, if attempts are made to forcibly straighten the joint, even after tenotomy of the flexor tendons, the result is simply a dislocation of the second phalanx beneath the first (see Fig. 9). The articular surface of the first phalanx becomes rapidly denuded of cartilage and covered with fibrous tissue, so that an imperfect joint must result, even if the joint surfaces are restored to their relative position.

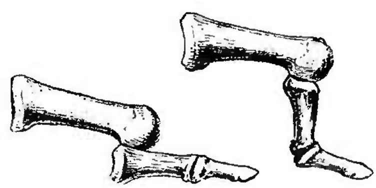


FIG. 9.—DIAGRAM TO SHOW HOW FORCIBLE STRAIGHTENING OF A HAMMER TOE MAY RESULT IN DISLOCATION. The lateral ligaments, which are not shown in the figure, are attached on each bone at a point somewhat below the centre of the lateral aspect. Any attempt at forcible straightening with the ligaments intact must therefore result in the dislocation of the base of the second phalanx beneath the head of the first, as shown in the left-hand figure.

**TREATMENT.**—The treatment of this deformity is somewhat troublesome; it may be carried out in three ways: (1) by means of mechanical appliances designed to prevent the flexion of the second phalanx; this in acquired cases should be combined with treatment directed to the cure of the co-existing hallux valgus and also with tenotomy of the contracted ligaments or other structures around the joint; (2) by removal of the head of the first phalanx, so as to allow the joints to be easily brought straight; and (3) by amputation.

(1) **Appliances.**—Before employing mechanical appliances it is best, particularly in the more advanced cases, to commence by dividing the lateral and anterior ligaments of the first inter-phalangeal joint and (in the rarer cases calling for it) the flexor tendon; a tenotome with a very small cutting blade should be used for the purpose. The line of the joint is carefully defined by the finger nail, and the point of the knife made to penetrate the skin at right angles to the long axis of the toe, at the junction of its dorsal with the lateral aspects, and pushed directly down into the joint, the lateral ligament to be divided being rendered tense by lateral pressure on the point of the toe. Very slight movement of the knife generally divides the ligament immediately, when the process is repeated on the opposite side. The toe is then forcibly straightened and

is secured to an apparatus designed to prevent a recurrence of the flexion. A convenient form is a T-shaped splint (see Fig. 10), the horizontal limb passing transversely beneath the sole of the foot, at about the level of the tarso-metatarsal articulations, and being secured there by means of a strap or band, while the vertical part passes underneath the toe and extends as far as its tip; the splint should be well padded, and the toe strapped down to it.

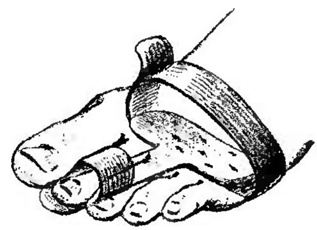


FIG. 10.—T-SHAPED SPLINT FOR HAMMER TOE. A greater amount of pressure over the first interphalangeal joint may be obtained if necessary by inserting a pad of lint or wool between the tip of the toe and the splint.

*This procedure is only of use in the milder forms*; in the more severe ones, particularly those that are congenital in origin, the toe will not come straight, even after division of the ligaments and tendons, for the skin and all the other structures are permanently shortened, and the result of attempts to straighten the joint is simply to dislocate the base of the second phalanx below the head of the first. In severe cases also the articular surfaces are so much altered that, even if they were brought properly into contact, an imperfect result would be obtained. In the slighter cases, however, especially in the earlier stages of the acquired forms, tenotomy of the lateral ligaments and extension may suffice to bring the ends of the bones into good position. The treatment for the co-existing hallux valgus (see p. 16) should never be neglected, as it is most important to prevent the pressure of the first toe on the second. No permanent good is likely to accrue where the hammer toe is straightened and the hallux valgus left untreated. When there is a tendency to flexion in all the toes, a special splint with bands passing over the dorsal surface of each toe will be required (see Fig. 11). Later on, when the tendency to flexion has been greatly reduced, a simple and efficient splint may be made by attaching a stout glove-finger of suitable size to a piece of whalebone or flexible steel, covered with chamois leather; this lies on the dorsum of the foot beneath the stocking, and is fastened by a broad tape round the instep. The toe goes into the glove-finger (see Fig. 12).

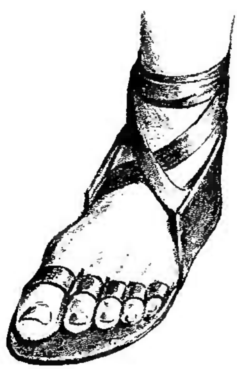


FIG. 11.—SPLINT FOR ALL THE TOES. This is used when there is contraction of several toes.

Some form of splint must be worn for a long time, in fact, it can probably never be entirely dispensed with, and the question arises whether it is really worth the patient's while to submit to such a method of treatment. Without long-continued splinting, treatment by tenotomy and extension is very unsatisfactory; in severe cases, even with the splint, the results are very poor. We are, therefore, of the opinion that it is best, except in the very slightest cases, to substitute for tenotomy an operation which

FIG. 12.—SPLINT FOR USE IN AFTER-TREATMENT OF HAMMER TOE. This is one that can be easily improvised, and is suitable for use where it is merely desired to prevent the recurrence of flexion. It is made of whalebone or light flexible steel, which can be bent to fit the outline of the foot. If preferred, it can be made to lie along the sole of the foot.

obviates all necessity for the subsequent employment of a splint, and which, while it does not lay the patient up for any length of time, gives an extremely satisfactory result.

(2) **Excision of the head of the first phalanx.**—The operative procedures which may be adopted are removal of the head of the first phalanx, excision of the joint or amputation; the latter method is not at all to be recommended. To remove the toe, in acquired cases, is simply to favour the increase of the hallux valgus. With the possible exception of working men, who wish to get to work as quickly as possible, and who therefore insist on amputation, we strongly advise the removal of the head of the first phalanx in all but the very slightest cases. If enough bone be removed, the toe can be straightened without the least tension, and there is no necessity to divide any ligaments or tendons. After a few weeks the patient has a movable joint which has little tendency to become flexed again; the result is much better than that of excision.

The operation is done as follows. An incision is made along the dorsum of the first phalanx parallel to and a little to one side of the extensor tendon; it should extend from an inch above the line of the first inter-phalangeal joint and run well beyond it, and should be carried directly down to the bone. The soft structures are then separated from the end of the first phalanx by a periosteum detacher and a few strokes of the knife, the head of the bone is made to project into the wound and is nipped off by cutting pliers. The bone is generally divided about a quarter of an inch above the articular surface, but enough must be removed to allow the tip of the toe to be brought straight without any tension. After the bleeding has been arrested, the corn over the first inter-phalangeal joint is pared away, the wound united by one or two fine sutures and a cyanide dressing applied. The plantar splint already referred to (see p. 13) is then put on, and in applying it care should be taken to have an extra amount of padding beneath the tip of the toc; this ensures the latter being kept straight when the bandage is applied. As soon as the wound has healed, the toe and the front part of the foot should be put up in a silicate bandage, and the patient may be then allowed to walk about. After from six to eight weeks, the bandage can be dispensed with and the patient may be regarded as well.

**After-treatment.**—Special attention must be paid to the socks and to the fit of the boots; the latter should not be too short, as otherwise the end of the toe will be pressed upon and flexion will recur. The socks should be furnished with a separate compartment for the great toe. When hallux valgus is present and was originally the exciting cause of the deformity, the measures detailed below for the treatment of that condition must be adopted simultaneously.

## HALLUX VALGUS AND BUNION.

By the term Hallux Valgus is understood a condition in which there is abduction of the great toe to a more or less marked extent. As a consequence of this abduction, the inner side of the head of the first metatarsal bone becomes more or less uncovered and, consequently, is directly subjected to pressure against the boot; inflammation therefore takes place in the exposed bone and the periosteum over it, and this leads to considerable thickening of these structures. There is subsequently developed in the subcutaneous tissues over the enlarged bone a bursa which is subject to repeated attacks of inflammation. This condition is commonly designated by the term bunion; by an inflamed bunion is meant one in which the bursa over the enlarged bone has become inflamed. The inflammatory attacks in the bursa may pass off, leaving additional thickening of the surrounding structures, or they may go on to suppuration, which may be followed by extensive cellulitis of the foot, perforation of the metatarso-phalangeal joint of the great toe, septic arthritis, necrosis, etc.

The great toe may be deflected outwards so as to lie under or over the second; in the latter case (which is the usual one) the toe is also rotated so that its upper surface looks somewhat inwards, and its inner border is directed towards the sole. Thus, there is here a compound deformity, namely, abduction of the toe combined with rotation, and it is very important to bear this in mind when attempting to remedy the condition.

The affection is essentially produced by the use of ill-fitting boots, those in which the toe of the boot comes to a sharp point opposite the middle of the foot, being the chief offenders. Bootmakers are apt to forget that a boot pointed in this way can only be worn by crowding the toes together, and that if the boot must be brought to a point, the latter should be towards the inner side of the foot so as not to deflect the great toe from the straight line of the inner border of the foot (see Fig. 13).

Bunion is especially marked in those who suffer from gout or rheumatoid arthritis; indeed it is probable that one of these conditions is necessary for the full development of the trouble.

Cases of hallux valgus may come under observation: (1) at an early stage, when the divergence of the toe and the enlargement of the end of the bone are comparatively slight; (2) when the condition is well developed, with considerable enlargement of the bone, and the formation of a bursa over it; and (3) when the bursa has suppurated and a sinus is left.

**TREATMENT.**—(1) **In the early stage** a good deal may be done to render the patient comfortable and to prevent further development of the

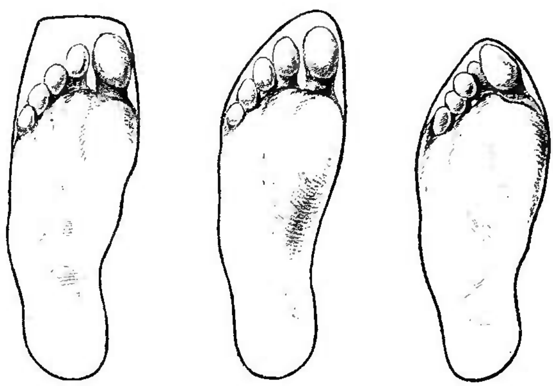



FIG. 13.—BUNION. DIAGRAM ILLUSTRATING THE PRINCIPLES TO BE OBSERVED IN MAKING BOOTS. *C* shows the deflection of the great toe and the cramped position of the others entailed by wearing the ordinary pointed-toed boots; it will be seen that the point of the boot lies along the middle line of the sole. *B* shows the outline of the sole of a boot constructed on sound anatomical principles. The inner border of the front part of the sole is nearly parallel to the long axis of the foot, the boot comes to a point opposite the great toe, and is sloped away from that point to the outer border in accordance with the length of the other toes, which are thus not cramped at all. *A*, a very usual form of so-called anatomical boot which, while it is free from the most flagrant faults of the usual pointed-toed variety, is not so good as *B*. The inner border of the sole is not quite straight, and so tends to deflect the great toe somewhat, while the squareness of the end of the boot both leaves a lot of unnecessary space between it and the toes and detracts considerably from the appearance of the foot. (After *Meyer*.)

deformity by the use of properly constructed *boots* combined with some mechanical arrangement designed to counteract the abduction of the great toe. The boots must not be too narrow, and the inner border of the sole, as far as the extremity of the great toe, must be almost straight. Care must be taken to see that they are long enough; short boots, as has already been mentioned, are an important factor in the production of the deformity. The most suitable boots, on the whole, are those which go by the name of anatomical boots (see Fig. 13); in them the inner border is straight, and passes well beyond the tip of the great toe, and the outer border is rounded to correspond to the curve of the other toes. The boots cannot be said to be very comely to look at, but nevertheless they must be worn in these cases.

In addition to the use of suitable boots, means must be employed to press the toe inwards, and thus to overcome the abduction. In quite early cases a pad of lint between the first and second toes may be employed, but it is apt to press injuriously on the other toes, and does not always attain the desired end. A better plan is to have the sock made with a separate compartment for the great toe (the so-called "*digitated socks*"), to see that a suitable boot is worn, and to have the toe frequently manipulated so as to bring it into a straight line with the inner border of the foot. In most cases, however, it is advisable to employ some form of apparatus, for a time at least, so as to keep the toe in its proper position; of these various forms have been introduced at different times. In addition to the sock furnished with a separate compartment for the great toe, a very common plan is to make use of what is known as a "*toe-post.*" This is made by fastening to the sole of the boot a vertical piece of stout

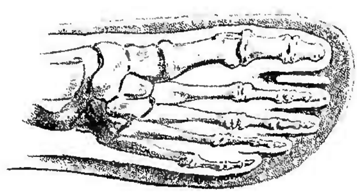


FIG. 14.—DIAGRAM TO ILLUSTRATE THE EMPLOYMENT OF A "TOE-POST." The "toe-post" is seen in the cleft between the great toe and the second. It is made of stout leather or wood, and is fixed to the sole of the boot, which should be of the shape shown in the figure. The great toe is thus confined in a compartment from which it cannot escape, and no lateral deflection is permitted.

leather, or other suitable material, in a position corresponding to the interval between the great and the second toe when the former has been pulled into position (Fig. 14). The great toe is first of all brought straight by introducing between it and the second a small pad formed of a strip of flannel rolled up. The foot is then introduced into the boot, and the great toe slips into its proper position. The pad between the two toes can be easily removed by pulling upon a string fastened to the end of the flannel bandage, which uncoils and is withdrawn. The use of a toe-post of course necessitates the employment of a digitated sock. The plan answers eminently well for the slighter cases, but where the deflection is very great and the trouble is of long standing, considerable friction is caused by the outward pressure of the toe against the post, and pain and sometimes ulceration is caused, so that the patient is unable to continue it. Under these circumstances a special form of *splint* must be employed. A great variety of these have been introduced; one that is fairly satisfactory is here figured (see Fig. 15); it is applicable to cases which are not very far advanced, and in which there is no marked rigidity. It consists of a metal spring running along the inner border of the foot and curving outwards beneath the ball of the great toe. The spring runs nearly to the tip of the great toe, and to its extremity a band is attached which passes around the point of the toe, the other extremity of the apparatus being fastened by means of an elastic band to the ankle. Opposite the arch of the instep the spring articulates, by means of a movable joint, with a small vertical plate, which takes purchase from the instep and acts as a fulcrum. An elastic band runs from the posterior end of the splint around the outer side of the foot, over the ankle, and is brought down and fastened to a hook on the vertical piece or fulcrum on the inner side. The result

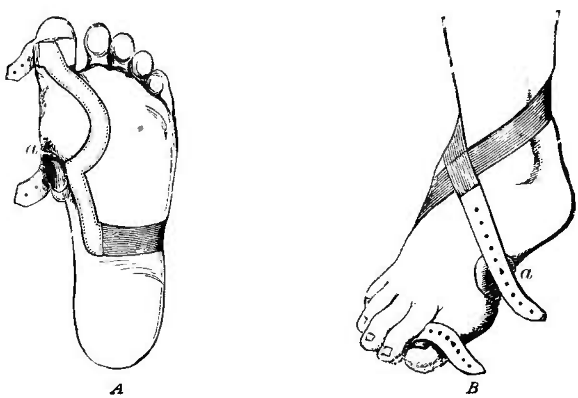



FIG. 15.—BUNION SPRING. The spring is applied to the foot as shown in *A* and the great toe secured to it. The fulcrum of the lever *a* rests immediately behind the enlarged head of the metatarsal. The band at the posterior end of the spring is then carried outwards across the sole at right angles, across the front of the instep, round behind the ankle and downwards again across the front of the instep to the inner border of the foot, where it is attached to the fulcrum *a*; this is shown in *B*. Sufficient traction must be exerted on the band to pull the toe into position; if this cause pain, as much traction must be employed as can be borne with comfort, and this can be gradually increased. The boots in which these springs are worn should have specially stout soles so as to avoid all risk of breakage. (*Krohne* and *Sesemann*.)

of this is of course to draw the posterior end of the splint outwards towards the heel. The front portion, and with it the great toe, is carried inwards, and the faulty position thereby rectified. The apparatus is made light enough to go inside a boot of fair size, and most patients can wear it without any marked inconvenience. A very important point in connection with the wearing of apparatus for the correction of this deformity is that, whatever be the form employed, it must be worn by night as well as by day, for if its use be discontinued at night, the toe tends to assume the faulty position again, and the process of cure is greatly retarded. In these milder cases, should there be any tenderness of the joint or inflammation of the bursa over it, the application of lead or lead and opium lotion, with the foot in the elevated position, will usually suffice to reduce it very rapidly.

(2) **Where the deformity is more severe,** and the patient suffers considerable pain, it is best to proceed at once to operative measures, for

instruments are not likely to do much good when the affection has reached an advanced stage; they merely act as an additional impediment to locomotion, while the permanent enlargement of the bone, which is the chief cause of the trouble, cannot be diminished by anything short of operation. In addition to this also, the bursa over the joint will probably have undergone a series of attacks of inflammation and its walls will be permanently thickened, so that no palliative method is likely to give more than mere temporary relief.

Various *operative procedures* have been employed, of which we shall describe two. The one which we prefer was described in the *Illustrated Medical Journal*, Vol. III., 1889, page 271, and is performed as follows. After a very thorough disinfection of the part, an incision is made along the inner border of the dorsum of the toe, extending from just beyond the articular surface of the head of the metatarsal bone backwards to a point half an inch behind that at which the enlargement of the bone ceases.

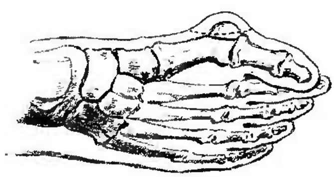


FIG. 16.—BUNION. RESECTION OF THE ENLARGED PORTION OF THE HEAD OF THE FIRST METATARSAL. The operation is fully described in the text. The dotted line shows the skin incision, the continuous one that of the bone section. The great toe in the rectified position is represented in Fig. 14.

The incision should be curved towards the sole at each end, but it should not be carried too far on to the plantar surface for fear of subsequent pain in the scar (see Fig. 16). The incision is carried down to the bone both at its anterior and posterior extremities, and a flap is then turned downwards so as to expose the whole of the enlarged end of the bone. While turning down the flap it is as well to take the opportunity to dissect out the bursa; the periosteum should not be taken up with the flap. After the whole of the enlargement has been completely exposed, the thickened portion is removed by means of a chisel and hammer, the bone being divided from behind forwards, the line of the incision corresponding to that of the shaft of the metatarsal bone. The whole of the enlarged inner surface of the head of the metatarsal is removed, and with it a small portion of the articular surface is generally taken away. The operation upon the bone is completed by rounding off the upper and lower margins of the cut surface with a chisel so as to avoid sharp edges which might exert injurious pressure subsequently; the surface of the bone should be left absolutely smooth and without any sharp edge at all. This is a point of particular importance, as failure to properly observe it may lead not only to considerable pain afterwards, but also to a recurrence of the trouble. The internal lateral ligament is of course necessarily detached from its insertion into the metatarsal bone. After the removal of the bone it is well to introduce a tenotomy knife into the joint and to divide the external lateral ligament so as to properly remedy the abduction. In very bad cases also, where the deflection is extreme, it may sometimes be necessary to divide some of the tendons (more particularly the long extensor), but in the majority of cases this is not called for.

After division of the ligaments the toe is forcibly brought inwards, and the deformity is somewhat over-corrected, that is to say, the great toe is brought into a position of slight adduction. In doing this it may be necessary to divide, by means of a tenotomy knife, any structures which are tight enough to resist the adduction of the toe. Care must be taken to see that the rotation of the phalanges upon the metatarsal bone, to which reference has already been made (see p. 15), is also carefully corrected; in order to do this it is generally necessary to divide the outer part of the dorsal ligament. When the toe has been brought straight, an attempt should be made to shorten the internal lateral ligament so that it may form an obstacle to recurrence of the deformity. It is not very easy to do this accurately; the best plan is to pass two or three catgut stitches through the remains of the ligament, and fasten it back to the periosteum behind the point of section of the bone. The wound should then be stitched up without the use of a drainage tube, the usual cyanide dressings put on, and an internal wooden splint applied extending along the inner border of the foot from the heel to beyond the toe.

The *splint* should be especially thickly padded immediately behind the area of operation. When the posterior part of the splint has been fastened to the heel and the instep, a considerable deflection inwards of the toe can be obtained by drawing it to the extremity of the splint by a separate bandage. The deformity will then be over-corrected, the toe being in a position of slight adduction and fully extended. After ten days the dressings are removed, the stitches taken out, and the toe carefully moved by the surgeon himself, who takes care to keep it in its proper position. Then, while the toe is held in a position of slight adduction and extension with the rotation corrected, a narrow boracic lint bandage is wound around it and carried up over the foot and instep, and bandages soaked in a solution of silicate of potash are applied outside this. After this it is well to re-apply the wooden splint already mentioned, and it should be kept on for two or three days, at the end of which time the *silicate bandage* will have firmly set. The wooden splint may then be taken off and the patient allowed to walk about with the foot in a gout-shoe.

The bandage should be kept on for six weeks, when it will be found that the toe retains its position fairly well. *Passive movements* should next be begun and carried out regularly for two or three weeks, so as to get rid of any adhesions that may have formed in the joint during the process of healing; these however very rarely give rise to any trouble. The patient should then wear a sock with a separate compartment for the great toe, and for two or three months it is well also to wear the spring apparatus just described for bunion (Fig. 15), so as to keep the member in its adducted position. Sometimes the result is so good that this is not called for, and the use of a boot with a toe-post is all that is necessary. Special attention will have to be paid to the boots, which must be constructed on the principles laid down on page 16. In about three or four months after the operation the patient is generally able to discard all apparatus, and if proper boots be worn there will be no fear of recurrence of the trouble. The results of the operation are extremely satisfactory, and it certainly merits a wider use than it apparently enjoys. It is important to remember with regard to it, however, that the joint is necessarily opened and that strict asepsis is therefore a matter of primary importance.

Another operation has been proposed, in which the special aim is not so much the removal of the enlarged bone as the correction of the eversion. This is done by a wedge-shaped osteotomy just behind the enlarged head of the first metatarsal, through an incision somewhat internal to the one above described (see Fig. 17). After the removal of the wedge of bone the toe is brought straight and secured in position by splints until union has occurred. This operation no doubt overcomes the abduction, and in that respect has a certain amount of advantage over that just described, but it leaves untouched both the bursa over the prominent head of the metatarsal bone and the enlargement in the bone itself, which are essential parts of the disease. In our opinion such a partial operation is seldom called for; in very bad cases, however, accompanied by almost complete anchylosis of the joint, it may be performed, as there might be considerable difficulty in bringing the toe straight after the division of the ligaments, as carried out in the operation first mentioned. Even in these cases, however, we should be inclined to recommend that, in the first place, the bursa and the enlargement of the bone should be removed as described above (see p. 19), and that subsequently, if the toe will not readily come straight, an osteotomy of the metatarsal bone should be performed just behind the head, so as to rectify the lateral displacement.

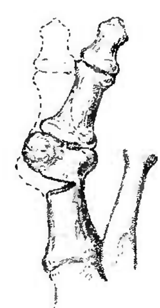


FIG. 17.—BUNION. CUNEIFORM OSTEOTOMY OF THE NECK OF THE FIRST METATARSAL. The dotted lines show the position of the toe after the operation is completed. It shows well one great defect of the operation, viz., that the projection on the inner aspect of the bone still remains exposed to pressure.

Excision of the great toe joint has also been employed for this affection and is strongly advocated by some; we cannot recommend it at all. Removal of the head of the first metatarsal very considerably impairs the walking power of the foot, and, in view of the satisfactory results obtained by the procedures already described, we are inclined to think that such an operation is entirely unnecessary.

(3) The surgeon is sometimes called upon to treat a **bunion in which suppuration has occurred.** These cases should be first of all treated upon the general principles applying to suppurative bursitis (see Chap. XIV.). The cavity should be laid freely open and drained, and dressings suitable to the degree and character of the inflammation, such as cyanide gauze or warm boracic fomentations, etc., should be applied. It is out of the question to adopt any of the operative procedures just described for the radical cure of the bunion, until the wound has been soundly healed for some weeks; its cure should then be undertaken upon the lines already laid down.

## HALLUX FLEXUS—HALLUX RIGIDUS.

In this condition the great toe is somewhat bent downwards towards the plantar surface, and any attempt to extend it gives rise to considerable pain. The result is that the patient cannot walk with the foot in the normal position owing to the necessity of avoiding movement of the toe; generally he walks upon the inner border of the foot, which is kept in the abducted position. The deformity is essentially associated with flat foot, and indeed in many cases it appears to be the direct result of it.

The condition of hallux rigidus is described as existing alone; undoubtedly cases are met with in which the great toe is painful and stiff but not flexed. The condition of flexion will however invariably develop later if the affection be left untreated. Hence we shall describe the treatment of the two affections under one head.

**TREATMENT.**—The treatment of this affection is mainly that of flat foot. The use of a *Whitman's spring* combined with the various *exercises* recommended in the treatment of flat foot (see p. 38) will often, especially in the earlier cases, cause the patient to lose his pain very rapidly; the stiffness of the joint then rapidly disappears, and locomotion is no longer painful. In the more severe cases, however, it may be necessary to combine with the treatment of the flat foot, *division of the lateral ligaments* of the joint and possibly also of the plantar fascia.

Moreover, in neglected cases of very long standing marked alterations take place in the joint and the ligaments, so that, although the flat foot may be remedied, no real improvement is effected in the toe, which remains stiff and painful. These cases therefore call for some more *radical operation* for their cure, and this may take the form either of removal of the base of the first phalanx or of the head of the metatarsal bone, the aim of the operation being to allow the joint to be brought straight by removing one of the articular surfaces which enter into it.

The operation usually done is removal of the head of the metatarsal; the great objection to it, however, is that this structure is one of the most important factors in proper progression, and its removal will therefore be likely to seriously interfere with the usefulness of the foot. A perfectly good result, as far as position is concerned, is obtained by removing the base of the first phalanx, and this is the procedure that we would recommend in those advanced cases in which one of the severer methods of operative treatment is called for.

The operation is readily done through an incision about an inch in length, parallel and a little internal to the inner border of the extensor tendon. The periosteum is detached from the first phalanx by a suitable rugine, and the base of the bone is then nipped off with a strong pair of cutting pliers. This at once allows the toe to be brought straight without any tension. The wound should be stitched up without a drainage tube, the usual antiseptic dressings applied, and the toe fixed by means of a plantar splint so padded that the toe is somewhat extended. When the wound has healed, the great toe and front part of the foot should be put up in a *silicate bandage*, and while this is being applied the arch of the foot should be restored as much as possible by bending the metatarsal bones downwards, so that while the parts are being kept at rest for proper consolidation to occur, the arch of the foot is also well supported. After about six weeks the apparatus may be left off, and the patient, provided with a Whitman's spring (see Fig. 23), is allowed to walk about. The results are usually very good; there is no pain on walking, and locomotion is perfectly satisfactory.

## METATARSALGIA, OR MORTON'S DISEASE.

This is an important condition, presenting many points of interest, and was first fully described by Morton, of Philadelphia, after whom the disease is named. It consists essentially of a painful affection of the foot, the seat of the pain being usually in the neighbourhood of the heads of the third and fourth metatarsal bones. The pain, which is of a neuralgic character, is referred to the plantar aspect; it may be so severe that the patient is entirely unable to walk, or to bear any pressure upon the sole at that point. Besides this, it is generally impossible for the patient to wear narrow shoes, and in some cases boots or shoes of any kind cannot be tolerated. It is generally noticed that as soon as the shoes are taken off and the foot elevated, the pain diminishes or ceases entirely.

A further characteristic of the disease is that callosities form upon the sole beneath the head of the fourth metatarsal; sometimes they also form beneath the head of the third, or even the second, and then, to avoid pain, the patient bears his weight upon the inner border of the foot, and avoids putting any pressure upon the outer side at all. These callosities, besides adding considerably to the pain, are liable to attacks of inflammation, which still further cripple the patient. If the foot be examined, it is found that, when the toes are flexed towards the sole and the metatarsal bones are looked at from the dorsal surface, the heads of those in the neighbourhood of which the pain is most marked are on a lower level than the rest. This is apparently due to some relaxation of the ligaments that bind the heads of the metatarsal bones together. The pain is supposed by Morton to be due to a lateral compression of the foot, so that the head of the fifth metatarsal compresses branches of the external plantar nerve against the head of the fourth. Although doubtless in some cases this explanation may be the correct one, in others the pain is probably to a great extent due to the increased pressure exerted upon the sole by the head of the bone which has become displaced downwards from its normal position.

The affection not infrequently follows upon injury, but cases undoubtedly occur in which there is no history of injury of any kind: these are generally the ones in which narrow boots are worn, and in which there is a lateral compression of the metatarsal bones. The condition is also often associated with flat foot, and sometimes, when the depression of the arch is corrected, the whole trouble disappears. It occurs more frequently in women than in men.

**TREATMENT.** This may be divided into palliative and operative, the majority of cases, except those of long standing, yielding as a rule to the former.

(1) **Palliative Treatment.** The first essential is that the patient should wear *properly fitting boots.* It is of the greatest importance that they should be sufficiently wide and should everywhere afford proper support to the foot. They should be made to a plaster cast of the foot, as it is otherwise very difficult to combine proper support with avoidance of undue pressure. In addition to properly fitting boots, a *Whitman's spring* (see p. 39) should be worn to support the arch of the instep, and the tiptoe *exercises*, which will be fully described in the treatment of flat foot (see p. 38), may with advantage be combined with this so as to strengthen the structures in the sole. *Massage* is of considerable value, while douching of the foot is also useful. If there be much pain an anodyne linament, such as belladonna, or the application of belladonna plasters to the sole of the foot, may be called for. If belladonna plasters are used, and there are callosities present, a hole should be cut in the plaster opposite the callosity, much in the same way as the central hole is made in a corn plaster. The majority of cases which in the early stage are treated in this manner will yield perfectly satisfactory results.

(2) **Operative Treatment.** In bad cases, however, more particularly those in which the affection has lasted for a considerable time, no great benefit results from any of these procedures, and it is necessary to have recourse to operative interference. The procedure which has yielded the best results up to the present time is *removal of the head of the metatarsal*

*bone* which is unduly depressed; in most cases this is the fourth, but sometimes it is necessary to remove the head of the third as well. The operation is a simple one, and is performed by making a longitudinal incision upon the dorsal aspect of the foot, over the head of the affected metatarsal bone, parallel to but rather on one side of the extensor tendon. The edges of the incision are held aside, the tendon hooked out of the way, and the soft parts are separated from the head of the bone by means of a suitable periosteum detacher. The neck of the metatarsal is then cut through by cutting pliers or a saw, and after division of the ligaments attaching it to the neighbouring bones, the head is removed. The patient will require to lie up for about three weeks after the operation, and it is essential that subsequently he shall wear properly constructed boots—boots, as has just been said, made to fit a plaster cast of the foot, so as to give it support in every direction. Should flat foot be present he must also be fitted with an artificial support to the instep.

## CONTRACTIONS OF THE FINGERS.

The majority of contractions that are met with in the fingers are acquired. A not very uncommon condition, which is congenital or hereditary, is one in which the little finger is flexed, and is in a position very similar to that assumed by a hammer toe. The finger is flexed at the first interphalangeal joint whilst the second and third phalanges are in the same straight line, or the terminal phalanx joint may be somewhat hyper-extended.

**TREATMENT.**—The conditions may or may not call for treatment, according to the degree of deformity present. In slight cases it passes practically unnoticed, and does not cause any inconvenience. When, however, the deformity is extreme, or when it is necessary to remedy it in order to enable the patient to carry out some particular form of manual labour, and especially when the right hand is affected, the treatment should be conducted practically on lines identical with that recommended for hammer toe (see p. 12). In the slighter cases *division of the anterior and lateral ligaments* may be performed, and the finger afterwards kept on a splint for a considerable time. The latter should at first be worn both night and day, and then, after the lapse of from four to six weeks, it may be left off during the day, and a narrow posterior splint applied during the night. The results, however, are generally very unsatisfactory; the deformity being congenital, unless treatment be commenced at a very early age, the joint surfaces are so altered that restoration of function is rarely perfect, and it is quite a question whether it is worth the patient's while to go through a prolonged course of treatment by splints when there is a great chance of the deformity recurring.

The simplest plan in these cases is to perform an operation similar to that employed for the cure of hammer toe, namely, the *removal of* *the head of the first phalanx.* This can easily be done by a lateral incision upon the inner side of the little finger, so as to expose the neck of the bone, which is divided by cutting pliers, and the head removed. The wound is stitched up, the finger brought straight and fixed to a splint, and kept upon it from four to six weeks. At the end of that time passive movement is begun and the finger may be left free.

## DUPUYTREN'S CONTRACTION.

This affection is essentially due to a contraction of the digital processes of the palmar fascia, the main body of that structure usually being only secondarily affected. In typical cases the course of the affection is extremely slow. It is generally symmetrical and usually first affects the ring finger on each side; the next to be affected is generally the little finger, and in bad cases the remaining fingers may become attacked one after another, but in any case the ring finger is the most markedly contracted. The condition is more frequently met with in men than in women, and generally attacks those over fifty years of age. It is not uncommonly associated with gout, rheumatism, or osteo-arthritis. In some cases it is said to be hereditary, but whether it is that the tendency to this particular deformity is hereditary, or whether it is due to the associated hereditary gouty condition, it is hard to say. It is a noteworthy fact that the contraction is particularly prone to occur in persons, such as carpenters and the like, whose occupations entail considerable and repeated pressure by tools and instruments against the palm of the hand.

**PATHOLOGY.**—The essential alteration is a thickening and shortening of the palmar fascia and the various processes of fibrous tissue given off by it. These changes are mainly confined, in the early stages at any rate, to the digital processes, the result of their shortening being a flexion of the finger at the metacarpo-phalangeal joint. Later on, as the contraction gets more marked, there is flexion of the first interphalangeal joint as well; the second generally remains unaffected, the two terminal phalanges being nearly in the same straight line. Still later in the disease, the thickening affects the body of the palmar fascia, which then shows irregular masses of fibrous tissue upon it. In addition to the palmar fascia and its digital processes, the thickening also affects the small fibrous bands which pass from the surface of the fascia to the skin. The result of this is that the skin becomes bound down to the palmar fascia and much puckered, so that there are often hard horny ridges and irregular thickenings in the palm, which are found to be due to the thickened fibrous slips with the adherent skin over them. This point is one that it is important to bear in mind when treating the condition. There is no primary contraction of the flexor tendons, and it is almost invariably found that, after all the fascial structures have been divided, the tendons offer no bar to the re-position of the finger. When, however, the affection has lasted for a long time, there is marked secondary contraction of the ligaments of the various articulations that have been kept flexed, and these structures will require division before the fingers can be brought into proper position.

**TREATMENT.**—Nothing but operative interference is likely to be successful. Attempts to prevent or overcome the deformity by stretching the fascia by splints, elastic traction, and the like, merely cause great pain, irritate the fascia, and lead to a rapid increase in the contraction. At the same time it must be admitted that the operative treatment of this condition is not so satisfactory in its results as could be wished, because there is always a marked tendency to the reproduction of the deformity. The operative treatment may be carried out subcutaneously or by means of open incisions.

(1) **Subcutaneous division** of the palmar fascia and the processes connected with it is the method most commonly employed, but it is not always the most satisfactory. Before performing this, or indeed any operation upon the palm, certain preliminary steps should be taken to soften the skin as much as possible. They should be persevered with for several days beforehand, and should take the form of frequent soaking of the palm in water as hot as can be borne, washing with soft soda-soap, and frequent inunctions of glycerine, vaseline, or lanoline. The inunction should be done by a process analogous to the kneading process of massage (see Part I., p. 22). The operation itself must he carried out with scrupulous regard to antiseptic precautions, the skin being purified in the manner described for the disinfection of the skin in general (see Part I., p. 161). A tenotomy knife with a very small cutting blade is cautiously insinuated into the fat between the skin and the fascia with its blade parallel to the surface of the latter; the cutting edge is then turned towards the fascia, and the contracted bands (which are rendered evident by traction upon the finger) are divided one after the other, the knife being pushed in various directions according to their situation. As a rule a good many punctures are required, and the fascia must be scored in all directions. The principal seat of division will be in the digital processes, so that the punctures are generally made between the transverse crease of the palm and the line of the first interphalangeal joint. Where there is also puckering of the skin, the knife should be swept between the skin and the fascia, with the blade parallel to the surface of the latter, so as to free the adherent portions. The operation should be carried out with the greatest care and thoroughness, and considerable time has usually to be spent over it; from half to three-quarters of an hour is not at all infrequently required to find and divide all the tight bands of fascia present. It is no good whatever to attempt to cure the affection by simply dividing the fascia by one or two transverse divisions of the main contracted mass.

In bad cases it will be necessary, in addition to the division of the fascia, to cut the ligaments of the affected joints, particularly the first interphalangeal. This can be done quite easily by slipping the tenotomy knife into the joint and dividing the ligaments. After all the tense fascial bands have been divided, the finger is put firmly upon the stretch and the palm kneaded, so as to rupture any fibres that may have escaped division. In doing this it is often found necessary to re-introduce the tenotomy knife, and to divide some tight band that has not previously been noticcd. A pad of antiseptic gauze is then placed in the palm, and the hand put up on a palmar splint (see Fig. 18) which is padded especially thickly beneath the fingers, so as to produce good extension when the hand is bandaged down to it. Care must, however, be taken not to extend the fingers unduly when the contraction is great and the skin much thickened, partly because considerable pain would be caused and

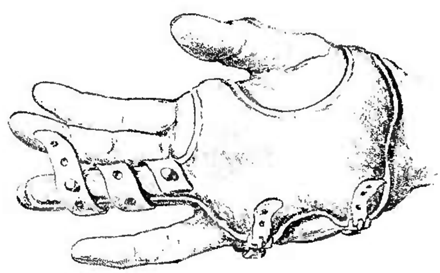


FIG. 18.—DUPUYTREN'S CONTRACTION. SPLINT FOR USE IMMEDIATELY AFTER SUBCUTANEOUS DIVISION OF THE FASCIA. This is a very useful form, as it is made of light metal well padded, and can therefore be bent somewhat should it be difficult to get the finger straight immediately after tbe operation; it can then be straigbtened out gradually later on as the finger stretcbes. (After *Adams.*)

partly because the skin may be tightly stretched and slough, since its vitality has been considerably interfered with by the operation. In bad cases it is better, therefore, to leave the fingers somewhat flexed for the first 24 or 48 hours, and then gradually to increase the extension. This can easily be done by readjusting the splint and increasing the padding, or by fastening the metacarpals to the splint by an elastic bandage, so as gradually to press the palm down flat upon the splint, the fingers being separated from it by the padding. In the course of a week or so the fingers should have become so stretched as to be rather over-extended.

At first the splint must be worn night and day for three or four weeks; at the end of that time a dorsal splint may be substituted for it. The best form of dorsal splint is one which takes purchase from the lower part of the forearm about three or four inches above the wrist, and is fastened round the latter with suitable straps. From this point the splint should extend over the inner side of the dorsum of the hand as far down as the knuckles, and from this main piece separate prolongations, one for each of the affected fingers, arise. These prolongations are bent somewhat backwards from the main portion of the splint, so that when the fingers are fastened to them, which is best done by means of elastic bands, they are pulled well back into a position of slight hyper-extension (see Fig. 19). By this arrangement the thumb and any of the fingers that are not affected are left free, so that the patient can use the hand to a certain extent. It should be worn night and day until at least six weeks have elapsed from the time of operation, but it should be taken off two or three times daily so as to allow the fingers to be exercised, and massage and passive movement to the palm and finger to be employed; at the end of six weeks it may be left off during the day and worn only at night. The use of the splint at night should not be given up for at least six months after the operation; at the end of that time it can generally be abandoned

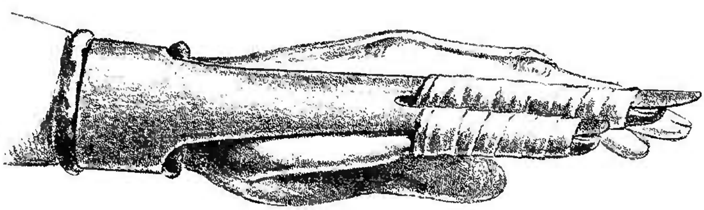


FIG. 19.—DUPUYTREN'S CONTRACTION. SPLINT FOR MAINTAINING FULL EXTENSION AFTER SUBCUTANEOUS DIVISION OF THE FASCIA. This splint is somewhat similar to that shown in Fig. 18, except that it is applied on the dorsal surface of the hand, and takes purchase from the wrist. Hence more powerful extension of the fingers can be got. The finger prolongations (which will vary in number according to the fingers affected) can be bent backwards if necessary, as the splint is made of malleable metal.

entirely. Where there is much stiffness of the joints, and considerable rigidity of the skin with hard horny thickenings, a course of treatment by the superheated air apparatus (Tallerman's) is very useful in getting the part supple; the fingers should be repeatedly moved, the palm kneaded, and glycerine or lanoline rubbed into it, so as to soften the skin as much as possible.

The usual result of subcutaneous division of the fascia carried out in this manner is that the patient remains well for three or four years, and then the contraction recurs, and a second operation is required, the results of which may be as satisfactory as those of the former one. No permanent cure can, however, be looked for by this, or indeed, unfortunately, by any other method.

(2) **The open operations** of any value for the treatment of Dupuytren's contraction are two in number—(*a*) dissection out of the whole of the contracted fascia, and (*b*) division of the fascia and the skin by a V-shaped incision, so as to enable the finger to be extended, without removal of any portion of the fascia. Each method has its own particular value, and the indications for each will be considered immediately; meanwhile we shall describe the two operations.

(*a*) **Excision of the contracted Fascia.**—After the skin has been softened beforehand as much as possible in the manner just described, it is thoroughly disinfected, and a vertical incision is made over the contracted band extending from the root of the finger (or further down, if necessary) to its upper limit, and then transverse incisions are made at each end of the vertical incision, so that the flaps of skin can be turned out on each side (see Fig. 20). If there are any marked horny indurations in the skin over the contracted band, they should be included in an elliptical incision, and removed at the same time. Considerable difficulty is often experienced in turning aside the skin over the contracted fascia if the

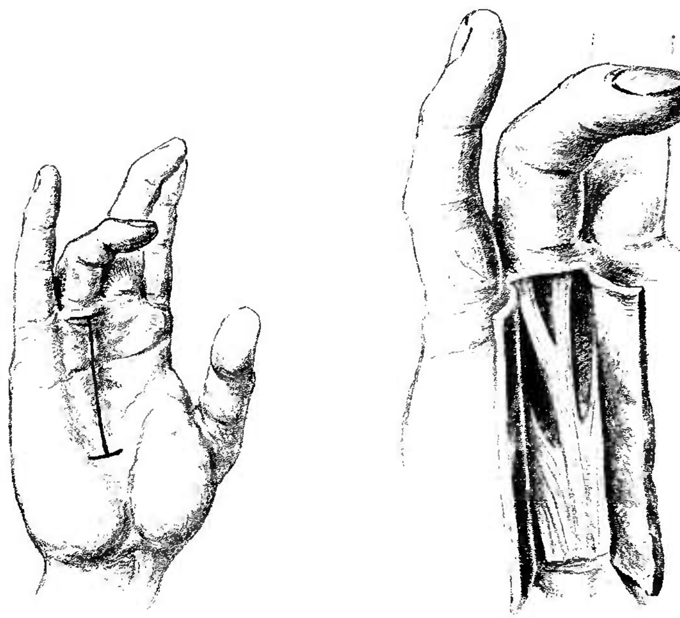


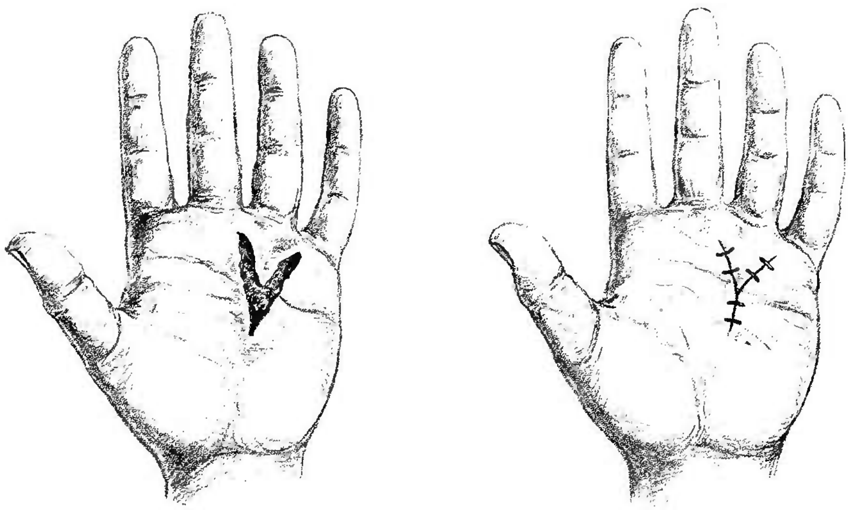
FIG. 20.—EXCISION IN DUPUYTREN'S CONTRACTION OF THE PALMAR FASCIA. The left-hand figure shows the incision made over the contracted band of fascia that is to be excised. In the right-hand figure (drawn to a larger scale), the flaps are shown turned aside, and the slips of contracted fascia requiring to be dissected out are seen.

finger be much flexed, and in these cases it is a good plan to introduce a tenotomy knife before making the skin incision, and to sweep it between the skin and the fascia so as to separate the two structures from one another; this, however, should only be done in one or two places, and then very cautiously, because to a certain extent it endangers the vitality of the skin. After the flaps are turned aside the contracted band of fascia is dissected completely and cleanly out together with all the slips going to the fingers. Subsequently, by means of a tenotomy knife, the contracted ligaments around the joint may be divided if this should be found necessary in order to bring the finger straight.

It is by no means easy to approximate the edges of the wound after the operation, especially when a portion of the skin has been excised.

This is largely due to the fact that the skin is shortened by the disease both in the transverse and the longitudinal directions. It is, however, necessary to stitch the skin together as closely as possible, and immediate skin-grafting should be employed for any raw surface left. It is imperative that no granulating surface should remain, as otherwise the scar which forms will materially hamper the progress of the case. The after-treatment is exactly the same as that described for subcutaneous tenotomy.

(*b*) In the other operation, a **V-shaped incision** is made in the palm and carried through both skin and fascia. The apex of the V should



*A* *B*

FIG. 21.—THE V-SHAPED OPERATION FOR DUPUYTREN'S CONTRACTION. *A* shows the hand after the incision has been made through the fascia and the finger straightened. The raw surface thus left is closed by employing sutures in the manner shown in *B*. There is often a small raw surface left at the junction of the three limbs of the Y; this should be covered by a skin graft.

be opposite the centre of the base of the finger which is most contracted, and from this point incisions are carried upwards into the palm on each side, diverging from each other and ending about the transverse crease (see Fig. 21, *A*). The incisions are carried down through skin and fascia, the latter being completely divided, and no attempt is made to separate the former from the latter. The finger can then be stretched out without tearing through or dividing any tight bands. After the finger is brought straight a large triangular wound is left in the palm, but this can generally be stitched together if the skin be at all supple, so that little or no raw surface is left. The sides of the wound are brought together by stitches, and the apex of the V fits in between them where they diverge higher up (see Fig. 21, *B*), so that there is complete closure of the wound. In some cases the skin is not sufficiently elastic and a certain amount of raw surface is left, which should be immediately covered with a skin graft.

The preliminary treatment of the palm, in order to render it supple, is the same as before, and the after-treatment is identical with that for the subcutaneous operation (see p. 28). The immediate result of this operation is usually satisfactory, but here, as in the former case, the contraction tends to recur.

The after-treatment is the same as that already described for the other method (see p. 28).

We shall now briefly consider the points that would lead the surgeon to prefer any one of these operations to the others in particular cases. (1) In early cases, where the fingers are not bent beyond a right angle, subcutaneous tenotomy is usually as satisfactory a method as any other, and is the one that should be chosen. (2) Where there are only one or two tight bands, where the skin is not markedly puckered, and where the fingers are not greatly contracted, the best method is to remove the fascia by careful dissection,—the second procedure described. (3) In very advanced cases, where the fingers are tightly bound down to the palm, this latter operation oannot be performed, because it is impossible, on account of the contraction of the fingers, to get proper access to the palm so as to make the requisite incisions. Under these circumstances the best treatment is to perform tenotomy in the first instance, and to get the finger as straight as possible by this means. As a rule, however, tenotomy will not allow the finger to come quite straight because the skin itself is contracted, and therefore the result is incomplete. The third operation described, namely, that by the V-shaped incision, may be very usefully combined with tenotomy so as to complete the straightening of the finger, which the former method has commenced. The two operations should, however, be done at different times. The result of the tenotomy is to endanger the vitality of the skin at various points; this, however, very rarely sloughs, unless too great pressure be brought to bear on it; but if a V-shaped incision were made immediately after the tenotomy was completed the damaged portions of the skin would almost certainly die. Hence a sufficient time must be allowed to elapse between the tenotomy and the open operation to allow these damaged portions of skin to properly recover, and during this time the fingers should be kept somewhat extended on a splint; three weeks' interval is usually enough. It is quite useless to attempt to perform the operation of dissecting out the contracted fascia immediately after tenotomy has been done, because all the tense bands have been divided, and they cannot be properly recognized. This is the reason why the V-shaped operation is to be preferred to the other in these cases.

## CONTRACTIONS AFTER BURNS.

It is not at all uncommon, especially in young children, to get contraction of the fingers as a result of the cicatricial contraction following upon burns, and this is of the greatest importance because of the resulting uselessness of the hand. The burns are generally produced by grasping something red-hot, such as a poker, or falling on to the bars of a grate, and burning the palmar surface of the fingers. The result of this is a granulating wound which, when cicatrization is complete, gives rise to ridges of cicatricial tissue extending from the palmar surface of the tips of the fingers to the palm, the fingers becoming bent and rigid from the contraction of the scar. It is generally absolutely impossible to extend the affected fingers.

**TREATMENT.**—The deformity is somewhat difficult to remedy. If the bands be simply divided transversely, recurrence of the contraction will almost inevitably occur as the wound heals, and the deformity will be reproduced. A transverse division of the cicatricial band, followed by immediate skin-grafting of the raw surface, also fails to give a satisfactory

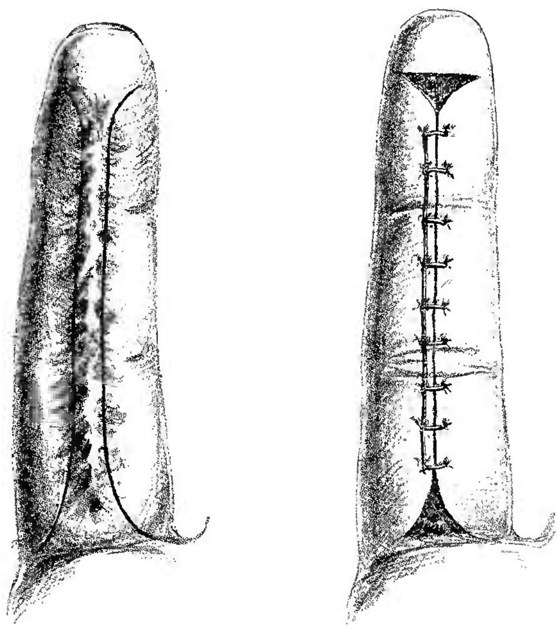



FIG. 22.—OPERATION FOR THE RELIEF OF CONTRACTION OF A FINGER AFTER A BURN.—*A* shows the incisions for raising the lateral flaps; the portion between them is cicatricial and is dissected out. *B* shows the finger straightened after this has been done. The flaps are sutured together throughout most of their extent, the triangular raw surfaces left above and below being covered by skin grafts.

result. The best treatment, on the whole, is to dissect out the entire cicatrix in the skin and all the cicatricial tissue on the front of the finger, and then to straighten the latter. This may be done as follows. An incision is carried from end to end of the finger upon each side of the central cicatrix, and as near to it as possible, and at each end the incision is curved outwards so that it nearly reaches the dorsum (see Fig. 22, *A*). In this way a flap is marked out on each side of the finger, and these are dissected up so as to completely expose all the cicatricial tissue. The central cicatrix and the cicatricial tissue surrounding it are then dissected out, after which it will generally be found that the finger can be brought straight, although in some cases, where the contraction has lasted for a considerable length of time, it may be necessary to divide, in addition, some of the various ligaments around the joints. After the finger has been straightened, the flaps may be got to meet in the middle line throughout the greater part of their extent, a triangular raw space being generally left at either end; the latter must be covered with skin-grafts (see Fig. 22, *B*). The advantage of this plan over that of simply dividing the cicatrix transversely and then skin-grafting is that over the centre of the finger corresponding, say to the middle phalanx, the raw surface is completely covered in by skin so that no contraction occurs. Should any contraction occur where the skin-grafts have been applied, it is not a matter of such great moment. In order still further to guard against the tendency to contraction, the hand should be put upon an anterior splint, with the finger hyper-extended, until the wound has healed. After about a fortnight's interval, a back splint, similar to that already described for use in Dupuytren's contraction (see Fig. 19), should be substituted, and to this the finger or fingers are fastened back day and night for six or eight weeks. At the end of the first fortnight, when the wound has healed, the splint should be removed three or four times a day, and massage and passive movements carefully carried out. After eight weeks the splint is left off during the day, and the patient should be encouraged to use the fingers constantly. The splint, however, should be worn at night for six or eight months longer.

# CHAPTER II.

## FLAT FOOT.

FLAT foot is essentially an affection of adolescence; it may however occur in comparatively young children, and it is also met with after growth has ceased. It is sometimes spoken of as "spurious valgus," but in reality it has nothing in common with true valgus, as it is primarily due to the giving way of the arch of the foot.

**CAUSES.**—The primary cause of this affection has been variously described by different authors, but it consists essentially of an inability of the instep to support the weight of the body which is thrown upon it. The affection may develop either acutely or gradually. Acute flat foot is generally the result of some inflammatory condition affecting the structures in the sole, more particularly the calcaneo-scaphoid ligaments; it is common after gonorrhœa as one form of gonorrhœal rheumatism, after rheumatism itself, and after any inflammatory conditions about the foot which soften and weaken the ligaments. In most cases the condition develops slowly, and this is most marked in weakly subjects and in those whose occupations entail prolonged standing, such as barmaids, shop-assistants, and the like. It is also met with in association with rickets and with various ricketty deformities of the extremities, particularly genu valgum, where the weight of the body is thrown more upon the inner border of the foot than upon the sole; in fact, any condition which leads to abnormal eversion of the foot tends to throw the weight upon its inner border and favours the production of this deformity. The condition seems to be more common in males than in females.

**PATHOLOGICAL CHANGES.**—As the result of the yielding of the arch of the foot, the head of the astragalus becomes partially dislocated inwards and downwards from the scaphoid bone, and in bad cases it may only articulate with the latter at its extreme outer part. As a consequence, the head of the astragalus forms a marked prominence beneath the skin on the inner border of the foot, the arch of the foot disappears, and the whole sole is applied flat to the ground. There is also a tendency for the anterior part of the foot to become abducted, so that in bad cases the inner border of the foot may be actually convex and the outer concave. The outer border of the foot subsequently becomes somewhat elevated, and the patient walks more on the inner, although not to the same extreme degree as in cases of talipes valgus.

As flat foot develops, a certain amount of pain is practically always present, although it varies considerably both in situation and degree. In the acute form of the disease, due to an inflammatory condition of the ligaments, the pain is usually so severe that the patient is entirely unable to walk. Here it is chiefly felt about the centre of the sole beneath the head of the astragalus, and there is also marked tenderness on upward pressure at that spot. This is no doubt due to the stretching of the ligaments about the mid-tarsal joint. In the more advanced cases, in addition to these symptoms, considerable pain is also experienced along the outer border of the foot, both on the outer side of the metatarsus and about the external malleolus. The pain in the latter situation is often due to actual pressure of the os calcis against the tip of the fibula. Except in very extreme cases, the tendons about the ankle are unaltered, but, in long standing ones, the peronei tendons get tense, and their division is necessary before the deformity can be overcome.

In very severe cases indeed, the peronei tendons may be dislocated from their groove and lie upon or anterior to the external malleolus. In cases of long standing, marked changes also occur in the bones; the uncovered portion of the head of the astragalus becomes deprived of its cartilage and somewhat enlarged, so that it cannot be replaced in its proper position. Sometimes actual bony anchylosis may take place.

**TREATMENT.**—For the purposes of treatment flat foot may be divided into five more or less distinct stages. (1) A patient who has hitherto had a normal arch to the foot begins, comparatively suddenly, to complain of pain on standing referred to the centre of the sole. On examination there is considerable tenderness on upward pressure in the sole, and obliteration of the arch of the instep. This form of the affection is generally known as "acute flat foot," and is usually associated, as has already been said, with an inflammatory condition of the ligaments supporting the head of the astragalus. Here, in the early stage, there is no difficulty in bringing the foot into proper position and restoring the arch; no bony deformity has yet taken place, nor is there any shortening of the ligaments or tendons on the outer side of the foot.

(2) Chronic cases characterized by very slight pain, in which the arch can be readily restored by manipulation.

(3) Those in which there is considerable deformity, and in which the arch can only be restored with difficulty.

(4) Bad cases, with marked deformity which cannot be reduced without the employment of considerable force.

(5) The most severe cases of all, accompanied by much bony de-

formity or anchylosis, in which reduction is impossible even with great force.

(1) **Acute Flat Foot.**—The treatment must be directed firstly to the arrest of the inflammatory condition which is the primary cause of the affection, and, secondly, to the support of the arch of the instep until the parts have had time to become consolidated. The main essential is rest; the patient must be prohibited from standing or bearing any weight at all upon the foot. Another essential is to arrest the inflammatory condition causing the trouble. The means at our command for this purpose are numerous and the choice of any particular form will to a large extent depend upon the cause of the affection.

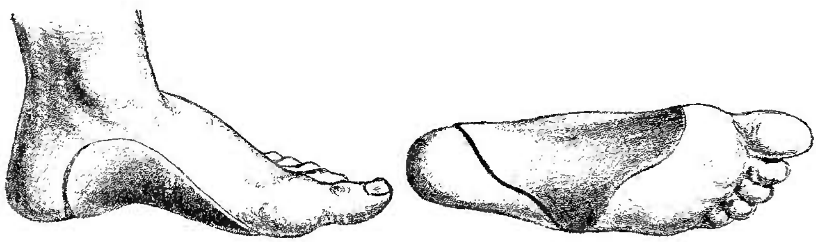
In *gonorrhœal cases*, for example, the treatment must be directed to the general condition as well as to the local disease. This will involve the use of the methods appropriate for the treatment of gonorrhœal diseases of joints and ligaments, which we shall describe in detail in the following volume. It will suffice here to say that in the early stages the application of leeches and hot fomentations are of the greatest value; as the acuter symptoms subside, the use of iodine may be substituted, and later still the employment of massage and passive movement. In all cases the patient should lie with the knee bent, and the leg resting upon the outer side of the foot—a position somewhat closely resembling that of the tailor when at work. The general treatment most suitable for the condition will consist mainly in the internal administration of quinine and iron, whilst locally, injections, or still better local applications to the urethra by the urethroscope should be employed to arrest the gonorrhœal discharge. This question will be dealt with more fully under the heading of gonorrhœa.

It is absolutely essential for the successful treatment of these cases to remember the great tendency there is to the production of anchylosis after gonorrhœal arthritis. Whilst rest is essential in the earlier stages, the use of fixation apparatus, such as plaster of Paris, must be very cautiously employed, and should not be continued for too long a time. Wherever it is found that the arch of the instep is sufficiently maintained by making the patient lie in bed with the knee flexed and the weight of the leg bearing upon the outer border of the foot, it is better to avoid any form of fixation apparatus entirely, and, as soon as the condition of the parts will allow, to employ massage and active and passive movements.

In the cases associated with the ordinary *rheumatic condition*, salicylates should be administered, whilc, if the pain be at all acute, hot fomentations locally are of considerable value. The patient should also be confined to bed, and, for the first few days, should be encouraged, as in the example just described, to lie with the knee bent and the foot resting upon its outer side in tailor-fashion. In these cases this position alone will almost entirely restore the arch of the instep.

**Fixation.**—In all cases of acute flat foot, except those due to gonorrhœa, it is well, when the pain begins to subside, to put the foot up in plaster of Paris with the deformity rather over-corrected; that is to say, with the arch of the instep somewhat exaggerated. The foot should be kept in the plaster for about three weeks, or at any rate until the acute inflammatory condition has subsided. As soon as the acuter symptoms have passed off, complete rest may be given up, and massage and douching substituted for it, so as to strengthen the muscles of the foot.

**Exercises.**—Suitable exercises are also of considerable importance. It will be found that when the patient raises himself upon the toes, the short muscles of the foot are brought into action, and the arch of the foot is markedly increased; exercise of this sort is of the greatest value. The patient should stand with the feet together, and the toes pointing directly forward, and should then gently and slowly raise himself upon tiptoe, bending the knees slightly at the same time. This exercise repeated for a certain number of times—at first from ten to twenty twice daily, and later on for from five to ten minutes at a time two or

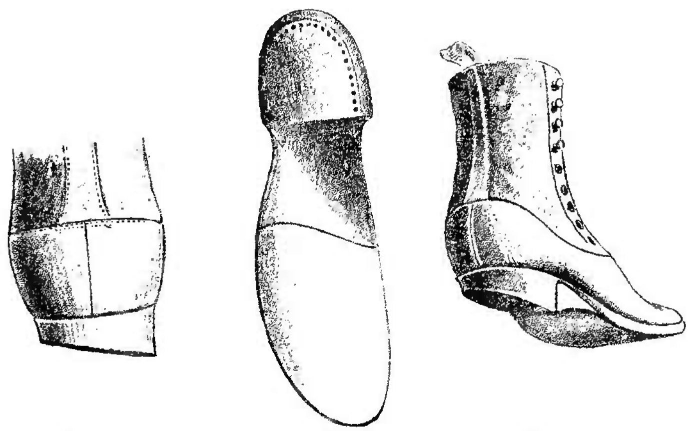


*A* *B*

FIG. 23.—WHITMAN'S SPRING FOR FLAT FOOT. *A*. The splint is seen from the inner side applied to the foot; it shows the prolongation upwards. In *B* the splint is seen from below, and shows the extent of the spring in front, behind, and externally.

three times a day—will do much to restore the arch of the foot. Another exercise of considerable value is the following. After the patient has raised himself upon tiptoe in the manner just mentioned, the knees are separated, while the feet remain in their original position, so that the lower extremity forms a letter O; in other words, a sort of artificial genu varum is formed. This throws the weight of the body upon the outer border of the foot, and so tends to increase the arch of the instep. A third exercise, somewhat similar to the above, consists in standing upon the outer border of the foot with the feet together, the soles being directed inwards towards one another. These exercises should not be carried to the extent of tiring the patient. They should be begun very gradually, and steadily and slowly increased, and it is better to practise them several times a day for a very short time than to have them carried out for too long at a single sitting. For a week or two after the plaster casing has been left off the patient should be content with these exercises, which should be combined with massage and rest with the limb in the tailor-position; no attempts should be made at walking.

**Whitman's Spring.**—When, however, the tenderness in the sole has almost completely disappeared the patient may be allowed to walk about with a suitable support in the boot. The best form of this is Whitman's spring, the so-called "artificial instep" (see Fig. 23), which should be made of steel or aluminium; the latter is preferable because there is often considerable sweating in flat foot, and aluminium does not rust as steel does. The apparatus consists of a spring moulded to the arch of the instep, whilst the foot is held in its proper position. It fits the arch of the foot accurately, extending forwards almost to the balls of the toes, outwards to the outer border of the foot, and backwards to just in front of the tuberosity of the os calcis. On the inner side it is enlarged upwards and extends well on to the inner side of the foot. With a properly made spring, the weight of the foot is not borne upon the



*A* *B* *C*

FIG. 24.—BOOTS FOR FLAT FOOT. In *A* is shown the obliquity of the heel as seen from the back. In *B* the boot is seen from below and both the obliquity of the heel and the filling up of the waist or arch of the instep by carrying the heel right forward to meet the sole are shown. This prolongation of the heel forwards is oblique in the same direction as the heel; it is represented by the unshaded area in front of the heel in *C*, which is a view of the inner side of the boot. (Modified from *Hoffa*.)

apparatus at all until the arch begins to sink; the foot rests upon its normal bases of support, namely, the under surfaces of the heads of the metatarsal bones and the tuberosities of the os calcis, and the spring only comes into action when the arch of the foot sinks unduly. These springs should be accurately fitted, and each one should be carefully made and fitted to the individual who has to wear it. Instrument makers generally keep a number in stock and sell them to patients without ascertaining whether they fit properly or not. With a badly fitting apparatus the spring either extends too far forwards or backwards, and causes considerable pain, so that the patient is often entirely unable to wear it. When, however, they fit properly the patient soon becomes accustomed to them and cannot do without them. Sometimes they cause a little discomfort at first, and, until the patient has become accustomed to them, they should only be worn for a short period, the length of time being gradually increased as tolerance is established. They should ultimately be worn in the house-shoes as well as in the boots, as long as there is any tendency to sinking in the arch of the foot.

**Boots.**—In addition to the use of these springs, the sole of the boot should be strengthened beneath the instep, for, if this be not done, the arch tends to sink in spite of the spring. This is best effected by continuing the heel forwards on the inner side of the boot until it meets the front part of the sole; it is also of advantage to make the sole and heel thicker on the inner side than on the outer, so as to raise the inner border of the foot (see Fig. 24). Besides this, the patient should be cautioned not to turn the toes out whilst walking; they should be directed straight forwards, and the knees rotated slightly inwards. When walking also, it is well to direct the patient to raise himself on tip-toe from time to time, and to walk rather upon the toes than flat upon the sole. Care should be taken not to allow the patient to walk too far at first, and in no case should he be allowed to continue walking until the foot feels tired; the amount of exercise can soon be gradually prolonged.

(2) **Where the condition is chronic,** where there is but little pain, and where the arch can be readily restored to its normal condition, it is not necessary to employ absolute rest in bed with fixation in plaster of Paris. From the very first the exercises above described should be carried out, friction, massage, and douching should be employed, and gentle exercise while wearing a suitable Whitman's spring encouraged; the other details, which are fully described above, must also be attended to. In these cases treatment must be continued for a very long time; indeed, in many patients the use of a spring becomes a necessity for the rest of their life, and it must be placed both in the walking boots and the house-shoes. Careful attention should also be given to any co-existing causes of the flat foot. Should the patient be weak or anæmic, the general condition will require attention, and iron, principally in the form of Blaud's capsules, may with advantage be administered. Should there be any deformity, such as genu valgum, which may be the cause of the affection, appropriate means should be employed for its removal. It is of course quite futile to attempt to treat a case of flat foot depending upon genu valgum, unless the primary cause be corrected.

(3) **Where there is marked obliteration of the arch, accompanied by considerable deformity,** and where, in addition, there is some difficulty in restoring the arch by manipulation, it may be necessary to have recourse to some form of elastic traction in order to properly support the instep. The same method may also be called for in the cases in which Whitman's spring gives rise to so much pain that it is borne only with great difficulty. The best apparatus for this purpose is Mr. Golding Bird's modification of Barwell's spring, which is essentially

an artificial tibialis anticus muscle (see Fig. 25). Mr. Golding Bird's apparatus consists of a suitable sling of webbing encircling the ankle joint, passing down over the outer side of the instep beneath the arch of the foot, and terminating on the inner side just above the head of the astragalus in a hook to which the elastic apparatus is fastened. This consists of a firm india-rubber band or door-spring fastened at its lower extremity to the sling just mentioned, while its upper end is attached to an outside leg-iron which is hinged into the heel of the boot below, and is

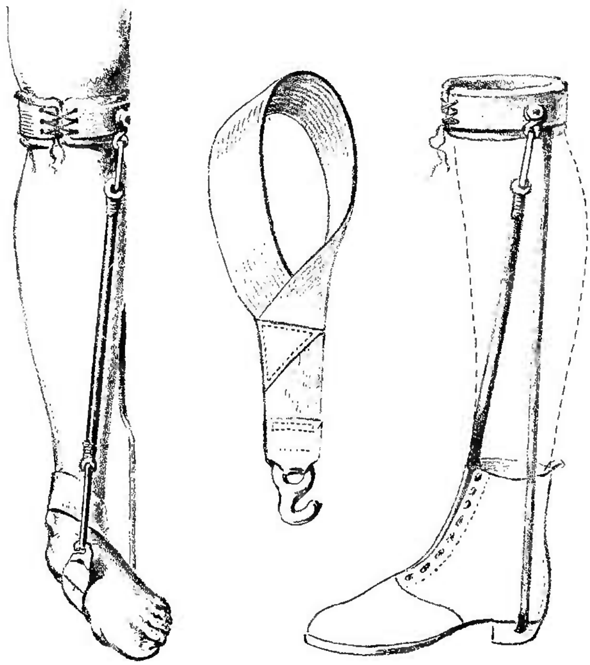


FIG. 25.—ARTIFICIAL TIBIALIS ANTICUS FOR USE IN FLAT FOOT. In the centre is seen the sling of broad webbing which is shown applied to the ankle in the left-hand sketch in which the attachment of the artificial muscle (an india-rubber spring) is shown to the sling below and to the leg band above. In the right-hand figure the apparatus is seen applied with the boot and the leg-iron in position. (Modified from *Golding-Bird.*)

fastened to the leg by an encircling band just opposite the crest of the tibia. The apparatus is applied as follows. After the stocking has been put on, the sling is arranged around the ankle and beneath the instep, and, whilst the free end is firmly pulled upon, the boot is put on and the leg-iron adjusted to the heel. The elastic band is then fastened in position, and the upper end of the leg-iron is adjusted; a suitable slit may be made in the upper leather of the boot, and through this the free end of the sling is passed before the spring is attached to it. In this apparatus the pressure upon the arch of the instep is more uniform and elastic than that exerted by the metal spring. It supports the arch of the foot extremely well, and without any of the pain that is usually more or less marked when a Whitman's spring is used in these more severe cases. At the same time it must be confessed that the apparatus is cumbrous and expensive, and we do not advise its use where the metal spring answers its purpose. It is, however, the best method to employ where there is much spasm, and, as a result, considerable pain. The other accessory methods of treatment will be the same as those already described for the preceding cases.

(4) **In the still more advanced cases,** where it is impossible to restore the arch of the instep by manipulation, and where the deformity is due principally to the shortening of the ligamentous structures on the outer side of the foot, as well as in some cases to shortening of the peroneal tendons, steps must be taken to stretch the tense structures. The patient should be placed fully under an anæsthetic, and the foot should then be manipulated in all directions, so as to break down any adhesions that may be present. Should any tendon or ligament be found unduly tight, it should be divided by a tenotome. If mere manipulation of this kind should not enable the surgeon to restore the arch of the instep satisfactorily, still greater force must be employed to stretch or break through the resisting structures. This is best carried out by means of a Thomas's wrench (see Fig. 40), which is adjusted to the anterior part of the foot, and by means of which the parts may be forcibly brought into position. After this has been done the foot should be put up in plaster of Paris, with the deformity over-corrected, and kept in it for from four to six weeks. It is well to renew the casing about once every ten days, as it is apt to get loose and somewhat inefficient. In the intervals, when the case is removed, the limb should be massaged, and passive movements in all directions should be carried out. After the lapse of about six weeks from the time of the operation, the tip-toe exercises, referred to on p. 38, should be commenced, and these should be combined with the use of douching and massage, as there recommended. It will also be essential to support the arch of the instep, and in the first place this is best done by Golding Bird's apparatus, for which Whitman's spring may be substituted later on as the parts become more consolidated. The general treatment is the same as that already described.

(5) **In the worst cases,** where even the forcible application of a Thomas's wrench fails to bring the parts into proper position, the treatment is most difficult. The bony deformity is extreme, and the pain and disability from which the patient suffers are sometimes so great that some form of operative procedure becomes necessary. Some surgeons advocate excision of the astragalo-scaphoid articulation, some remove a wedge from the neck of the astragalus, whilst others excise a wedge-shaped portion of the tarsus, without regard to the structures removed. The operations most generally useful are the removal of the head of the astragalus, or a partial excision of the astragalo-scaphoid joint as described by Ogston.

**Ogston's Operation** has for its object the production of bony anchylosis between the scaphoid and the astragalus, after the foot has been got into proper position. It is performed as follows. After the patient has been put under the anæsthetic and the parts thoroughly disinfected, the surgeon attempts, by means of the hand, aided, if necessary, by a wrench, to break down adhesions, and to bring the parts as far as possible into good position. In doing this it may be found necessary to divide the peroneal tendons. After the various structures have been loosened in this way, an incision is made along the inner aspect of the foot, extending from just below the anterior margin of the internal malleolus, downwards and forwards to a point beyond the tubercle of the scaphoid. In deepening the incision the tendon of the tibialis anticus must be carefully avoided; it can readily be drawn out of the way with a retractor. The joint between the astragalus and scaphoid is then exposed by dividing the ligaments, and then, by means of a periosteum detacher insinuated beneath it, the whole of the articular cartilage covering the head of the astragalus and the corresponding part of the scaphoid, is stripped off. If after doing this it is still impossible, owing to the altered shape and increased size of the astragalus, to bring the foot into proper position, enough of that bone may be removed with a chisel to enable this to be effected. The foot is then forcibly inverted and adducted, whilst at the same time the arch of the instep is raised by depressing the metatarsal bones and toes. When the foot has been thus brought into a satisfactory position, a hole is drilled through the scaphoid from before backwards and outwards and continued on into the head of the astragalus. Through this is inserted an ivory peg which serves to keep the bones steady in their proper position; the peg is cut off flush with the scaphoid. The wound is then closed without a drainage tube, and antiseptic dressings are applied, outside which a plaster of Paris casing, extending from the base of the toes up to about the centre of the calf, is immediately put on, the foot being held in proper position while the plaster sets.

If no pain be complained of, the casing need not be disturbed for about six weeks after the operation, by which time bony union will be fairly complete, and the patient may be allowed to walk. Should there be any pain, however, or should the case become loose, it must be removed, the wound re-dressed, and a fresh casing applied. At first, after leaving off the plaster of Paris, the arch of the instep should be supported by a Whitman's spring, but this can generally be discarded in about two months. The boots should be well made with a high arch to the instep, and the latter should be still further supported by extending the heel forwards (see p. 40).

The objections urged against this operation are partly that it is not always easy in bad cases to bring the foot into proper position after it, and partly that the transverse tarsal joint loses its mobility and that therefore the foot is deprived to a certain extent of its normal elasticity. Nevertheless, the actual result is a vast improvement upon the condition of the patient before operation, and is far better than any result that can be obtained by mechanical means in cases which have reached this degree of severity.

**Excision of the Head of the Astragalus.**—Perhaps the best operation on the whole is the removal of the head of the astragalus alone, and in most cases we prefer either this or Ogston's operation. It can be readily done by the same incision as that just described for Ogston's operation, and it is not necessarily followed by anchylosis. The disadvantage of the operation is that, as a result of the absence of anchylosis, there is a tendency for depression of the arch to recur, and, therefore, after the operation a Whitman's spring must be constantly worn.

**Stokes' Operation.**—In order to overcome the objection entailed by the rigidity of the transverse tarsal joint left after Ogston's operation, Stokes has devised an operation in which a wedge-shaped piece of bone is removed from the side of the neck of the astragalus. The foot is then forcibly rectified and kept in position until union has occurred. The operation is, however, not a particularly successful one, for in long-standing cases, where there has been some amount of dislocation at the transverse tarsal joint, the mal-position is not rectified, and the operation gives practically no increase in the mobility of the joint.

**Removal of a wedge-shaped piece of the Tarsus.**—In cases of the most severe type the only chance of a successful result is by removal of a wedge-shaped piece of the tarsus, the base of the wedge being on the inner side of the foot, and the apex at the outer. This operation is performed in a precisely similar manner to that which will be described for bad cases of talipes varus, except that in the latter case the base of the wedge is on the outer side of the foot, and we may therefore refer to the description there given (see p. 91). As a result of this operation the bones become anchylosed, but, as has already been said, in speaking of Ogston's operation, the patient is really very much more comfortable if the foot has been brought into accurate position, notwithstanding the anchylosis. Other operations, such as excision of the astragalus, or of various tarsal bones, have been performed, but they have nothing to recommend them in preference to the procedures already described.

# CHAPTER III.

## CLUB-FOOT.

BY the term Club-foot or Talipes is understood a permanent deformity of such a nature that the foot is inclined at an angle to the leg, so that the sole no longer rests upon the ground in the normal position when the patient bears his weight upon it. The directions in which the foot may be displaced are various, and the displacements may be either simple or compound. Of the simple forms of club-foot we may enumerate *Talipes Equinus*, where the heel is drawn up and the toes are pointed, the patient walking upon the extremities of the metatarsal bones; *Talipes Calcaneus*, where the reverse condition exists, the front part of the foot being drawn up and the patient walking upon the heel; *Talipes Varus*, in which the foot is inverted, and the patient walks upon its outer border; and *Talipes Valgus*, where the foot is everted, and the patient walks upon the inner border. In the great majority of cases, however, the deformity is a mixed one, the most frequent being *Talipes Equino-varus*, which is a combination of talipes equinus with talipes varus. *Talipes Equino-valgus*, *Talipes Calcaneo-valgus*, and various other less important forms are also met with; there is also the affection known as *Pes Cavus*, or hollow club-foot, where the plantar fascia is much shortened and the arch of the instep greatly exaggerated. The cases of club-foot may be divided into two great classes, namely, the congenital form, in which the condition is present at birth, and the acquired one, in which the affection develops at some later period.

**CAUSES AND PATHOLOGICAL CHANGES.**—**Congenital talipes** is probably due in the main to some arrest of development in the fœtus, more particularly to some cause which leads to failure of the rotation of the foot from its fœtal into its post-natal condition. During early intra-uterine life, the feet commonly lie in a position closely resembling talipes equino-varus, but shortly before birth the lower extremity becomes rotated in such a manner that the foot assumes its normal position; if from any cause this rotation does not take place, congenital talipes equino-varus is the result. Congenital club-foot may also be associated with imperfect development of the bones of the leg; for instance, absence of the fibula may give rise to a talipes valgus, and in the same way, though more rarely, absence of the tibia may give rise to a talipes varus.

In most cases of congenital talipes there is imperfect development of some of the bones of the foot. This is most marked in the astragalus and takes the form of an actual alteration in the axes of the bones; at first, at any rate, the muscles are not altered in length. In addition to the alteration in the shape of the bones, shortening of some of the ligaments very rapidly occurs, and as time goes on, if the deformity be uncorrected, the shortening of the ligaments becomes still more marked, whilst the muscles, accommodating themselves to the altered position of the limb, may also become permanently altered in length. It is of great importance in the treatment to remember that, while in the early stage we have only to do with a faulty shape and position of the bones, in later life there is, in addition, a permanent shortening of the tendons, fasciæ, and ligaments. The bony deformity increases and becomes permanent as life goes on, and, if the patient be allowed to attain adult life with the foot in its faulty position, it will be found that the shape of the bones and the position of their articular surfaces are so completely altered that some very radical operation is required to rectify the condition.

Of **acquired club-foot** there are numerous causes. The most frequent form is the *paralytic*, resulting from the paralysis of certain groups of muscles, generally due to infantile paralysis; the muscles most frequently affected are those of the front and outer aspect of the leg. As a sequel to the loss of power in the muscles, the foot, by its mere weight, assumes a faulty position. Later on, the unaffected muscles become shortened, their action being unbalanced by the paralysed ones, and the condition present is then one of permanent contraction of the active muscles, and paralysis and degeneration of the affected ones. As the case progresses, the structure and direction of the articular surfaces may actually become altered if steps be not taken to keep the foot in proper position. Another cause of the paralytic form of the deformity may be a direct injury to a nerve trunk, such as a gun-shot or other wound, or a fracture involving the nerve. In other cases, the deformity may result from *spastic contraction* of certain muscles, due to various causes, such as affections of the central nervous system, local nerve irritation, and so forth. Again, the deformity may be caused by *myositis* due to the presence of some inflammatory focus in the affected muscles or their vicinity which leads to their contraction, or it may result from inflammation in the neighbourhood of tendons which gives rise to adhesions while the foot is in a faulty position.

There are also many other less frequent causes of talipes. For example, it may result from the contraction of *cicatrices* after wounds, ulcers of the leg, burns, etc., or as the result of *joint diseases* where proper attention has not been paid to the position of the foot. In these cases, the usual deformity seen is talipes equinus, which is due to the natural pointing of the toes, aided in many cases by the weight of the bed-clothes. Again, in cases of marked *ricketty curvatures* of the lower extremity, there is often some form of talipes present, particularly talipes valgus. The affection may also occur as the result of *ostitis*, and this is most frequently seen in cases of acute osteo-myelitis affecting only one of the bones of the leg. Here the disease may cause the destruction of the epiphyseal line in the affected bone, so that there is arrest of growth in it; the result is that, as the other bone grows, the foot will be displaced and talipes will ensue.

**TREATMENT.—General Indications.**—From the point of view of treatment the causation of the affection is of the first importance. If the affection be of **congenital** origin, the treatment in the earlier stages need not be directed so much against contraction of the tendons as against the alterations which have occurred in the shape of the bones, and its aim must be to rectify by suitable position the altered direction of the bones whilst they are still soft and capable of being influenced. If, however, the condition remains untreated until later life, a satisfactory result may only be obtainable by means of some operation dealing directly with the bones. In the case of the **acquired** variety on the other hand, the primary lesions are usually situated in the muscles and soft parts, and the alteration in the shape and structure of the bones only occurs when the deformity has been allowed to continue for a considerable time; hence, the chief attention in the early stage must be directed to the condition of the muscles and ligaments. In the *spastic* cases, means must be taken to relieve the spasm, while at the same time division of some of the tendons may be necessary. Where the club-foot is of *paralytic* origin, the chief point in the treatment is to restore the power of the muscles by such means as massage, electricity, and the use of suitable apparatus to prevent over-stretching of the weak muscles and undue contraction of the sound ones. Where the affection is caused by *cicatrices*, the source of contraction must be removed or neutralized; similarly with other forms of the affection. In all cases, the earlier the treatment is begun, the better is the prospect of a good result, for, as has already been said, if treatment be neglected in the early stages, whatever may have been the primary lesion causing the mischief, the final result is alteration in the shape of the bones and the direction of the articular surfaces, shortening of ligaments, tendons, etc.,—a condition in which simple division of tendons or ligaments, manipulations, and the use of apparatus fail to restore the foot to its proper position, and in which some much more severe measures must be had recourse to.

## A.—CONGENITAL CLUB-FOOT.

**General Points in the Treatment.**—These cases fall into three distinct groups. (1) Those in which the deformity can be completely rectified by manipulation alone; these are the cases in which there are no shortened structures to materially impede the re-position of the foot, and where the deformity in the bones is only slight.

(2) Cases in which the condition has lasted for a longer time, and which are marked by shortening of the tendons and ligaments, resulting from the long-continued faulty position of the limb; when these contracted structures are divided the foot can still be replaced in its proper position with a little effort, the alterations in the bones not having yet reached such an extent as to offer any great impediment to its performance.

(3) The third group consists of those cases in which the deformity has lasted for a very considerable time, and where the obstacles to reduction are not merely the presence of tight tendons, ligaments, and fasciæ, but are caused by the alterations in the bones themselves (more especially in the direction and extent of the articular surfaces) which have reached such an extent that re-position by mechanical means is impossible. These alterations in the bones consist, as we have already said, partly in changes in their shape and direction, and partly in alterations in the articular cartilages. Whenever, as the result of the faulty position of the foot, some portion of the articular cartilage has remained for a long time out of contact with the articular surface of the corresponding bone, fibroid changes occur in it converting it into fibro-cartilage; ultimately the whole of the uncovered portion of the articular surface becomes completely destroyed. Thus, even when the bones are placed in proper position, the opposed surfaces are no longer covered with articular cartilage. Besides this, alterations in the shape of the bone beneath may also develop. This is generally in the direction of over-growth, so that it is no longer possible to bring the two joint surfaces into proper relation with each other, and before this can be done some alteration in their shape must be made mechanically.

A very important point to remember in the treatment of all cases of club-foot is that the patient must not be regarded as cured as soon as the foot has been got into its proper position, or even after it has been maintained in its new position for some weeks. As a matter of fact, if the treatment be left off too soon, a relapse takes place almost at once and the subsequent condition may become almost as bad as or even worse than if no treatment at all had been employed. Hence, in all cases of club-foot, it must be impressed on the parents that the treatment should be continued for a long time, even after apparent complete recovery; several years at least should be devoted to it.

(1) **In the cases in which it is possible without the exercise of any force to get the foot into its normal position,** the treatment will consist in the methodical employment of manipulations so as to keep the parts stretched, and the adoption of means designed to strengthen the action of any muscles that may be deficient in power; and further, in overcoming the bony deformity which already exists, and *a fortiori* in

preventing any further development of it. The first two objects are fulfilled by the use of suitable *manipulations* and massage, whilst for the third some form of apparatus must be employed.

When congenital club-foot is detected early enough to be remediable by the hand, the nurse must be carefully instructed to over-correct the position of the foot several times a day, and it is of great advantage that this correction be carried out, in the first instance at any rate, by the medical man himself. It should be done by grasping the anterior half of the foot with one hand and gently, firmly, and slowly bringing it into its proper position, whilst the posterior half is fixed by the other hand. It is essential that these manipulations should be carried out without the employment of any force at all, as, if roughly done, spasm of the muscles is at once set up; this interferes considerably with the proper replacement, and teaches the child very soon to resent the manipulations, so that after a few days no further progress is made. The foot should be, so to speak, rather coaxed than forced into its proper position. It will usually then be found that re-position can be very readily effected, and the child does not object to the renewal of the manipulations on subsequent occasions. After the foot has been brought into proper position it should be held there for from five to ten minutes. In the course of a few days it will generally be found possible to over-correct the deformity without exciting the least spasm of the muscles, and this should be aimed at in all cases. At the same time the nurse should gently rub and manipulate the leg, the muscles on the side opposite the deformity especially being firmly kneaded with the view of increasing their power, so that they may tend to keep the foot in proper position.

These manipulations, however, are not in themselves sufficient to lead to a permanent cure, and in the intervals between their employment the foot should be fixed in its normal position, or, if possible, in a position in which the deformity is somewhat over-corrected; this exerts a constant gentle pressure and thus gradually the soft cartilaginous bones are moulded into their normal shape. In the early stages this is better done by a light splint than by any of the more complicated forms of apparatus, which, owing to the small size of the foot, are not likely to exert their proper influence. The *splint* which we prefer (see Fig. 26), consists of a light metal leg-piece which is moulded to the back of the leg, extending from just above the os calcis to the upper part of the calf, and a flat foot-piece which is cut to the shape of the foot. The two are connected by a stout copper wire bent as shown in the figure, and this should be strong enough to resist the action of the muscles, but at the same time sufficiently pliable to be readily bent into different positions by the nurse. The splint should be carefully padded with chamois leather, and is bent so that it fits the foot whilst the limb is in the faulty position; in this position both the foot and leg are firmly applied to the splint by suitable bandages. The nurse then grasps the foot-piece with one hand, and the leg-piece with the other, and then gradually brings the splint, and with it the foot, into its normal position; after a few days the limb may be brought into a position of over-correction.

In bringing the foot into position, the stout copper wire connecting the two portions of the splint is gradually bent, but it is sufficiently stout to retain its new position when the pressure is relaxed, and thus resists the tendency of the muscles to reproduce the deformity. The splint should be taken off two or three times a day to permit of the manipulations referred to above, and before being reapplied it should be bent back into the false position; it is then fixed on the leg and foot, and the limb afterwards brought into the over-corrected position.

Besides manipulations and the use of retentive apparatus, special importance attaches to the employment of suitable *massage* designed to maintain

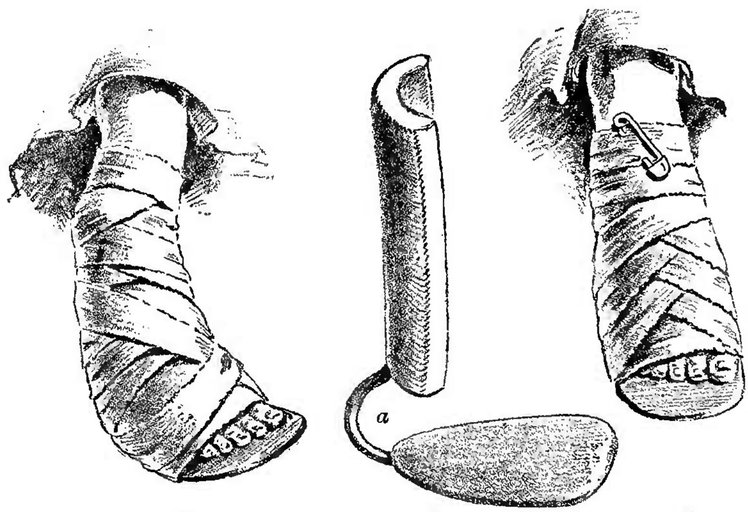



FIG. 26.—METAL TALIPES SPLINT. *A* shows the splint before application. *B* illustrates the splint applied to the foot while still in its faulty position. The splint is easily made to fit the foot by bending the stout copper connecting wire *a*. *C* shows the faulty position of the foot rectified by bending the splint back into the position shown in *A*, while the foot is firmly fixed to it.

the full power of the muscles of the lower extremity, which of course tend to be somewhat interfered with while the limb is kept on the splint. In some cases benefit may be obtained from the use of a *galvanic current*, especially when the muscular action is feeble. It should be applied for ten minutes every day to the muscles both at the back and in front of the limb; and massage, with or without *douching* with hot and cold water, may be used every day for about the same length of time. When the child is old enough to learn to walk, the metal splint just described or a Scarpa's shoe (see Fig. 41) may be employed; and, in addition, *exercises*, such as tiptoe exercises, rising on the outside of the foot, etc., varying according to the nature of the deformity, should be employed.

(2) **In the second group of cases** in which there are structures definitely resisting re-position, means must be taken to overcome these obstacles. This is best done by dividing the structures (which are chiefly ligaments and tendons) by a tenotomy knife. The methods of performing *tenotomy* in various situations will be referred to in detail when we come to speak of the individual forms of club-foot. Here it is sufficient to say that the resisting structures must be divided freely, and the foot must then be put up on a suitable *splint* in the corrected position, which later on is exchanged for a position of over-correction. Whether complete correction should be carried out at once, or should be delayed for from two or three days to a week, depends upon the circumstances of the case. Where the tendons which have been divided are very contracted, immediate and complete correction is sometimes inadvisable, more especially when the tendon affected is the tendo Achillis, for if immediate correction be made there may be either no union at all or else that which occurs is long, imperfect, and weak, and may lead to a deformity of the opposite kind. In most of the other tendons, however, and in all cases where the contraction is not very great, there is considerable advantage to be gained in putting up the foot immediately in the corrected position, and substituting for this in a few days a position of over-correction. After sufficient time has been allowed to elapse for union to occur between the divided ends,—which is usually from two to three weeks,—the other accessory methods already described should be begun; they are careful manipulations, massage, electricity, and the application of splints. When the patient is older and begins to walk, a suitable mechanical arrangement permitting the use of the joints within normal limits should be combined with the other forms of treatment. These will be referred to in detail when dealing with the individual forms of the deformity.

(3) **In the third and most severe class of cases** the treatment to be adopted will vary with the amount of deformity present, but as a rule the division of tendons, fasciæ, and ligaments, and the subsequent use of manipulations and retentive apparatus are not sufficient, and very *extensive operations*, involving the division of numerous ligaments and other structures about the foot, or in some cases even the removal of part or the whole of the affected bones may be called for. Here again, the precise indications for the various operations will be given when speaking of the different forms of club-foot. As a rule it is in the severe and long-standing cases of equino-varus that these procedures are most often called for, but they are also sometimes found necessary in other varieties of club-foot when the deformity has been allowed to remain uncorrected for a great length of time.

## B.—ACQUIRED CLUB-FOOT.

**General points in the Treatment.**—In the acquired variety the treatment will vary very considerably with the particular case under notice. For example, in the **paralytic form**, in which the deformity is in the first instance due not so much to contraction of muscles or alterations in the bones, as to paralysis of one group of muscles, with unbalanced action of the opposing groups, the treatment must be directed to maintaining the foot in its proper position, and to attempts to restore the functions of the paralysed muscles, or to replace them by suitable apparatus. It is always easy in the early stages of this form to correct the deformity without the employment of any force and without putting any muscles, tendons, or fibrous structures on the stretch. When, however, the deformity has been allowed to persist for a considerable time, shortening of the muscles and fibrous structures takes place, and their division becomes necessary before the foot can be brought into proper position. In the early stage, therefore, the treatment embraces the means, already indicated (see p. 50), for maintaining and improving the nutrition of the paralysed muscles; besides these it will be necessary to employ some apparatus to prevent recurrence of the deformity. When contraction of tendons, fasciæ, or ligaments has taken place secondarily, tenotomy will be called for, and then the treatment is much the same as in the second group of congenital cases to which we have already referred (see p. 51).

In the **spastic cases** the treatment is directed first of all to the cure of the spasm of the muscles, and this is unfortunately not by any means easy. Tenotomy is often of considerable benefit, even at an early stage; the very presence of a tight tendon seems to act as a stimulus in keeping up the spastic contraction, while its division not only enables the foot to be restored to its proper position, but may actually have a curative effect upon the spasmodic condition itself.

When the deformity is due to **cicatricial contraction**, as for example after ulcers or burns, various plastic operations may be necessary to remove the contraction. The nature of the operation depends so much upon the amount and position of the contracting material that it is extremely difficult to lay down any special rules. In these cases prevention is the only really satisfactory treatment, and therefore in all ulcers or burns of any size about the lower third of the leg, skin-grafting should be employed quite early, and a suitable apparatus applied so as to obviate the contraction which is otherwise almost certain to follow cicatrization. When contraction has actually occurred and has lasted some time, the muscles and tendons beneath the scar become shortened and the fascia tense, and even although the cicatrix which was the original cause of the trouble be dissected away, the mal-position of the foot is not as a rule relieved thereby, and some more radical operation will have to be undertaken for its rectification. Sometimes it is possible to dissect away the scar along with the deep fascia, and to bring the foot into position either by manipulations or wrenching or after tenotomy of tendons or fasciæ, and then, by employing skin-grafting, to prevent recurrence of the deformity; this is more likely to be the case if the foot, during the healing process and for some time afterwards, be kept in the over-corrected position. On the other hand, however, in many cases, in spite of free removal of the cicatrix and the fascia, followed by wrenching, it is impossible to bring the foot into proper position; if the disability caused by the deformity be very great it will then be necessary to resort to some more severe procedure, such as the removal of portions of bones, or even amputation.

The removal of a portion of bone may be called for to relieve the tension on the parts, and thus to permit of the foot being brought straight, but in the majority of cases it is not a very satisfactory procedure. Sometimes, in bad cicatricial deformities about the back and sides of the leg in the neighbourhood of the ankle joint, removal of an inch or two of the tibia and fibula may enable the foot to be brought to a right angle, or even actually into its normal position, and it may be kept there by subsequent wiring of the divided ends. Even here, however, the result is not as a rule quite satisfactory, and that for two reasons; in the first place the contraction extends to the ankle joint itself, so that even when the leg is shortened sufficiently to prevent the contracted tissues from displacing the foot, the rigidity of the parts in the neighbourhood of the joint may still prevent the foot being brought into proper position. In the second place it is a matter of increased difficulty to bring the ankle joint into its proper position after the bones of the leg have been divided, for the lower fragments of the tibia and fibula are so short that it is impossible to get a proper purchase upon them in order to move the ankle joint, and break down adhesions in it. Nevertheless, this operation has in some cases been done with marked benefit. The cases in which it is most likely to be successful are those in which it is found that, when the knee is fully flexed, there is a certain amount of movement remaining in the ankle joint, so that the front of the foot can be to some extent, at any rate, brought up towards a right angle. In the majority of these cases the main deformity is that of talipes equinus, with possibly a little tendency to varus, and therefore in them it is more a question of getting the foot to a right angle than of overcoming any lateral displacement.

Of course, if this operation be performed, the most scrupulous attention must be paid to antiseptic precautions. It is done by making an incision along the anterior border of the tibia, and a second one along the outer border of the fibula; the periosteum is then separated from the bones, and the requisite amount removed. It is well to make the section of the tibia oblique, so as to provide a larger surface for coaptation, and if this be done, the best method of uniting the bones afterwards is by screws. The fibula should, in the first instance, be merely cut across with bone forceps or a saw, and when the necessary amount of the tibia has been removed it will at once be seen how much of the fibula must be excised. The two ends of the fibula should be fastened together by a silver wire of moderate thickness, whilst the tibia is united by two or three fairly long fine screws.

The limb should be put up with the foot at a right angle, and any lateral displacement remedied as far as possible by side splints; these may be replaced at the end of from ten to fourteen days by a suitable plaster of Paris casing which will require to be kept on for at least eight weeks. Owing to the slowness with which union occurs under these circumstances it is impossible to dispense with the apparatus earlier, and, owing to the liability to non-union after an operation of this kind, it is useless to attempt to promote the movement of the ankle joint until the union of the bones of the leg is complete. As soon as this has occurred, passive movement must be begun, and it will usually be found that the degree of mobility present in the ankle before the operation will still remain. Of course, by careful movement and massage, and later on by forced movements under an anæsthetic, it may be possible to largely increase it.

When the ulceration, or the burn, is situated upon the foot itself, the bone calling for removal will generally be the astragalus, but the actual operation required will depend entirely upon the nature of the deformity and the situation of the cicatrix. In some cases, no doubt, amputation will be the better practice, but no definite rules can be laid down, on account of the great variety of conditions that may be met with.

## C.—THE INDIVIDUAL FORMS OF CLUB-FOOT.

### TALIPES EQUINUS.

In this form of club-foot the heel is drawn up and the toes are pointed. The condition is very rarely congenital; it usually results from some inflammation in the calf muscles or in their vicinity, which leads to their contraction. It may also occur from loss of power in the anterior group of leg muscles as the result of infantile paralysis, from cicatricial contraction of ulcers or wounds in the calf of the leg, or from long-continued pointing of the foot during a prolonged illness, when care has not been taken to keep the pressure of the bed-clothes off the toes by a cradle. It may also occur in connection with disease of the ankle or the tarsal joints in which a secondary contraction of the muscles of the calf has occurred.

Talipes equinus varies in degree in different cases. Sometimes the heel may be drawn up to such an extent that the sole of the foot is almost in the same plane as the back of the leg; sometimes the chief trouble is that the ankle cannot be flexed beyond a right angle. In the severe cases the patient walks upon the balls of the toes, which are generally hyper-extended upon the metatarsals by the pull of the extensor tendons which have also become contracted; the main trouble is caused partly by the increased length of the lower extremity and the small basis upon which the patient stands, and partly by the formation of callosities and bursæ over the ends of the metatarsal bones, and the frequent attacks of inflammation and suppuration which their presence almost necessarily entails.

In the milder cases it will be found that when the patient stands the sole is applied normally to the ground, but on any attempt to walk, the weight is borne mainly upon the front half of the foot, the heel being drawn up off the ground, although not nearly to such an extent as in the more severe cases. This leads to limping, and causes a certain amount of pain, which is felt chiefly in the back of the leg and about the heel and is due to the stretching of the tendo Achillis.

In the slighter cases, and in those in which the deformity has lasted only a short time, the essential obstacle to the reduction of the deformity is the contraction of the calf muscles which gives rise to undue tension of the tendo Achillis. When the deformity is more marked, and particularly when it has lasted for a considerable time, certain secondary alterations take place about the foot. The chief of these is contraction of the plantar fascia which leads to an exaggeration of the arch of the instep, and ultimately produces the condition known as *talipes cavus*, or hollow club-foot. This exaggeration of the instep causes pain in walking, which is mainly complained of in the sole, and is due to stretching of the shortened plantar fascia; callosities also generally develop, particularly over the head of the first metatarsal bone, and give rise to considerable additional pain. In some cases also, permanent shortening of the long flexors of the toes and of the peroneus longus takes place, whilst, in addition, inversion of the foot at the mid-tarsal joint may occur, producing the condition of talipes equino-varus. In very long-standing cases, especially those in which the deformity is extreme, the posterior ligament of the ankle joint becomes shortened, and, more important still, the upper articular surface of the astragalus becomes altered both in shape and structure. The chief change takes place in its anterior part where the cartilage which normally covers it becomes converted into fibrous tissue, and that portion of the articular surface which, owing to the new position of the foot, is now out of contact with the lower end of the tibia, becomes considerably enlarged, so that it is impossible for the astragalus to pass back into its proper position, even when all the other causes producing the deformity have been removed.

**TREATMENT.**—From the point of view of treatment we may divide talipes equinus into three classes. (1) The mild cases, in which the foot cannot be flexed beyond a right angle, but in which there is no contraction of any other structures than the calf muscles.

(2) The more severe cases, in which the heel is considerably drawn up and in which at the same time there is secondary contraction of other structures, such as the plantar fascia, the posterior ligament of the ankle joint, and possibly also some of the tendons already mentioned.

(3) The most severe cases of all, in which the elevation of the heel is extreme, and in which the affection has lasted long enough for profound alterations to have occurred in the bones and in the articular surfaces, and where, therefore, the re-position of the foot is a matter of extreme difficulty.

(1) **In the first group,** all that is necessary is to divide the tendo Achillis, and then to maintain the foot in proper position by means of suitable apparatus; this may advantageously be combined with exercises. Some authorities recommend that exercises alone should be employed so as to stretch the calf muscles gradually, and advise that tenotomy should not be done. It may be possible in some cases to overcome the trouble in this way, but as a general rule it is neither a satisfactory nor a safe procedure. The constant pulling upon a tight tendon is extremely apt to set up spastic contraction in the calf muscles, and also to lead to a fibroid thickening in the muscles, both conditions being likely to increase the contraction. On the other hand, *division of the tendo Achillis* is followed by such satisfactory results that there is no reason whatever for adopting a longer, more painful, and less certain method. The operation is performed as follows. After the patient has been anæsthetised, and the part thoroughly disinfected, the limb is turned over upon its side, steadied upon a sandbag, and the surgeon then introduces a tenotomy knife on one side of the tendo Achillis—for choice on the inner side. The tenotomy knife should be very sharp, with a cutting edge of not more than a quarter of an inch in length; the rest of the blade should be rounded, narrow, and blunt, so as to lie in the small puncture in the skin made by the cutting portion without increasing the opening.

Much difference of opinion exists as to whether this or any other tendon should be divided by introducing the knife along the deeper surface of the tendon and cutting towards the skin, or *vice versâ*, by insinuating the knife between the skin and the tendon, and dividing the latter by cutting towards the deeper structures (see Fig. 27). The objections urged against the former procedure, which is the one more often adopted, are of considerable importance. In the first place it is very easy to include between the knife and the skin vessels or nerves, which must then be inevitably divided along with the tendon; in the second place the surgeon is very apt, in his anxiety to avoid the inclusion of these structures between the knife and the tendon, to puncture the latter, and to leave some fibres undivided,—an occurrence which would render the whole operation nugatory; finally, when the last fibres are divided, and the tendon suddenly gives way under the knife, the latter is very apt to be thrust through the skin, and thus to convert a subcutaneous operation into an open one. As a matter of fact, many surgeons, with the view of avoiding the latter accident, employ two knives, the first, a sharp-pointed one for making the track, and the other, a blunt-pointed one which is introduced along the track, after withdrawal of the first, and made to divide the tendon. This is, however, a quite unnecessary complication, the more so as it is not easy to push the blunt instrument along the track made by the sharp one. The objection urged against division of the tendon from without inwards is chiefly that, as the tendon gives way, the knife may divide important structures beneath; as a matter of fact most of these structures lie in soft mobile tissues, and yield before the point of the knife, so that it is very seldom that an accident of this kind occurs. We therefore prefer to divide tendons from the skin surface downwards. It is a method by which one can be perfectly certain of not leaving any fibres undivided, whilst the accidental enlargement of the skin opening is certainly avoided. With regard to the latter point, however, it must be confessed that at the present time, with the operation conducted perfectly aseptically, enlargement of the skin wound is, from the antiseptic point of view, a matter of no consequence whatever; at the same time it

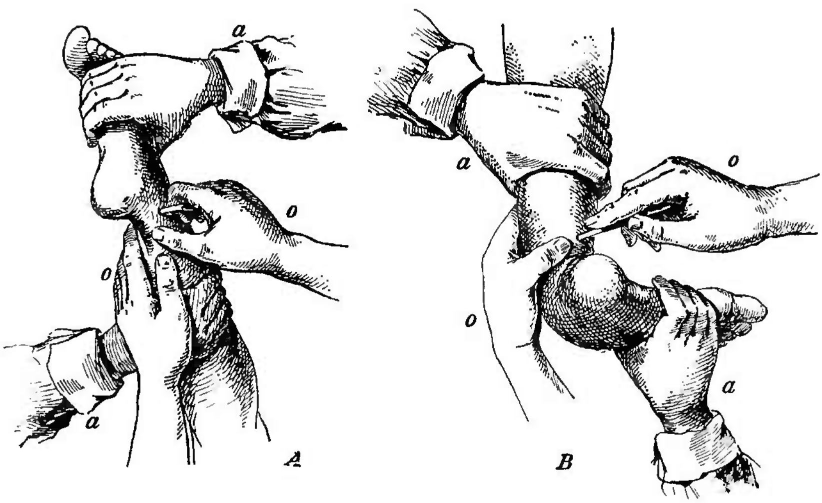



FIG. 27.—THE METHODS OF DIVIDING THE TENDO ACHILLIS SUBCUTANEOUSLY.

*A. Division of the tendon from its deep surface towards the skin.* The tenotomy knife is here introduced on the outer side at right angles to the skin, and is thrust across just in front of the anterior surface of the tendon until its point is just beneath the skin on the inner side, where the surgeon notes its position with the forefinger of the left hand. In the drawing the assistant is in the act of making the tendon tense for the surgeon to divide it. It is more usual to introduce the knife from the inner side.

*B. Division of the tendon from its superficial surface towards the bone.* This is the method we prefer and bave described in detail in the text. In the drawing the point of the tenotome is shown as it is being insinuated between the skin and the tendon; the surgeon notes its progress beneath the skin by means of the left thumb or forefinger. The parts are represented as being fully relaxed by the assistant in order to facilitate the passage of the tenotome across the back of the tendon.

In both drawings the surgeon's hands are denoted by the letters *o*, *o*, while those of the assistant are marked *a*, *a*. (*Hoffa.*)

is best avoided, because of the possibility of the scar in the skin becoming adherent to the cicatricial tissue between the divided ends of the tendon, and thus hampering the movements of the latter.

In division of the tendo Achillis, the knife should be introduced on the inner side of the tendon, about half an inch beyond its margin and about an inch above its insertion into the os calcis; the blade should lie flatwise on the tendon. In fat children it is not always easy to define the edge of the tendon, and in them it is best to make the puncture about midway between the inner border of the tibia, which can always be felt, and the back of the leg. The position of the tendon is made much more evident by putting the foot upon the stretch whilst the puncture in the skin is being made; as soon, however, as this is done the tendon should be relaxed as much as possible by depressing the toes, in order to enable the surgeon to insinuate his knife more readily between it and the skin. The foot should be in the charge of an assistant, so that the surgeon is free to employ the fore-finger of his left hand to ascertain the progress of his knife as he insinuates it between the skin and the back of the tendon, and to make sure that no tendinous fibres are left between the knife and the skin (see Fig. 27, *B*). When the point of the knife has been passed well across to the opposite border of the tendon, the cutting edge is turned towards the latter, and then the assistant puts the tendon firmly upon the stretch whilst the surgeon presses the knife against it and divides it with a steady, slight sawing movement; when the division is complete the tendon suddenly gives way and a gap appears between the divided ends. Before withdrawing his knife the surgeon should ascertain with the fore-finger of his left hand that there are no other tight structures requiring division; sometimes the sheath of the tendon is also contracted and requires to be nicked. The principal reason for dividing the tendo Achillis at the spot recommended, namely an inch above its insertion into the os calcis, is that division at a lower point is not always satisfactory, because a series of tendinous slips are often given off at about that spot, to be inserted into the upper part of the os calcis, and should they escape division the proper relaxation of the tendon will not occur. When the tendon has been divided, the foot should be forcibly flexed two or three times, so as to stretch or tear through any other tight bands.

It is very rarely that any *accidents* happen during the performance of this small operation. Sometimes, however, there is bleeding from divided veins, the one most likely to be damaged being the short saphena, but this soon stops with very slight pressure. The puncture of a large arterial trunk like the posterior tibial artery is a matter of extreme rarity, and we ourselves have never met with such an accident; should it occur, the best plan would probably be to enlarge the skin incision, cutting directly down to the artery and tying the divided ends, in preference to running the risk of the formation of a false aneurysm, which might occur, especially if the artery were only partially divided. Some surgeons, however, suggest that it is best in the first instance merely to apply firm pressure by means of a pad over the bleeding vessel, and then, should a false aneurysm form, to adopt the appropriate treatment for it later. At the same time one need not to be too ready to cut down, merely because arterial blood spouts from the wound; it may be from some much smaller vessel than the posterior tibial, and if this be completely divided, the application of a small pad and bandage will arrest the bleeding immediately. Should the wound in the skin be made too large from an accidental slip of the knife, its edges should be brought together carefully by a stitch or two and a gauze dressing applied in the usual manner. The real disadvantage of a large skin incision nowadays is not the risk of sepsis, as was formerly the case, but the possibility of adhesion of the scar to the new material thrown out between the ends of the tendon.

*After-treatment.*—The next point that arises is the question as to whether the deformity should be at once over-corrected and the foot put up in that position, or whether it should be left for a few days in its faulty position until a certain amount of reparative material has been thrown out between the divided ends of the tendon. The answer to this question depends very largely upon the degree of deformity present. If, when the foot is fully flexed, there be an interval of two inches or more between the divided ends of the tendon (a condition, however, which is unusual in the milder forms of talipes we are now considering), there would certainly be some risk of imperfect union, and the uniting material between the cut ends would probably be thin and soft, instead of broad and firm; in other words, a condition of talipes calcaneus may be substituted for that of equinus. Hence, under these circumstances it is better to apply a small pad of cyanide gauze over the puncture, to place the limb on a splint without any attempt to rectify the deformity, and to leave it for about a week, so as to allow plastic material to be poured out between the divided ends of the tendon before they are markedly separated.

On the other hand, in the milder cases which we are now considering, the foot may almost invariably be put up at once at right angles upon a suitable splint, the one we prefer being the metal splint with a stout copper wire connection, which has already been described (see Fig. 26). The dressing (a piece of cyanide gauze or salicylic wool) applied to the puncture should be quite small and should be fixed on with collodion, and care must be taken to see that the bandage which fastens the limb to the splint does not press upon the gap between the divided ends; should it do so, the formation of plastic material between the ends may be greatly interfered with.

After about a week the deformity should be over-corrected. In the cases first mentioned, where the separation between the ends of the tendon is considerable, it will be sufficient by the end of that time to bring the foot up to a right angle with the leg, and subsequently to increase the flexion every two or three days, until, at the end of another week or ten days, the foot should be at the extreme limit of flexion. In the milder cases, however, to which we have been referring, this limit of flexion can usually be reached within a week after the operation, when the foot should be fixed in plaster of Paris in this over-corrected position for another fortnight. After three weeks from the operation the continued use of splints or plaster of Paris casings may be abandoned, and the limb carefully and regularly massaged, while the patient is encouraged to carry out exercises designed to develop the muscles that are at fault. By this time the uniting material will be sufficiently firm to connect the ends of the tendons; it is, however, not yet very strong, but the patient may be allowed to walk about, provided he walks largely flat-footed, and does not put much strain upon the tendon.

At this stage the following arrangement will be found of great practical value. A piece of wood of suitable size and thickness, such as the lid of a cigar-box, long enough to extend from the heel to at least three inches beyond the tips of the toes, is taken and cut to the shape of the foot. A piece of strapping between two and three inches broad, and

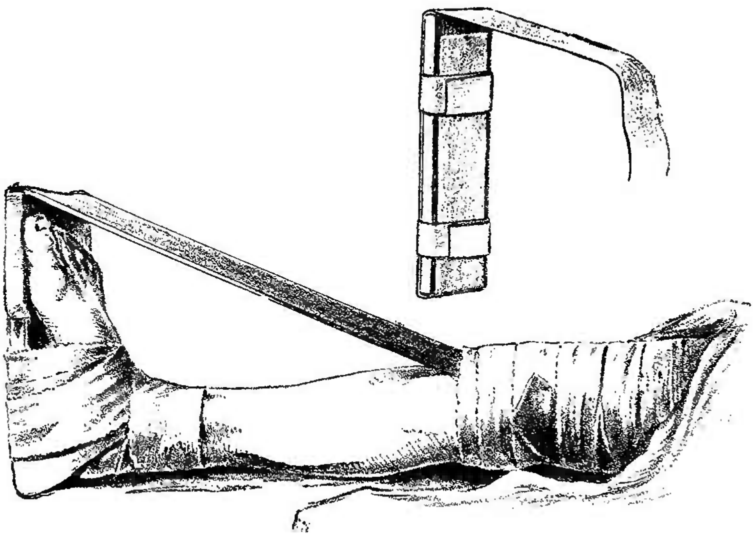


FIG. 28.—SAYRE'S APPARATUS FOR USE AFTER TENOTOMY OF THE TENDO ACHILLIS. The method of application is given sufficiently in detail in the text. The smaller sketch above is to illustrate the method of fastening the strapping to the foot-piece of the splint; it will be seen that it commences on the upper surface of the splint near its anterior margin, runs backwards along the upper surface, down round the posterior edge and finally runs forward along the under surface and round the anterior margin of the splint, where it terminates in a long free end which is shown applied to the thigh in the larger drawing. The length of the foot-piece varies; the more leverage it is desired to exert the further should it project beyond the toes.

sufficiently long to reach from the middle of the thigh to the toes and then twice the length of the splint, is applied first to the upper surface of the splint, beginning near its anterior extremity, carried along the upper surface, round the posterior edge, and then along the lower surface and over the anterior edge again. This part of the strapping is then firmly incorporated with the splint by means of two or three transverse pieces of strapping (see Fig. 28). Upon the splint thus prepared are laid two or three thicknesses of boracic lint so as to form a padding, and the splint is then fastened at the heel, sandalwise, by a broad strip of strapping passing around the instep and the posterior part of the splint to the front of the foot; the splint is then secured to the foot by an ordinary bandage. The long piece of strapping which now hangs over from the front of the splint is next carried up along the anterior surface of the thigh, the foot meanwhile being held at right angles, and the knee in the fully extended position. The strapping is applied to the limb, and fastened in position by a bandage, which commences just beneath the patella and is carried up to about the centre of the thigh. The free upper end of the strapping is then turned down, and the bandage carried downwards over it; in this way the strapping is thoroughly incorporated with the bandage, and both are firmly fastened to the skin of the thigh. Should the strapping slip, as it generally does, after two or three days, it is not necessary to apply fresh strapping in order to tighten it, but a second bandage may be applied over the old one, and carried down rather further below the patella; this will keep the strapping taut. The patient should be encouraged to walk wearing this apparatus; the effect of this is that, as the splint is longer than the foot, considerable leverage is exerted upon the ankle joint, and the latter is well bent as the patient walks. The flexion is far more effectually carried out than if the foot were simply encased in a shoe. By the use of this apparatus, also, the calf muscles are left free, and massage can be applied to them. The apparatus will generally require renewal about once a week.

About six weeks after the operation, more vigorous exercise should be commenced, and this may be carried out while the patient is wearing the splint just described. The following exercise is of considerable value. The patient stands upright, the heels together, and the soles flat on the ground, and he then gradually sinks downward, flexing the knees and hips until he is able to touch the ground with the tips of the fingers, when he again gradually resumes the upright position. This should be done from six to ten times in succession, and should be repeated several times during the day. At the same time massage and galvanism should be applied to the calf muscles, and for about six weeks after the operation the patient should wear either the apparatus just described, or some other form of artificial splint which is so arranged as to raise the toes when he walks. As a general rule it will be found best, after about eight weeks from the time of the operation, to employ a surgical boot, furnished on each side of the leg with irons attached to a band passing around the upper part of the leg, and made with a hinge opposite the ankle joint, fitted with a stop to prevent the foot being extended beyond the right angle. It is well to have this boot made somewhat longer than the foot, for it then acts in a manner similar to the splint we have described, and exerts a greater leverage than if it were the exact length of the foot. This boot is of course more sightly and convenient than the splint, and it may with advantage be fitted with a spring which tends to keep the toes raised and the heel depressed (see Fig. 29); this is especially necessary when the tendo Achillis was much contracted prior to its division.

(2) **In the second group of cases,** in which changes other than the shortening of the tendo Achillis occur, the secondary contractions must be remedied before the tendon is divided. The most important contraction is that of the plantar fascia, the dense central portion of which is most commonly affected; the shortening may be so extreme as to actually produce the condition known as talipes cavus.

*Division of the plantar fascia* should be practised and the foot unrolled some weeks before the tenotomy of the tendo Achillis is done. Should the latter structure be divided at the same time as the plantar fascia, it will be found a matter of the most extreme difficulty to stretch the sole sufficiently,

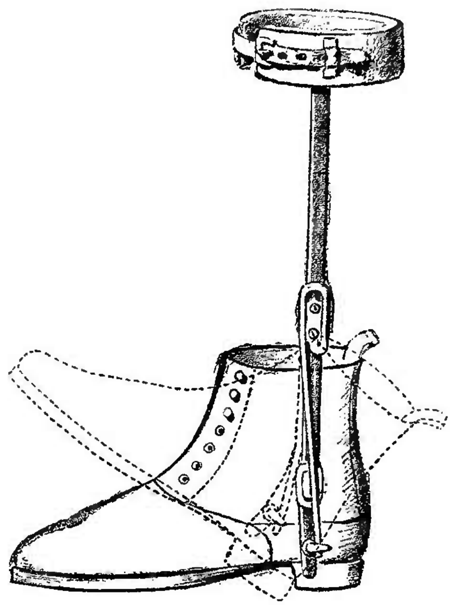


FIG. 29.—BOOT FOR USE AFTER TENOTOMY OF TENDO ACHILLIS. The dotted line shows the position the boot tends to assume when the foot is off the ground; it thus continuously stretches the tendo Achillis. The boot should be made a good deal longer than the foot, and it should have a stop at the ankle-joint hinge to prevent the toes being pointed. (*Hoffa.*)

because there is no fixed point in the foot from which purchase can be taken; if the tendon be left undivided, a perfectly satisfactory *point d'appui* is obtained. The plantar fascia is generally easily divided by putting the sole of the foot firmly upon the stretch, and dividing all the contracted bands by a tenotomy knife. It is best to commence the division as far back as is convenient. The patient is anæsthetised, and special care is taken in the disinfection; the anterior half of the foot is then grasped by the surgeon's left hand and strongly abducted so as to make the fascia tense, whilst the tenotomy knife is introduced between the skin and the fascia about half an inch to one side of the most prominent tense band, and at about the same distance in front of the tuberosity of the os calcis. As soon as the point of the instrument is introduced through the skin, the pressure upon the sole is relaxed, and the knife, with the blade held parallel to the surface, is then carefully insinuated between the skin and the fascia. The surgeon should bear in mind that the latter comes very close to the skin, and is often in intimate connection with it. After the blade of the knife has been pushed well beyond the tight band, the fascia is once more put firmly upon the stretch, the cutting edge of the knife turned towards it, and it is at once divided by a few downward strokes. After division of the first tense band it will generally be found that others start into prominence, and these must be methodically divided, either from the same puncture or from another more conveniently situated. After all bands that are felt to be tense have been divided, the foot should be forcibly stretched, either with the hand alone or aided by the wrench. If it be possible to stretch the foot sufficiently to get it quite straight, or rather into the over-corrected position, by the hand alone, it is far better to do so, as less damage is done to the tissues. In many cases, however, more particularly in the small feet of young children, it is difficult to stretch the sole adequately with the hand alone, and in these cases Thomas's wrench is usefully employed. This will be described presently when speaking of the treatment of talipes equino-varus (see p. 84).

*After-treatment.*—After the foot has been thoroughly stretched in this manner, it should be brought into the over-corrected position, the small punctures dressed with cyanide gauze and collodion, and the metal splint already described (see p. 49) applied. Care must be taken in arranging the padding of the splint that no undue pressure is exerted upon the heads of the metatarsals; the padding should be somewhat thicker in front of and behind the balls of the toes, so as to leave a certain amount of depression into which they may sink. The foot is then firmly bound to the splint. Should the tendo Achillis not be too tight to allow the foot to come to a right angle, the patient may be allowed to stand, wearing the splint, within a week after the operation; the standing position helps still further to promote the stretching of the sole. Should, however, the contraction of the tendo Achillis be very marked, this will not be possible. If there be much pain complained of after the operation, the splint should be taken off and the padding readjusted. This is an important matter, for, should a slough form on the balls of the toes, very considerable trouble may result, and a permanently tender scar may be left behind.

In many cases it is necessary to repeat the tenotomy of the plantar fascia some three or four weeks after the first operation. In no case should the tendo Achillis be divided until the foot has been thoroughly unfolded, and the sole restored to its normal condition. The second tenotomy should be practised further forward than the first, so as to divide the individual slips of fascia which escaped division in the first operation, and which have become tense subsequently. After the surgeon is satisfied that the sole is sufficiently stretched (this is usually in from a month to six weeks after the treatment has been begun), the tendo Achillis may be divided in the ordinary manner, and the subsequent treatment carried out as already described in speaking of the first stage of the affection (see p. 59).

(3) **In the most severe group** of talipes equinus two conditions are met with; either simple talipes equinus, in which the heel is drawn up and the sole of the foot is fairly straight, or very marked equinus combined with a certain amount of talipes cavus. We shall take the consideration of the former group first.

(*a*) It is well to commence the treatment with a free division of the plantar fascia, even although it may not be markedly contracted. In these bad cases simple division of the tendo Achillis is not sufficient to allow the foot to be brought into its proper position. This is due partly to contraction of the ligaments about the ankle joint, but mainly to the alterations which have occurred in the anterior part of the upper articular surface of the astragalus. In most cases the surgeon has to make a choice of some severe operative procedure, but, if the patient be young, a few weeks may with advantage be devoted to ascertaining whether, after a preliminary division of the plantar fascia, with a subsequent tenotomy of the tendo Achillis and the posterior ligaments of the ankle joint, continuous upward pressure upon the front of the foot by means of a splint will not lead to a cure of the deformity. If, however, it be found after a fair trial of these means (which are those described for the treatment of the second group of cases) that the deformity is not overcome, further procedures, directed more especially to the change in the shape of the astragalus, must be had recourse to. The operations at our disposal are excision of the astragalus, removal of a portion of the upper surface of that bone, excision of the ankle joint, or finally, amputation.

(*α*) **Excision of the Astragalus.**—In ordinary cases, where the circulation and nutrition of the parts are good, excision of the astragalus yields an excellent result, and is probably the best of the procedures above mentioned. The foot left after this operation is a very useful one, and the ankle joint is freely movable; the os calcis rises to some extent between the malleoli, and, if the operation be performed in young subjects, it is almost impossible to tell, when they reach adult life, that anything has been done.

The operation for excision of the astragalus will be fully described in Part III. in speaking of excisions; we may here, however, say that many lines of incision are used for the purpose. We prefer two vertical incisions, one on either side of the front of the ankle joint; that on the inner side commences about two inches above the internal malleolus, over the anterior border of the tibia, and runs downwards over the ankle to the dorsal surface of the scaphoid. This incision is carried directly down to the bone, care being taken to avoid dividing the tibialis anticus tendon, which is easily seen and hooked out of the way. The second incision is very similar and is made on the outer side, commencing about two inches above the tip of the external malleolus, and carried downwards and forwards parallel with the inner incision to a point opposite the termination of the latter (see Fig. 30). The structures over the front of the ankle joint are raised by a periosteum detacher, and a copper spatula is passed in beneath the bridge of soft tissues thus raised, which contains all the tendons, vessels, nerves, etc. These are then pulled well forwards and protected by the spatula against any chance of injury. The lateral and anterior ligaments of the ankle joint are now easily divided and the astragalo-scaphoid articulation is opened. The strong calcaneo-astragaloid ligament is next divided, and then the astragalus can generally be seized by strong forceps and gradually pulled forwards and outwards or inwards and any resisting structures divided. At the posterior part of the bone the tendon of the flexor longus pollicis must be carefully separated from its groove by a periosteum detacher. After the astragalus has been removed, the bleeding is arrested, the wound stitched up, and the foot put up at a right angle upon a suitable splint. It is only in the most extreme cases that it becomes necessary to divide the tendo Achillis at the same time; if necessary, this, of course, must be done. In putting up the foot special

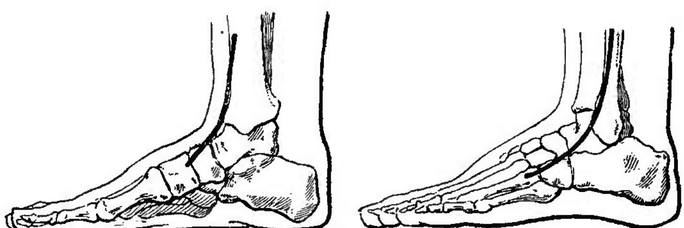



FIG. 30.—EXCISION OF ASTRAGALUS. *A* shows the incision on the inner, *B* on the outer side of the front of the ankle.

care must be taken to prevent inversion, and the best arrangement is Croft's plaster of Paris splint, which will be fully described in Part III. in dealing with fractures. Other useful splints are lateral poroplastic ones moulded to the foot while it is held at right angles to the leg in its proper position.

The chief point to remember in the after-treatment of excision of the astragalus is that there is a tendency to inversion of the foot, and this must be carefully and persistently guarded against. The splint should be kept on for about six weeks, at the end of which time the patient, furnished with a suitable apparatus, may be allowed to walk. This apparatus should consist of a boot to which are attached lateral irons fastened to a band around the upper part of the leg and furnished with hinges opposite the ankle joint (see Fig. 31). The boot should be worn for eight months or a year, when it will generally be found that the foot has accommodated itself to its new position.

($\beta$) **Partial resection of the Astragalus.**—In some cases, where the deformity is not so great, it may suffice to expose the front of the astragalus by incisions similar to those just described for its complete resection, and then by means of a chisel or a gouge to chip off enough bone from its upper and anterior surfaces to enable the articular surface to pass easily beneath the malleolar arch, and then, after division of the tendo Achillis, to bring the foot into the rectangular position. This operation, when it is feasible, is in some ways perhaps the best for adult cases, but in children excision of the astragalus, if carefully attended to afterwards, gives such perfect results that it is much the best procedure. If this method of removing a portion of the astragalus be adopted, particular care must be taken subsequently to preserve the movements of the ankle joint by frequent passive and active movements and massage. The movements should be begun within a day or two of the operation, and in the intervals between them the foot should be kept on a posterior splint with a hinged foot-piece which can be pushed up so as to over-correct the deformity.

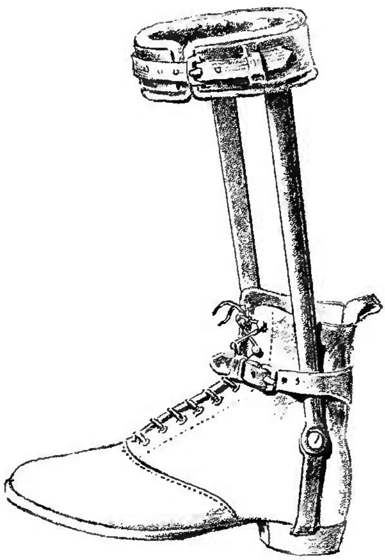


FIG. 31.—BOOT FOR USE AFTER EXCISION OF ASTRAGALUS. This is merely a boot fitted with stout lateral leg-irons which are fastened into the heel below and furnished with an ordinary hinge-joint opposite the ankle. The chief object of the apparatus is to prevent inversion of the foot.

($\gamma$) **Amputation.**—Amputation is of course extremely rarely called for in these cases, but sometimes,—when the condition is due to infantile paralysis, when there is extreme wasting of the parts, when the nutrition of the foot is markedly interfered with, when the latter is constantly subject to ulceration, and when in fact the foot would be useless even were it restored to its proper position,—Syme's or Pirogoff's operation (preferably *Syme's*) will yield a far more satisfactory result than any attempt to retain the foot and restore its functions by apparatus.

(*b*) In the second class of these severe cases of talipes equinus, those, namely, in which there is also marked talipes cavus and where the foot cannot be unfolded by the mere employment of tenotomy and splints, some more serious operation may be necessary. In these cases the patient is generally much crippled, and suffers great pain, when the weight is borne upon the sole, from stretching of the plantar fascia and the ligaments; at the same time callosities and corns form over the metatarsal bones, and cause the greatest suffering.

**Excision of a wedge from the tarsus.**—Should tenotomy and wrenching fail to restore the proper shape of the foot, it may become necessary to remove a portion of the tarsus, in order to bring the sole of the foot flat upon the ground, and this should be done and the foot brought straight before the tendo Achillis is divided. The operation is readily performed by means of straight incisions along the inner and outer sides of the foot, at about the level of the scaphoid bone; the incisions are carried down to the bone, the tendons and other structures on the front of the tarsus are peeled off with a periosteum detacher, and the structures in the sole of the foot are similarly treated. The soft parts are held aside by copper spatulæ introduced between them and the bones, and a wedge-shaped cut is made in the tarsus by means of a saw insinuated between the spatulæ and the bone. The portion of bone removed should have its base directed towards the dorsum of the foot, and the apex towards the sole. The bones should be removed without any regard to their articulations, and the block excised generally consists of the head of the astragalus, a portion of the scaphoid, and a portion of the cuboid. When this has been done, the foot can usually be brought satisfactorily into position; should there be any difficulty, further portions of the bones may be removed by a chisel.

It is of course necessary to employ, as preliminaries to this operation, division of the plantar fascia and thorough wrenching of the foot, and these should be done immediately before the soft parts are separated from the bones; it would be impossible to carry them out after the bones have been divided, and, therefore, a larger amount of bone would have to be taken away than is actually necessary. The size of the wedge should be such as to allow the patient to walk upon the under surfaces of the metatarsal bones instead of upon the ends. It should not be so great as to entirely obliterate the arch of the foot, and it is well to make the wedge rather small in the first place, and then, if necessary, to remove a second slice, the thickness of which can be readily estimated after the first wedge has been removed.

The bleeding is arrested, the wound stitched up without a drainage tube, antiseptic dressings applied, and the foot put into proper position. A splint is applied to the back of the leg and the sole of the foot, and retained for about six weeks, until bony union has occurred. By that time the tendo Achillis may be divided, and, if necessary, the posterior ligaments of the ankle joint also may be cut, so as to enable the foot to be brought up to a right angle in the first instance, and, subsequently, to an acute angle. After about three weeks longer, the patient may be allowed to walk about, and the treatment recommended for the first class of cases of talipes equinus is then carried out.

## TALIPES CALCANEUS.

As a congenital deformity this is comparatively a rare affection. When it occurs, it is usually the result of infantile paralysis affecting the muscles of the calf. When present at birth, it is often associated with an absence of the fibula, or some similar arrest of development of the leg. In the cases in which the fibula is absent, there is usually a compound form of the deformity which takes the shape of talipes calcaneo-valgus. In the paralytic form, the front part of the foot is drawn up by the unbalanced action of the muscles in front of the leg; the heel is depressed, so that in bad cases the upper part of the instep may lie in actual contact with the anterior surface of the leg, whilst the patient walks upon the extreme point of the heel. In all these cases there is generally a tendency to some valgus deformity as well.

**TREATMENT.**—As in all the other paralytic cases, it is quite easy to replace the foot in its normal position without the exercise of any force, as long as the affection is in its earlier stages; under these circumstances the treatment must be directed on the one hand to retaining the foot in proper position, whilst, on the other, efforts are made to maintain or restore the functions of the paralysed muscles as much as possible. To meet the first indication a suitable splint should be applied; in children the one which we prefer is the simple metal splint with the connecting stout copper wire, which has already been described (see Fig. 26), and which can be readily applied by the nurse. As in the other cases, the splint should be taken off several times a day to allow of the employment of manipulations designed to stretch the muscles on the front of the leg, and to apply massage to those on the posterior surface. Besides the employment of massage to the calf muscles, the use of the Faradic current is very beneficial, whilst at night, and in the intervals between the application of the massage and galvanism, the splint should be re-applied. If these measures be carefully carried out in the early stages, there will seldom be any necessity for division of tendons. As the child grows up and learns to walk, a suitable splint adapted for that purpose should be employed. This should consist of the usual leg-irons taking a grasp from the upper part of the leg just below the knee, the irons running down on each side of the leg, and being fastened below into the heel of the boot. It should also be provided with a hinge-joint opposite the ankle; this latter should have a stop so as to prevent the foot being bent upwards beyond a right angle, and it is well also, where there is considerable loss of power, to have some sort of artificial tendo Achillis adapted to the apparatus (see Fig. 32). The most convenient arrangement is an elastic spring attached to the heel of the boot below, and to the posterior aspect of the band around the

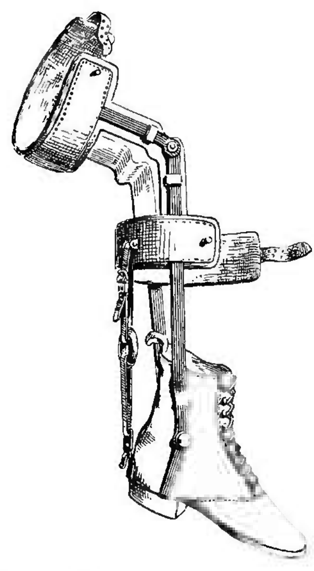


FIG. 32.—BOOT FOR USE IN TALIPES CALCANEUS. The india-rubber spring behind takes the place of the faulty calf muscles. The boot is often fitted with a stop at the hinge joint opposite the ankle so as to prevent the toes being raised unduly. (*Hoffa.*)

knee above. Thus, when the patient lifts the foot from the ground, the heel is drawn up by the band, and when the foot is brought to the ground, the weight of the body stretches the elastic and allows the foot to come to a right angle, where it is stopped by the hinge arrangement. When the patient is not walking, it is well to take off this apparatus, which is apt, under any circumstances, to be somewhat heavy for the much-enfeebled limb, to employ massage, electricity and douching, and then to substitute the simpler splint already mentioned above.

When electrical examination shows that there is still a considerable amount of healthy muscular tissue left in the calf muscles, something further may be done to promote the usefulness of the limb; this takes the form of shortening the unduly elongated tendo Achillis. As a preliminary measure, however, it may be necessary to divide any tendons on the front of the ankle which are rendered unduly tense when the foot is

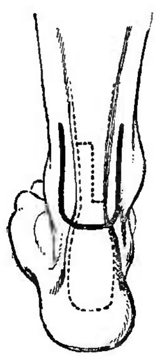


FIG. 33.—FLAP METHOD OF EXPOSING THE TENDO ACHILLIS. The line of section for the plastic operation for shortening the tendon is also shown, and it can be seen that there is no likelihood of the cicatrix in the skin becoming united to that in the tendon.

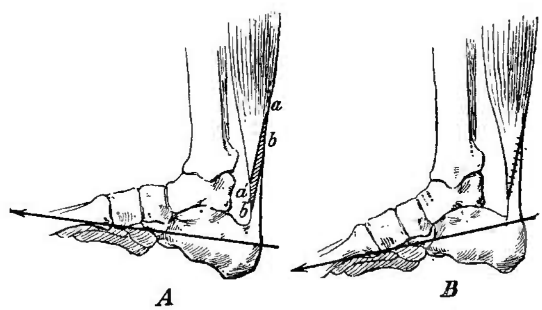



FIG. 34.—OBLIQUE SECTION FOR SHORTENING TENDONS. In *A* are shown the incisions, the upper one *a a'* commencing just upon the muscular fibres; the portion *a a' b' b* between the two incisions is of course removed. In *B* this has been done, and the cut surfaces of the tendon sutured. Enough has been removed to raise the heel and point the toes somewhat.

brought into its normal position. The operations for shortening the tendo Achillis are apt to be somewhat unsatisfactory, the principal reason for this being that the union between the divided ends tends to stretch somewhat after a time and thus to allow the deformity to be reproduced. Simple transverse division of the tendo Achillis and resection of a portion sufficient to restore it to its proper length is always inefficient, as the uniting medium invariably stretches subsequently. In order to obtain a successful result, the operation must be of a somewhat more elaborate character; it may be designed with the view of getting a broader and firmer uniting surface, or the tendon need not be divided at all, but its point of insertion into the os calcis may be changed.

1. **Plastic operations upon the tendo Achillis.**—If it be desired to divide the tendo Achillis, this structure should be exposed by turning up a flap, which is made by carrying a curved incision from a point about

half an inch to one side of the tendon, and at a similar distance above the proposed point of division, downwards, across the tendon, the lowest point being half an inch to an inch below the point of division, and then bringing it up to a point on the opposite side of the tendon corresponding to its starting point (see Fig. 33). The flap thus marked out is raised and hooked upwards so as to expose the tendon, the result of this being that the line of union of the flap will not correspond anywhere to the line of division of the tendon, and therefore there will be no risk of adhesion between the incision in the tendon and that in the skin. The actual method of shortening the tendon varies; there are two principal plans: (*a*) to divide the tendon obliquely, so as to have a broad surface for union, and (*b*) to divide it in a ⅂-shaped manner.

(*a*) **Oblique section of the tendo Achillis.**—The best way of carrying out the first plan, is to turn up a flap and expose the tendon in the manner just indicated, and then to divide the latter obliquely from above downwards and forwards (see Fig. 34). This oblique incision through the tendon

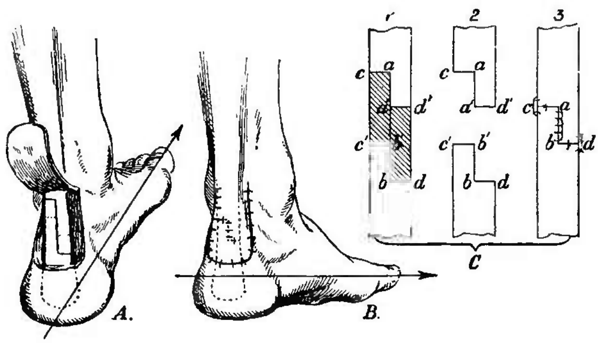



FIG. 35.—⅂-SHAPED SECTION FOR LENGTHENING TENDONS. In *A* the tendon is seen exposed by raising a flap; the dark line shows the incision in the tendon, the dotted ones indicating the amount of tendon removed after the latter has been thus divided. In *B* the tendon has been shortened and sewn together; the toes are a little depressed as in the preceding Fig. *C* shows diagrammatically the steps of the division of the tendon and the methods of suture. In (1) the line of incision in the tendon is *c, a, b, d*; when the two ends are separated, incisions along the dotted lines *a' d'* and *b' c'* are made to cut off the portions *a c c' b'* and *d' a' b d* (shaded in the diagram). This gives the tendon the shape and length represented in (2). The divided ends are then brought together and sutured as in (3). It is important to remember in cutting off the portions of tendon that *d d'* must be equal in length to *c c'*.

should be nearly two inches in length, and should commence close to, or even actually through, some of the muscular fibres. After the tendon has been divided in this manner, a sufficient portion of the lower part is removed by a second incision which is parallel to the first; the amount removed should be such that when the oblique surfaces are brought into accurate apposition, the foot shall either be at or slightly beyond a right angle to the leg. The foot is then brought into position, the cut surfaces of the tendon are carefully approximated and sewn together, preferably by a continuous suture. The flap is replaced in position and all hæmorrhage arrested, the wound is sewn up without the intervention of a drainage tube, and the usual antiseptic dressings are applied. By means of this operation, a broad surface for union is obtained, and, if care be taken not to put any tension upon the tendon for some weeks afterwards, the result is usually fairly satisfactory.

(*b*) **⅂-shaped section of the tendo Achillis.** The second plan is that of dividing the tendon by means of a ⅂-shaped incision. After turning up a flap as before, an incision is made in the tendon, commencing on one side, and running transversely across it as far as its centre. The knife is then turned downwards at a right angle to this incision, and the tendon is split vertically along the middle line for about a couple of inches. At the lower end of this incision the knife is turned transversely across the tendon, and directed towards the opposite side to that originally divided, and is made to divide the remaining half of the tendon (see Fig. 35). In this way, two long flaps of tendon are made, which lie side by side, and all that is necessary is to cut off a sufficient portion from each flap, so that when the divided surfaces are brought accurately into contact the necessary amount of shortening is obtained. A good practical rule is to make the vertical part of the incision just double the length of the portion of tendon that will require to be removed in order to bring the foot into proper position. After having cut away the requisite amount, the ends are brought into accurate apposition, and are carefully stitched with silk.[1] In some ways, this is the more satisfactory method; in it the union is a combination of a transverse with a vertical one, which is very strong, whereas in the other the union is oblique, and there is a possibility of its yielding. A further advantage of this particular method is that the division can be practised lower down, and need not involve the muscular fibres at all.

Various other plans have been devised, none of which are entirely satisfactory; we have contented ourselves with describing those that we have found of most practical value.

**After-treatment.**—Whichever method be adopted, care must be taken to keep the foot in a position of somewhat marked equinus for at least six or eight weeks, so as to allow of sound union between the divided ends; even after this time great care has to be exercised not to put strain on it for fear of stretching the uniting material. The patient should not be allowed to walk about to any extent for at least six months after the operation. When walking is permitted he should be furnished with the apparatus already mentioned (see p. 68), consisting of the lateral irons fitted into a surgical boot with a stop which prevents the joint being flexed beyond a right angle. From six weeks after the operation the calf should be thoroughly massaged and douched once or twice daily, and the Faradic current applied to the muscles.

2. **Transplantation of tendo Achillis.**—The other plan sometimes

[1] For the method of suturing a tendon, see Chap. XVII.

employed is not to divide the tendon at all on account of the danger of the union subsequently stretching, but to alter the bony attachment of the tendo Achillis to the os calcis. When, owing to the paralysis, the nutrition of the leg is faulty, and when, therefore, the union in such a slightly vascular structure as tendon will very probably be extremely imperfect, there is no doubt that a more satisfactory result will be obtained by altering the point of insertion of the tendo Achillis into the os calcis. The great objection to this plan is, however, that the amount of shortening obtained by its means is comparatively limited, and the method is only of real value when the amount of talipes calcaneus is very moderate.

Two operations have been recommended (see Fig. 36); in the first a flap with its convexity upwards is raised over the heel, and dissected downwards so as to expose the whole of the posterior part of the os calcis. A saw is then applied to the upper surface of the bone immediately in front of the tendon, and, by a vertical cut, a thin slice of the bone, with the attachment of the tendo Achillis to it, is sawn off. This slice of bone is pulled down until the insertion of the tendon is at a point as low as may be necessary, or as low as possible, and the bone is fixed into its new position by two or three small screws or nails. The projecting lower portion of the slice of bone is then cut off so as to make it level with the under surface of the os calcis.

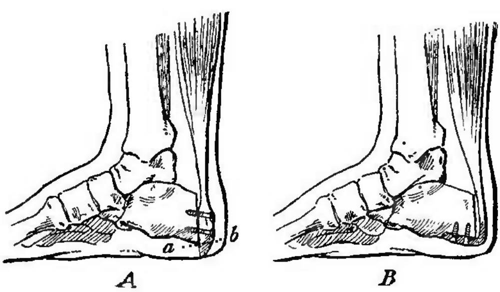



FIG. 36.—TRANSPLANTATION OF TENDO ACHILLIS. This is a diagrammatic representation of the two operations described in the text. In *A* the slice of the os calcis is drawn down as low as possible and fixed in position with screws; the portion below the dotted line *ab* is then sawn off. In *B* further shortening is obtained by turning the slice of bone round at right angles, making a raw surface with a chisel or saw on the under aspect of the os calcis and screwing the slice of bone down to it.

In some cases where the tendon is very long, it has been advised that the upper part of the bone thus sawn off should be turned round at a right angle and applied to a raw surface made by cutting off sufficient of the under surface of the os calcis; this is done to bring down the insertion of the tendon to the very lowest possible point. The results of attempts to produce great shortening in this manner do not, however, seem to be very satisfactory.

**After-treatment.**—After the operation the wound is stitched up without a drainage tube, the usual antiseptic dressings are applied, and the foot is put up on a splint so that the toes are markedly pointed, and ic kept in that position for about six weeks, until bony union is complete. After that time, the patient may be allowed to walk about with the boot already described (see p. 68).

## TALIPES VALGUS.

As a congenital affection, this condition is comparatively rare; when it does occur it is most frequently associated with absence of the fibula. Even as an acquired affection, the deformity is not very common; it then most commonly results from infantile paralysis, and the deformity is produced by the unbalanced actions of the peronei muscles, the tibiales and extensors of the foot being more or less completely paralysed. It may also occur in connection with ricketty deformities of the leg, or faulty union of fractures of the tibia and fibula.

**PATHOLOGICAL CHANGES.**—The principal alterations in the foot are stretching of the internal lateral ligament of the ankle joint with a corresponding amount of contraction of the external lateral ligament, and to a lesser degree, stretching of some of the other ligaments on the inner side of the foot. In the early stage it is quite easy to bring the foot into its normal position by manipulations alone, but in the later stages, as in all other cases of club-foot, the ligaments and the muscles (more especially the peronei) become contracted, and will require division before the foot can be restored to its normal position. In very severe or long-standing cases a certain amount of alteration in the shape of the bones also occurs, and this will form a still further obstacle to the reduction of the deformity.

**TREATMENT.**—In the early cases, in which the position of the foot can be readily rectified by the hand alone, the treatment will consist in preventing the occurrence of the deformity, and in trying to increase the strength of the weakened muscles, so as to enable them to pull up the inner border of the foot. This should be done, as in the other forms of paralytic talipes, by *manipulations* carried out by the nurse (who gradually inverts the foot, and brings it inwards at the mid-tarsal joint), aided by *massage* and *douching* of the muscles, (particularly the tibiales and extensors of the toes), and the employment of the *galvanic current.* In the intervals between the massage and passive movements, the foot should be kept in the corrected position by means of a suitable *apparatus.* In the early stage, before the patient learns to walk, the metal splint, which we have already frequently mentioned (see p. 49), is the most satisfactory, but when the patient is able to get about, he should be encouraged to do so with an apparatus designed to prevent eversion of the foot. This consists of the usual leg irons, the outside one being particularly strong, jointed at the ankle, and hinged to the heel of the boot, which should be constructed of thick leather, and should have the inner side of the sole and heel slightly thicker than the outer (see Fig. 37). The heel should also extend further forwards than is usually the case; in fact, the boot should be made much on the same lines as those recommended for flat foot (see p. 40), for in these cases of talipes valgus a certain amount of flat foot is generally present, and must be corrected. In many cases it is well also to employ Whitman's springs (see p. 39). The boot should only be worn while walking, and should be removed as soon as the patient complains of being tired, or of the apparatus causing pain. When it is taken off, the limb should be massaged and douched, and the lighter metal splint put on in its place.

In very advanced cases in which there is marked shortening of the peronei tendons, it will be necessary to divide them and in some cases also to divide the external lateral ligament of the ankle joint. The *division of the peronei tendons* is best carried out at a point about an inch and a half above the tip of the external malleolus, and in most cases the tendons of both the peroneus longus and brevis should be cut. The tenotomy knife is inserted between the tendons and the bone; the edge of the peroneus longus can be easily made out, and, as soon as it is divided, the peroneus brevis comes into relief and can also be divided. No important structures are endangered by the operation. The short saphena vein may sometimes be divided, but this is a matter of no consequence. After the tendons have been cut, the foot should be put up in a position of slight adduction. Whether the deformity should be completely remedied at once or not, depends, of course, on the amount of separation of the divided ends of the tendon that this will entail. If it be comparatively slight, there is no objection to completely correcting or over-correcting the deformity directly after the operation; if, on the other hand, it be considerable, it is better to allow the deformity to remain uncorrected or only partially corrected for about a week, and then gradually to complete it.

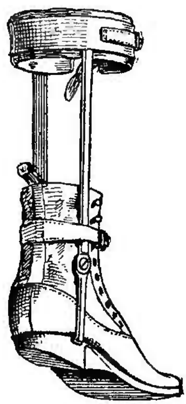


FIG. 37.—BOOTS FOR USE IN TALIPES VALGUS. These are in all respects similar to those for use in flat foot, with the addition of lateral leg-irons, the outer one being especially stout.
The drawing is a view of the boot from the inner side, and shows the obliquity of the heel and the filling up of the arch of the instep. Compare Fig. 24.

In some cases, especially in hospital out-patients, it is best to put up the foot in plaster of Paris. In doing this, any flat foot that co-exists must also be corrected; the toes should be pressed downwards, backwards and inwards, so as to raise the arch of the instep.

When there is sufficient union between the divided ends of the tendons, namely, after the lapse of about three weeks, treatment on the lines already detailed for the milder degrees of the deformity should be carried out (*vide supra*). In the case of a child not able to walk, massage of the weak muscles with proper manipulations and fixation of the foot on splints in the intervals should be employed; when the child can walk, the apparatus above recommended should be used in addition to massage and electricity.

When the deformity is associated with some deflection of the bones, either resulting from rickets or from injury, the treatment must, of course, be first of all directed to remedying the osseous deformity as much as possible. Thus, in ricketty cases, should the deformity be extreme, it may be necessary to divide the bones of the leg so as to bring them straight (see Chap. IV.). In traumatic valgus occurring after Pott's fracture, it will be necessary to perform an operation to restore the proper position of the bones of the leg, if such be found feasible. This matter, however, will be much better discussed in Part III. in speaking of Pott's fracture.

### TALIPES EQUINO-VALGUS.

It is not uncommon for a certain amount of equinus to be combined with talipes valgus—a condition which is known by the term talipes equino-valgus. It is perhaps more frequently met with as a congenital than as an acquired deformity. It does not, however, require any special description here, because the remarks that we shall make immediately about equino-varus may be applied equally to talipes equino-valgus. As in the treatment of equino-varus, the valgus deformity should be corrected before the tendo Achillis is divided.

### TALIPES VARUS.

Pure talipes varus is exceedingly rare, the great majority of the cases being combined with equinus, the condition then being spoken of as talipes equino-varus. True varus may, however, result from infantile paralysis, affecting only the peronei muscles and leaving the tibiales and the anterior muscles of the leg unaffected. It may also result from cicatricial contraction, or from badly united fractures of the leg. The treatment of this affection is the same as that of the varus deformity in talipes equino-varus, which we shall now consider.

### TALIPES EQUINO-VARUS.

This form of club-foot is the most common and the most important of all those with which the surgeon has to deal. The foot is in a position of adduction, the inner side being shortened and drawn up, whilst there is a marked lateral flexion of the mid-tarsal joint, the anterior part of the foot being drawn inwards. Sometimes the displacement of the front of the foot is so marked that its inner border forms an acute angle at the mid-tarsal joint. Besides this deformity the heel is drawn up as the result of the shortening of the calf muscles. The vertical plane of the whole of the foot is altered, the under surface of the os calcis looking somewhat inwards instead of directly downwards.

**PATHOLOGICAL CHANGES.**—The condition may be congenital or acquired. The *acquired* form may be due to infantile paralysis; to some spastic condition of the muscles, as in spastic paraplegia; to injuries, such as dislocations or fractures about the ankle joint; to diseases of that articulation; or to cicatricial contraction in its neighbourhood. In the *congenital* form there is not only tightness of certain tendons, but also alterations in the other structures of the foot, more particularly in the ligaments and bones. The most marked change in the bones occurs at the junction of the neck with the body of the astragalus, the normal angle of which is profoundly altered; instead of being about 38° as in the normal fœtal astragalus, it may, according to Parker, in certain cases of talipes reach as much as 50°. Under normal conditions the obliquity of the neck of the astragalus diminishes as the child grows, so that in the adult the angle of inward deflection of the neck is a little over 10°; on the other hand, in equino-varus in the adult, it may still remain at about 50°. It is quite evident that, with such a marked increase in this angle, the shape of the anterior part of the foot must be seriously altered, and that there is a distinct obstacle in the osseous system itself to the reduction of the deformity.

As the result of the equinus position there is a further change in the astragalus. The greater part of the upper articular surface of the bone is uncovered, and, as the result of this, the alterations already described in speaking of talipes equinus occur (see p. 55), while, at the same time, the portion which articulates with the tibio-fibular arch is narrower than it ought to be, and thus a certain amount of lateral displacement is allowed. As time goes on, changes also occur in the other tarsal bones, more particularly in the cuboid and the scaphoid, but, although these may give rise to an additional obstacle to the reduction of the deformity, their influence is not nearly so great as that of the deformity in the astragalus. In advanced cases also there is a marked alteration in the bones of the leg, the ankle being rotated inwards as a whole, so that the external malleolus comes to lie on a plane considerably anterior to that of the internal one, this condition being the exact opposite of the normal. These extreme changes are usually only reached, however, when the patient is allowed to attain adult life before any attempt is made to restore the foot to its proper position.

Besides the alterations in the bones there are also certain changes in the ligaments of the tarsus; those on the dorsum and the outer surface of the foot become elongated, while those on the inner side are considerably shortened and thickened. According to Parker the most important changes take place in the ligaments around the astragalo-scaphoid joint, in the anterior portion of the deltoid ligament of the ankle joint, and in the inferior calcaneo-astragaloid ligaments. In the early stage of the deformity these ligaments interfere more seriously with its reduction than does the altered shape of the neck of the astragalus itself, for in infants, where the bones are cartilaginous, it is comparatively easy to bend them into a new position, whilst the ligaments are tight and thickened, and are not so readily stretched.

The muscles and tendons are not contracted in the early stage of the disease, and in an infant a few weeks old there is usually little or no difficulty in reducing the deformity as far as the tendons are concerned; if, however, the deformity be allowed to continue they become tight, and the reposition of the foot cannot be carried out until after their division. The tendons chiefly affected in this way are those of the tibialis anticus and posticus, the tendo Achillis, and in some cases the tendon of the flexor longus digitorum; those requiring division are as a rule the two tibiales and the tendo Achillis.

**TREATMENT.**—In considering the treatment we have to take into consideration the alterations in the bones, the ligaments and the muscles, the last producing contraction of the tendons; the shortening of the plantar fascia; and finally, the tightness of the skin itself upon the inner border of the foot. The contraction of the plantar fascia and the tightness of the skin are points of special importance, for, unless means be taken to rectify these, the shortening of the inner border of the foot and the increase of the arch will not be remedied. In advanced cases also we find, in addition, that changes have occurred in parts subjected to pressure, which are normally not intended to bear any pressure at all. These changes consist essentially in the formation of callosities on the outer surface of the foot, and, in some severe cases, on the outer side of the dorsum. Beneath the callosities bursæ develop, and these latter are specially liable to attacks of inflammation and suppuration, which may cause considerable pain and give rise to further thickening and matting together of the soft parts in their neighbourhood.

The cases of equino-varus coming under the notice of the surgeon may be divided from the point of view of treatment into two main groups: (1) those in which the deformity can be readily reduced by manipulation, that is to say, those in which there are no resisting structures requiring division; and (2) those in which there are one or more resisting structures, and where, therefore, some form of operative procedure is required to restore the foot to its proper position. This second group may be further sub-divided into two great classes, namely (*a*) those in which the obstacle to reduction is formed by shortened tendons, fasciæ, or ligaments, and (*b*) those in which the obstacle is essentially due to some permanent alteration in the shape of the bones.

(1) **Treatment of cases where the deformity can be reduced by manipulation alone.**—It is mainly the very early congenital cases seen within the first few weeks after birth which come under this heading, and in them, if careful treatment be begun at once and carried out perseveringly, the deformity may be cured without the necessity for any operative procedure. In this early stage the deformity is essentially due to weakness of the muscles and to alterations in the shape of the bones, which, in their turn, are very possibly the result of some defect in the rotation of the foot during late fœtal life. The treatment of

these cases should, therefore, in the first place consist of manipulations designed to prevent the contraction of the muscles, and also to stretch any structures which are unduly tight; besides this, some form of retentive apparatus will be required to keep the foot in good position in the intervals between the manipulations. Both these measures tend to gradually restore the bones to their proper shape. Massage, and, in some cases, electricity should also be employed with the view of increasing the nutrition of the defective muscles. If the treatment be not begun at the earliest possible period, operative measures must precede it, since tight structures will have to be divided. Hence the treatment cannot be begun too soon; it should be commenced immediately the condition is noticed, which is usually within a very few days after birth.

(*a*) **Manipulations.**—The necessary manipulations are quite simple, but they should be carried out regularly and frequently and persevered with for a long time. They consist essentially in abduction and eversion of the foot at the medio-tarsal joint, and flexion of the foot upon the leg. It is of the greatest importance that these manipulations should be carried out quite gently, so as not to frighten the child or to produce pain; if pain be caused, spasm of the muscles on the inner side of the leg and foot is set up, and this offers an obstacle to the manipulations, so that the condition will be aggravated rather than improved. If, on the other hand, the manipulations be carried out gently and in a coaxing manner, the child becomes accustomed to them, does not resent them, and no spasm of the muscles occurs.

The front part of the foot should be grasped with the right hand while the leg is steadied with the left which embraces it just above the ankle joint. The metatarsus is then gradually carried outwards, until the inner border of the foot is quite straight. The right hand should next be slipped up a little more towards the heel, so as to grasp the whole foot, the toes lying between the ball of the thumb and the little finger. The entire foot is then gradually and steadily everted until the sole looks rather outwards, and while eversion is maintained the foot is gradually flexed at the ankle joint. The essential points in this procedure are firstly the unfolding of the anterior part of the foot, secondly, the overcoming of the inversion of the foot as a whole, and thirdly, the flexion of the foot at the ankle joint. It is of extreme importance to remember that it is not enough to produce eversion of the anterior half of the foot alone—that part, namely, in front of the mid-tarsal joint. This is a point often overlooked, not only in these early cases, but in those of every description, and the result is that after prolonged treatment, while the equinus and the faulty position of the front half of the foot have been overcome, the under surface of the os calcis looks inwards instead of directly downwards. It is of the utmost importance, therefore, that when the foot is everted the os calcis as well as the anterior part of the foot should be everted too.

After the foot has been brought into position by these manipulations, it should be held there with the right hand for from five to ten minutes, whilst with the left the leg is gently rubbed, and the muscles of the calf and front of the leg are steadily kneaded. These manipulations with the hand, and the accompanying massage, should be repeated three or four times a day, and after they have been carried out the foot should be put up on a proper splint, so as to prevent recurrence of the deformity in the intervals.

(*b*) **Apparatus.**—The most satisfactory splint for infants is the metal one already described (see Fig. 26); this should be bent, so as to fit the foot and leg in their faulty position, and, after these have been firmly fastened by bandages to the splint, one portion of the latter is grasped with each hand, and the limb is steadily and slowly brought into a position of eversion and flexion. This is quite easily done, as the copper bar yields to the firm pressure of the hand, but is of sufficient stoutness to prevent any recurrence of the deformity caused by muscular action on the part of the child. The splint should be worn continuously night and day, and should only be removed to allow of the manipulations and massage already described. When there is much weakness of the leg muscles, the galvanic current may with advantage be applied, but in the earlier stages it is better to avoid this, because it is likely to frighten the child, and, therefore, interferes with the performance of other treatment; in these congenital cases it is not of any real importance, seeing that there is no actual paralysis of any of the muscles concerned.

When the treatment is carried out methodically in this manner, it will be found that, at the end of three or four months from the commencement of treatment, the foot retains its position, even if the splint be left off for some little time; the splint should, however, be continued for at least two or three years after the deformity has been corrected. It must be remembered that, while the resistance of the muscles and the ligaments may be readily overcome, it takes a long time for the bones which are altered in direction to be moulded into their new position, so that, if the retentive apparatus be left off too soon, the deformity is almost certain to be reproduced. When the child begins to walk, an ordinary Scarpa's shoe will be more convenient and satisfactory than the arrangement just described. The method of employing Scarpa's shoe will be referred to immediately, (see p. 86).

So far, we have been speaking only of cases for which an intelligent nurse can be obtained, who can give the child constant attention,—conditions which of course only exist amongst the comparatively well-to-do. In practice among the poor, where there is difficulty in obtaining proper attendance, or where the parents are too stupid to carry out this treatment properly, the best procedure is to put the foot up in plaster of Paris in the corrected position at quite an early period of infancy. This is, however, not nearly so good a method of treatment as the one recommended above, as the plaster of Paris encloses the leg, and, therefore, the nutrition of the muscles is to some extent interfered with. The plaster also tends to be soiled by urine, and to get loose, and the skin beneath gets irritated and often ulcerated. In addition to these drawbacks, the foot of an infant is so small and yielding that it is very difficult to get a proper purchase upon it. If plaster of Paris be employed, it should be renewed at least once a week, and great care must be taken that the foot is held in the over-corrected position whilst the plaster is setting. This is difficult to do when the foot is held in position by the hands, because the bony points that have to be grasped in order to keep the foot in good position, are just those on which it is necessary that the plaster should get a good grip, and naturally, when the hand is removed, these parts are left unsupported, and must be subsequently covered.

In order to avoid this difficulty the best plan, in our opinion, is first to put the foot up upon a splint (preferably Sayre's apparatus), and then to encase the whole arrangement in plaster of Paris. The following are

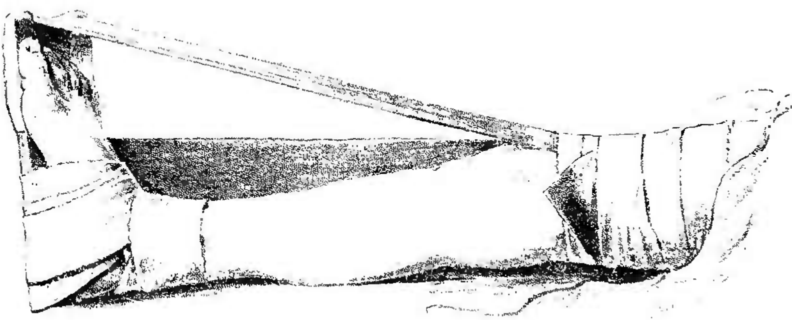


FIG 38.—SAYRE'S APPARATUS FOR EQUINO-VARUS. This is identical with that shown in Fig. 28, except that here there is the addition of the long outside strip of strapping designed to produce a certain amount of eversion of the foot.

the various steps in the procedure. First of all, the foot and leg, as high as the knee, are encircled by a boracic lint bandage. A piece of wood of suitable thickness, which may be cut from a cigar-box lid, is shaped to the sole of the foot, but made to extend about three inches beyond the tip of the toes (see Fig. 38). To this a long piece of strapping is attached in a manner identical with that described for talipes equinus; that is to say, the strapping begins on the upper surface of the splint in front, runs backwards round its posterior edge, and then forwards along its under surface around the anterior border. From this point the strapping must be long enough to extend rather more than half way up the thigh. The object of the strapping is to overcome the equinus deformity, but a second piece should be added to the splint so as to produce eversion of the foot. This should be attached to its outer border, immediately opposite the instep, carried transversely over the upper surface of the splint, around the inner border, then across the under surface to the outer border, and from this point the strapping must likewise be long enough to reach as far as the middle of the thigh. The splint, which is padded with boracic lint, is then applied to the sole of the foot and, in order to prevent it slipping backwards, a broad piece of strapping is carried sandal-wise around its posterior end and over the instep, whilst the rest of the foot is firmly fixed to the splint by a suitable bandage. The foot can then easily be got into a flexed and everted position by traction upon the free ends of the two pieces of strapping. The ends of these are pulled taut on the front and outer sides of the thigh respectively, and a bandage is firmly applied around the limb outside them. The redundant ends of the strapping are turned down over the upper edge of the bandage, and covered in by a few turns carried from above downwards over them. Thus the strapping, the thigh and the bandage are all firmly fixed together, and the foot retained in the corrected position. A plaster of Paris bandage is then applied to the foot and leg, and when this has properly set, the strapping may be cut through above and below the casing, and it and the bandage around the thigh removed; the foot is thus kept in position whilst the plaster of Paris is applied, without the necessity of holding it by the hand. Each time the plaster is removed and renewed the leg should be thoroughly rubbed and the galvanic current applied to the muscles.

When the child is old enough to walk it is better to substitute some form of apparatus for the plaster of Paris, and in poor patients, of whom we are at present speaking, probably the most suitable arrangement is the Sayre's apparatus, just described, without the plaster of Paris. The child walking on the flat piece of wood tends to evert the foot more and more, whilst the extra length of the splint fully corrects the equinus. The chief objection to the apparatus is that the strapping very soon slips, but this can easily be rectified by continuing the bandage below the knee so as to bring the strips of strapping in contact with the leg, and so to tighten the apparatus. In any case, however, it requires renewal every week.

(2) **In the second group of cases there are one or more tight structures** which oppose the reposition of the foot, and these must be divided before any other treatment can be adopted. In the earlier stages these structures are essentially tendons, fascia, or ligaments. The tendons chiefly affected are the tendo Achillis and those of the tibiales muscles. The fascia is the plantar fascia, whilst the ligaments are those around the astragalo-scaphoid joint, and also in some cases the anterior part of the internal lateral ligament of the ankle joint.

Although all these structures may require division before the foot can be got into proper position, it is advisable to carry out the rectification in two stages; in the first place, the various structures which prevent the reduction of the adduction and inversion of the foot should be divided, whilst the equinus is left uncorrected for a time; afterwards, when these deformities have been satisfactorily overcome, division of the tendo Achillis may be undertaken. This is a matter of great importance, because the tendo Achillis is of great value as forming a *point d'appui*, which fixes the posterior half of the foot and permits the proper unfolding of the anterior part. If the tendo Achillis be divided at the same time as the other structures, the greatest difficulty will be found in unfolding the anterior part of the foot from the want of such a fixed point.

**Tenotomy.**—The first stage in the treatment therefore consists in dividing all the various tight structures, with the exception of the tendo Achillis. In the first place, the tibiales tendons which interfere with the proper reposition of the foot must be divided, and in bad cases the tendon of the flexor longus digitorum will also require division.

*Division of the tibialis anticus tendon.*—The tibialis anticus tendon is usually divided just below the point where it crosses the ankle joint, and a little above its insertion into the internal cuneiform bone; at this point there is no risk of dividing any other structure. The position of the tendon can usually be defined by making it tense, which is done by abducting and everting the foot. A tenotomy knife is inserted on one side, close to the tendon, which should be relaxed so as to allow the knife to be insinuated between it and the skin. The cutting edge is then turned towards the tendon, which is again put upon the stretch by abducting and everting the foot, and is divided.

*Division of the tibialis posticus tendon.*—The tibialis posticus tendon is best divided through an open incision from one and a half to two inches above the internal malleolus, and immediately behind it. It is well, instead of cutting directly downwards on to the tendon, to turn aside a convex flap so as to avoid any risk of adhesion of the tendon to the cicatrix in the skin. A slightly curved incision is therefore made along the internal border of the tibia, with its convexity forwards, and the flap, containing skin and fascia, is turned back until the edge of the tibia is exposed; just behind it will be found the tendons of the tibialis posticus and the flexor longus digitorum. The former tendon lies next the bone and a blunt pointed tenotomy knife can be readily insinuated between it and that of the flexor longus digitorum. The knife is then turned towards the bone and the tendon of the tibialis divided. Should it be found that there is still some obstacle to abducting the foot, the tendon of the flexor longus digitorum may also be cut across; this, however, should be done on a different level to the division of the tibialis posticus. The wound is stitched up without a drainage tube and antiseptic dressings applied.

*Division of the plantar fascia.*—The plantar fascia if contracted must next be divided. This is necessary in many cases, and should be done just in front of the origin of the fascia from the os calcis. A tenotomy knife is introduced from the inner side of the foot, and carried across the sole between the skin and the fascia; it is important to remember that the skin is very close to the fascia, and that all resisting bands must be divided. As soon as one band is cut across, extension made upon the sole causes others to become tense, and these must also be divided, either from the same puncture or from another more conveniently situated. It is well also to divide the fascia from a second series of punctures somewhat further forward, and these should be made in front of the transverse crease of the foot. It is very important to make sure that the division of the plantar fascia has been thoroughly effected.

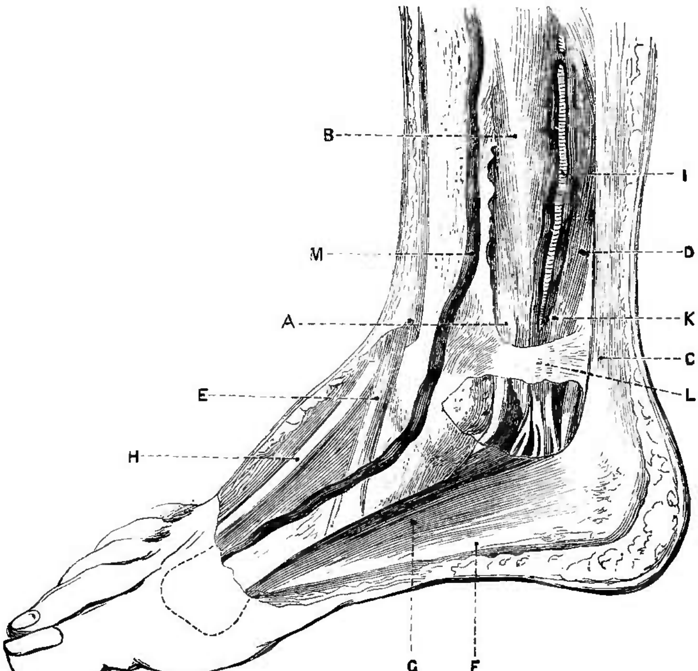



FIG. 39.—THE RELATIONS OF THE VARIOUS STRUCTURES REQUIRING DIVISION IN TALIPES EQUINO-VARUS.

A. Tibialis posticus tendon ; usual seat of division.
B. Flexor longus digitorum muscle; if it requires division this is usually performed a little lower down.
C. Tendo Achillis. Point at which it is usually divided.
D. Flexor longus pollicis muscle. Usually divided lower down.
E. Tibialis anticus tendon ; usual seat of division.
F. Plantar fascia. Point at which it is generally divided.
G. Abductor pollicis muscle.
H. Extensor longus pollicis tendon.
I. Posterior tibial artery.
K. Posterior tibial nerve.
L. Part of annular ligament.
M. Saphena vein. (*Erichsen.*)

Thirdly, in most cases, it is important also to divide the ligaments which oppose reduction. It is true that in comparatively mild cases the tight ligamentous structures may now be torn across by forcibly wrenching the foot into position, either with the hand alone, or with a Thomas's wrench, but in the majority of cases it is much better to divide the ligaments systematically in the manner recommended by Mr. Parker. This especially applies to the anterior part of the deltoid ligament of the ankle joint, which, if not divided, usually escapes tearing when the foot is wrenched, and may materially interfere with the reposition of the os calcis. Parker also lays great stress on what he terms the "astragalo-scaphoid capsule," which is made up, above and internally, of the superior astragalo-scaphoid ligament reinforced by fibres from the anterior ligament of the ankle joint and the anterior portion of the deltoid ligament, and, below, of fibres from the inferior calcaneo-scaphoid ligament.

*Syndesmotomy.*—Under this name, Parker has described an operation by which both tendons and ligaments may be divided through one incision. He makes a puncture a little below and in front of the tip of the internal malleolus, noting at the same time the position of the tibial arteries, and the direction of the tibial tendons as they curve towards the internal cuneiform bone. As the tenotomy knife is entered, the parts are fully relaxed, and it is pushed inwards over the dorsum just above the posterior tibial artery, and in front of the tendons, to a point just short of the anterior tibial vessel. Parker employs at first a sharp-pointed tenotome to make the track along which he then introduces a curved one until its tip can be felt in front of the tendon of the tibialis anticus. The cutting edge is then turned downwards, the parts fully put on the stretch, and the tibialis anticus tendon divided; as the knife cuts down on the subjacent bones and cartilage, the ligaments yield, while, on withdrawing the knife, the tendon of the tibialis posticus is divided. The essential point in this operation is, of course, the division of the ligaments, and this must be carried out very thoroughly. Should the tibialis posticus not be satisfactorily divided on the withdrawal of the knife, it can readily be done afterwards by a separate incision in the manner already described (see p. 82).

*Wrenching.*—After these structures have been divided, the foot should be thoroughly wrenched into position, and the deformity over-corrected; that is to say, the foot should be brought into a position of full abduction and eversion. If this can be effected by the hand, it is best, because the surgeon is then enabled to judge how much force he is employing, and at the same time there is not that bruising of the anterior part of the foot, which is almost a necessary accompaniment of the use of wrenches. On the other hand, when the foot is very small, it is difficult to get a proper hold of it, and, therefore, it may be necessary to employ some instrument to take its place, the best of these being Thomas's wrench (see Fig. 40). It is composed of two parallel metal bars covered with a thick india-rubber casing, and the bars can be approximated or separated by means of a screw in the handle of the wrench. One bar is placed transversely beneath the sole of the foot, just behind the ball of the great toe, whilst the other lies parallel to it over the dorsum. The bars are then approximated until the foot is well grasped, and it is then possible to manipulate the foot with the greatest ease.

*After-treatment.*—When all the resisting structures (except, of course, the tendo Achillis) have been divided, a collodion dressing should be applied over the tenotomy puncture, and the foot temporarily fixed on a splint. For the first two or three days the best arrangement is an internal splint, applied to the foot and leg. When the equinus is well marked it will be found that, after correcting the varus deformity, the foot lies almost in the same straight line with the leg, and that therefore the adduction of the foot and the inward bend at the tranverse tarsal joint can be remedied by a straight internal splint applied from the knee down to the toes. In three or four days' time, when the wounds have healed, it is well to put up the foot temporarily in a Sayre's apparatus, around which plaster of Paris is applied in the manner already described (see p. 80).

The subsequent treatment will depend to a large extent upon the patient's surroundings. In hospital patients who cannot afford any elaborate apparatus and who are unable to give proper attention to the care of the

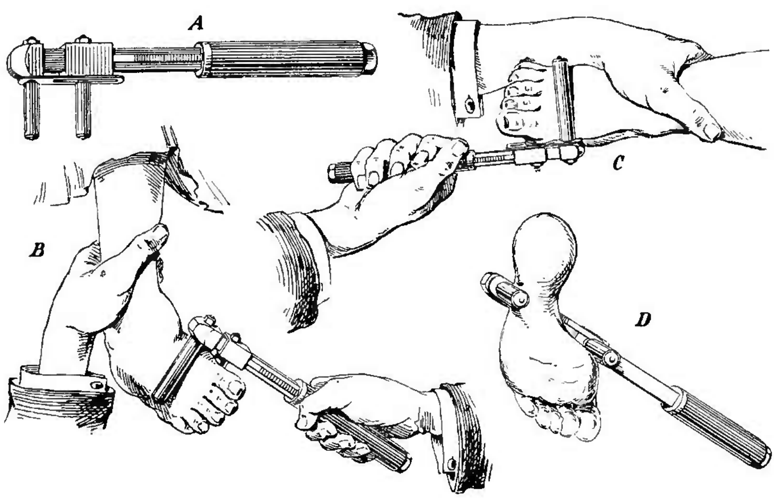



FIG. 40.—THOMAS'S WRENCH.—*A* shows the wrench, *B*, *C*, and *D* the methods of using it in a case of talipes equino-varus. (*Robert Jones.*)

foot, it is best to continue with the plaster of Paris bandages, which should be renewed about once a week, for from three to six months. Every time they are renewed the leg should be thoroughly rubbed and chafed, and the galvanic current applied to the muscles.

At the end of about six weeks or in some cases even earlier, it will generally be possible to carry out the second stage of the treatment, namely the correction of the talipes equinus. Before doing this, however, the foot must be very carefully examined in order to see whether any fresh shrinking of the ligaments or the plantar fascia has occurred. Should contraction have recurred, the tenotomy and wrenching must be repeated before the tendo Achillis is divided. The best indication of the proper time for the correction of the talipes equinus is that, when the apparatus is taken off, the foot should retain its corrected position, or, at any rate, it should be possible to at once make it resume it by the very gentlest pressure. When this stage has been reached, the tendo Achillis is divided and the equinus is treated on the lines already laid down (see p. 56). About three weeks later the patient may be allowed to walk about wearing a suitable apparatus; for poor people the most convenient is Sayre's (see Fig. 38). It can be renewed every week, and by means of it the foot is kept in good position. As the child walks on the flat sole-piece he everts the foot more and more, whilst the extra length of the splint tends to correct in a marked degree the talipes equinus as the patient vigorously bends the foot upwards on walking.

If the patient can afford a suitable apparatus, it is best to abandon the use of plaster of Paris about three weeks after the tenotomy, and to employ a suitable shoe or splint, with the use of which should be combined thorough massage of the limb and the occasional application of electricity. In young infants the splint with the copper band joining the leg- and foot-pieces, already described (see p. 49), is the best. It should be applied with the foot in the false position, and the varus deformity subsequently over-corrected. This splint should be taken off night and morning and the muscles thoroughly massaged and galvanized.

When the child grows old enough to learn to walk, or when treatment is not begun until the child is in the habit of walking, a Scarpa's shoe may be applied, and this should be worn continuously for many months and sometimes for years. It must always be remembered that, although the deformity may seem to be perfectly corrected, it takes a very considerable time for the shape of the bones to be materially influenced, and, if the apparatus be left off too soon, the deformity will inevitably be reproduced and often in a form which is more severe than it was originally.

*Scarpa's shoe* (see Fig. 41) consists of a leg-piece applied to the calf; on the outer side of this leg-piece is attached an iron bar connected with a foot-piece. Opposite the ankle there are two hinges, the upper one corresponding to the ankle joint proper, from which flexion and extension of the foot-piece is made, whilst the lower one raises or depresses the side of the foot so as to bring it into a position of eversion or inversion. Fixed to the outer side of the front of the foot-piece is a strong spring bent considerably outwards, and from this a band is carried around the anterior part of the foot which can thus be, by the outward pull of the spring, brought into a position of abduction. In some forms of the apparatus this movement is reinforced by a joint in the foot-piece beneath the instep, which, by means of a screw, is made to carry the front half outwards, and thus abduction of the front of the foot is more powerfully effected.

In applying a Scarpa's shoe the apparatus is first screwed into a position corresponding with the deformity, and the heel is then carefully fixed down to the foot-piece by the appropriate straps. When this has been done, the apparatus is fastened to the leg, and then the various racks are turned by keys and the deformity reduced as much as possible without giving pain. The reduction should not be carried so far as to cause pain, and there should be no undue pressure upon the straps which pass across the instep and fasten the heel to the splint, as otherwise sores may form beneath them. Much more will be done by gentleness and the gradual reduction of the deformity than by any violent attempt to over-correct it at once; the correction should be gradually increased from time to time until at last the deformity is over-corrected (see Fig. 41), but at no time should this cause any pain.

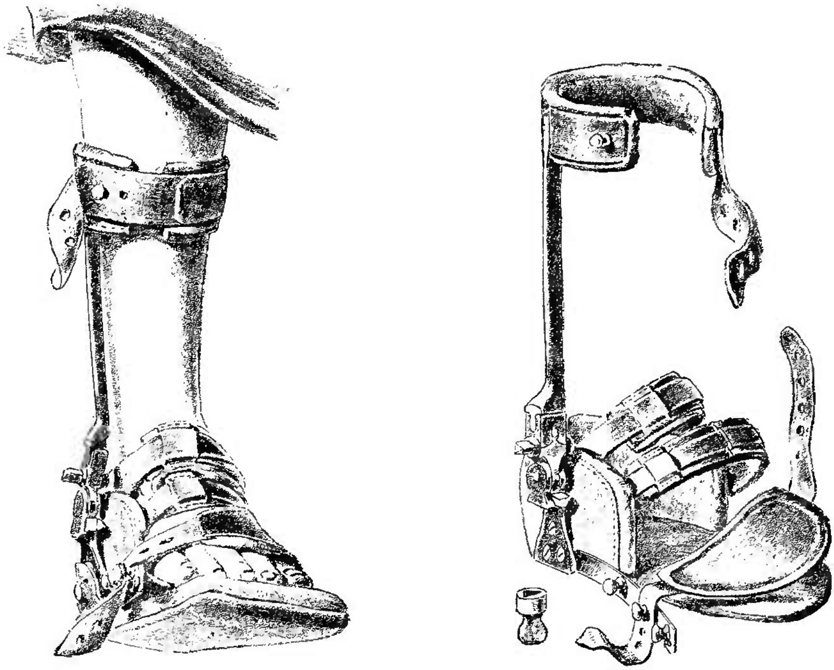


FIG. 41.—SCARPA'S SHOE. On the right-hand side is seen the apparatus before use. The two ratchets (turned by the key shown below the figure), the upper one for flexing and extending the ankle, and the lower for inverting or everting the foot, are seen near the junction of the outside leg-iron with the foot-piece. The broad sling used to pull outwards the front part of the foot is also seen in front attached to a button on the end of the stout spring attached to the outer side of the sole and exerting a forcible outward pull.
In the left-hand figure the apparatus is applied to a case of equino-varus. The foot is firmly everted, the toes raised, the heel depressed, and the front half of the foot pulled outwards. The shoe is put on when the foot is in the corrected or almost corrected position, and the over-correction obtained by turning the ratchets with the key.

The apparatus is likely to be of most service in children who can walk and who are over the age of three years; in younger children the foot is so small that the shoe cannot get proper purchase, and therefore the lighter metal splint is preferable. The shoe should be worn night and day, and should only be taken off for renewal and for the practice of massage and manipulations. Its use should be continued for several years—at the very least for three or four. The child may walk while wearing the apparatus. At the end of three or four years, when it is found that the foot retains its proper position when the child stands or walks, the splint may be dispensed with, but even then it is well to see that the boots are properly made to a cast of the foot in its corrected position, and in some cases a suitable spring or an artificial sole to raise the outer border of the foot is requisite. Even after the lapse of this length of time it is well to put on the shoe at night for another year or so in order to prevent the possibility of the foot resuming its deformed position whilst the patient is asleep.

(3) **The most severe cases of deformity.**—It is in the treatment of the third group of cases of talipes equino-varus that the greatest difficulty arises in practice. Here the obstacle to reduction is not merely the shortening of various soft structures about the foot, but also the more or less permanent alterations in the bones themselves. From the point of view of treatment we may divide these cases into two main groups: (*A*) those in which the patient is still young and the bones are soft and capable of being moulded to a certain extent, although the deformity in the osseous structures of the foot may be considerable; and (*B*) those in which the condition has remained untreated into adult life, and in which, therefore, the bones are fully ossified and have become firm and unyielding. In young subjects in whom the bones are still soft it is sometimes possible, even when there is marked deformity, to alter their shape and gradually to re-adjust the foot to its proper position by keeping up continuous pressure in the desired direction; this treatment, of course, is carried out in combination with free division of the resisting soft structures. In the more advanced cases, however, it is necessary to undertake some operative interference directly aimed at remedying the deformity of the bones.

(A) **The treatment of the first group** of cases consists either (*α*) in dividing all the resisting structures subcutaneously, and forcibly restoring the foot to its proper position by wrenches,—an apparatus, designed to keep up constant pressure on the bones, being subsequently applied, so as to mould them to their natural shape; or (*β*) in the performance of an open cutting operation by which all the soft structures causing the faulty position of the foot are divided, and the subsequent application of pressure in such a direction as to produce the required alteration in the shape of the bones. This latter operation is commonly known as "Phelps' operation."

(*α*) Of these methods, the milder is, of course, *the forcible restoration of the foot with wrenches* after all the resisting soft structures have been divided subcutaneously. This is done in the manner already described (see p. 84), and consists of tenotomy of any tight tendons, and division of the astragalo-scaphoid capsule, the plantar fascia and the internal lateral ligament of the ankle joint, (especially the front portion), followed by forcible wrenching of the foot, so as to tear through any ligamentous structures that may have escaped division. The later treatment consists in division of the tendo Achillis and the employment of various forms of apparatus, plaster of Paris, Scarpa's shoe, etc., so as to keep up constant pressure on the foot in the right direction, and thus gradually to alter the axes of the deformed bones. Nothing further need be said here concerning this method; it is only a somewhat more extended application of that already described for the second group of cases. In carrying it out it will often be found that the subcutaneous division of the tight structures must be repeated after an interval of from three to six weeks, and that the wrenching will also require repetition more than once. If, after a fair trial of this method of treatment, say for six months or a year, it be found that success is not likely to be attained, the surgeon must then proceed to some more severe operation, either Phelps' or some modification of it.

($\beta$) *Phelps' operation* is performed as follows. After the foot has been rendered thoroughly aseptic, it is placed with its outer side upon a firm sandbag, and an incision is made, commencing about half an inch in front of the tip of the internal malleolus, and extending downwards, and slightly forwards, to the sole. It is important not to carry this incision further down than the middle point of the sole, as otherwise trouble may afterwards ensue from pressure upon the scar in walking. The incision commences above, in close proximity to the tendon of the tibialis anticus, and it should divide all the structures down to the bone, and should run parallel to, and slightly in front of, the marked transverse crease in the foot, which corresponds roughly to the mid-tarsal articulation. The tendons of the tibialis anticus and posticus muscles, the plantar fascia and the muscles of the great toe are divided in this incision. As it is deepened in its progress to the bone, a portion of the internal lateral ligament of the ankle joint, and the ligaments about the mid-tarsal joint, are divided, and thus the head of the astragalus is exposed. When this has been done, the foot is forcibly wrenched into proper position, and any tight structures remaining undivided, and resisting the straightening of the foot, are thereby torn through. After this forcible straightening a deep triangular gap is left in the position of the incision, and this may either be left to heal by granulation, which is, of course, a very tardy process, or it may be covered in by skin-grafts, either immediately or, better still, after the lapse of about ten days. The method of skin-grafting has already been detailed in Part. I., p. 50.

The foot is secured to a metal splint in the corrected position. Should the tendo Achillis require division, as is generally the case, this is better done after an interval of from six to eight weeks, for the reasons which have already been mentioned (see p. 81). When the wound has healed, (which usually takes several weeks), the foot may be put up in plaster of Paris, and the after-treatment requires very careful attention. In these bad cases there is a very strong tendency to recurrence of the deformity, which is greatly aided by the contraction of the large scar left on the inner side of the foot; care must therefore be taken to counteract this tendency, and special precautions must be adopted for many months; in fact, the after treatment of these cases, when the wound has healed, is practically the same as that suitable for those in which a less severe operation has been done.

This operation has in many cases been very successful, although it is a somewhat drastic one; in order to mitigate its severity some surgeons have attempted to perform it subcutaneously by introducing the knife between the skin and the deeper parts, and then cutting everything right down to the bone. The objection to this is that the skin itself is always markedly shortened, and will not stretch; sloughing has also not infrequently occurred from the pressure of the extravasated blood beneath the skin, which is rendered unduly tense both by it and by the pressure brought to bear when the foot is forcibly straightened. The operation is more especially suitable for young children in whom the bones are still soft, and where the soft parts have contracted to such an extent that the deformity cannot be remedied by an ordinary subcutaneous division. It is not likely to be so successful in adults, or in those in whom the bone changes are extensive and permanent.

(B) **The operation required for the most severe cases,** such, for instance, as those where the patient has been allowed to grow up with the deformity uncorrected, will necessarily be more radical, and must involve *resection of some portion of the tarsus.* It will depend very much on the condition of the foot whether or not operative interference should be undertaken; some of these patients become so accustomed to use the limb with the foot in the deformed position that they can walk perfectly well, and hence, considering the severity of the operation, and the more or less imperfect result which may follow it, it is inadvisable to suggest operation to them. In other instances, however, there is so much pain and difficulty in walking from the formation on the outer side and dorsum of the foot of bursæ, which are constantly liable to repeated attacks of inflammation, that the patient urgently demands some operative interference which is then fully justified.

*Amputation.*—In those cases of this group, in which the exaggerated deformity is the result of infantile paralysis, and where there is almost complete uselessness of the foot, the question of amputation will arise. The answer mainly depends upon the vitality of the parts. In the paralytic forms the tissues are often very imperfectly nourished, ulcers are liable to form from the most trivial causes, chilblains are common, and consequently the result of extensive operations upon the skeletal structures of the foot is not at all satisfactory. It is therefore very much better under these circumstances to perform a Syme's amputation, and to fit the patient with an artificial foot, as he is then more likely to have a useful limb and to be free from trophic troubles, than after any partial operation which involves the retention of the foot. On the other hand again, in the congenital cases in which the nutrition of the foot is good, the question of amputation will only very rarely arise; it is only called for when repeated attacks of inflammation and suppuration in the various bursæ, possibly extending into the joints, have rendered the chance of remedying the condition by any form of tarsectomy very remote indeed. In such cases, however, Syme's amputation will leave the patient in a much better condition than before operation, or than could be obtained by any form of tarsectomy.

*The osteo-plastic operations* practised for the cure of club-foot are very numerous, but for all practical purposes they may be divided into two groups. In the first are those in which one or more of the tarsal bones are excised, and in the second are the operations involving the removal of wedge-shaped portions of the tarsus without any regard to the articulations of the portion removed. The operations included in the first group are numerous. Various tarsal bones, more particularly the astragalus and the cuboid, have been removed, but the results do not appear to be particularly good; the removal of the astragalus does not seem to influence the varus part of the deformity to any extent, while, on the other hand, it is of some value as a cure for the equinus.

The removal of wedge-shaped portions of the tarsus without regard to the articulation of the portion removed is, on the other hand, a valuable method. The operation, which is generally spoken of as "cuneiform tarsectomy," consists in removing a wedge-shaped portion of the tarsus at the transverse tarsal joint by means of a saw or chisel, the portion thus excised having its base directed outwards and slightly upwards, whilst its apex lies at the inner border of the sole. The amount of bone taken away will of course vary with the degree of deformity present, the object being to remove sufficient to permit the outer border of the foot to be shortened to the degree requisite to bring the concave inner border into its proper line. The parts included in this excision generally comprise portions of the os calcis, astragalus, cuboid, and scaphoid.

*Cuneiform tarsectomy* is performed as follows. The limb is thoroughly purified and steadied upon a sandbag, and the surgeon commences by dividing with a tenotomy knife all the shortened tendons, fascia and ligaments that can be reached on the inner side of the foot. This is similar to Parker's operation of syndesmotomy already described (see p. 84). It is important that this should be done before proceeding to divide bone, as otherwise an unnecessarily large amount of the tarsus will have to be removed in order to get the foot into proper position. One of the most important features in this preliminary procedure is the free division of the front part of the internal lateral ligament of the ankle joint, which will allow the os calcis to be pressed outwards towards its normal position, for in these bad cases the patient generally walks upon the outer side of the os calcis as well as upon the outer aspect of the dorsum of the foot. It is also advantageous to amplify the freedom of movement obtained after tenotomy by the use of Thomas's wrench (see p. 84).

After all the tight structures on the inner side of the foot have thus been relaxed to their utmost extent, the surgeon makes an incision along the outer border of the foot commencing at the base of the fifth metatarsal and terminating just in front of and about an inch above the tip of the external malleolus. This incision is carried directly down to the bone, and the soft parts are carefully raised in one mass from both dorsal and plantar surfaces of the tarsus by means of a suitable periosteum detacher. Although it is not absolutely necessary, the operation is greatly facilitated by making a second incision along the inner border of the foot, commencing just below and in front of the tip of the internal malleolus and terminating about a finger's breadth behind the base of the first metatarsal. This enables the soft structures to be raised from the bone on the inner side and thus the tarsus can be entirely denuded of all the soft structures, above and below, opposite the two incisions. It will be necessary to divide a portion of the extensor brevis digitorum muscle at its origin, and the insertion of the tibialis posticus tendon into the scaphoid will, in all probability, be cut through. After the soft parts have thus been thoroughly separated, they are retracted and protected from injury by the introduction beneath them of flexible copper spatulæ of suitable breadth, by which they can be forcibly pulled away from the bone.

The next stage consists in the removal of the wedge-shaped portion of the tarsus. As we have already said, the amount of bone to be removed will depend on the degree of the deformity, only sufficient being taken away to enable the foot to come straight. The section through the bone is best effected by a broad chisel (by means of which the surgeon is enabled to vary the amount removed at different parts), but as a preliminary measure it is well to mark out the intended dimensions of the wedge with a narrow saw. As mentioned above, the wedge should be so planned that its base is directed to the upper and outer surfaces of the tarsus, while its apex lies at the inner border of the sole. A section of this kind not only allows the front part of the foot to be raised but brings it also into a position of abduction. All bleeding is arrested and the foot brought into position. The surgeon then examines to see if enough bone has been removed; if not, the requisite amount may be sawn off.

The bleeding is arrested and the incisions are stitched up without the intervention of a drainage tube; with regard to the suturing there is a point of considerable importance that should be borne in mind. As a result of the long continuance of the foot in the faulty position, it will often be found that when the limb is brought straight the skin over the instep is very tight; if both the incisions be stitched up longitudinally a deep transverse groove forms between them over the dorsum of the foot, and the tension may be so great as to cause a partial sloughing of the skin. We are, therefore, accustomed to first of all stitch up the wound on the inner side in the ordinary way, and then, after having brought the foot straight, to suture the external one in any manner that will give rise to the least tension of the skin over the instep. As a rule this incision takes a somewhat ⊥-shape; that is to say, a certain portion of it at either end is stitched up longitudinally, but the central portion of the upper edge of the wound is folded upon itself and sutured together (see Fig. 42).

After the wound has been sutured the usual cyanide dressings are applied and the foot is placed upon a suitable splint. The best is a posterior splint along the back of the leg, furnished with a foot-piece at right angles, and the greatest care must be taken to see that the os calcis as well as the anterior part of the foot is well everted. As in the less severe forms of this affection, it is well to leave the division of the tendo Achillis until union has occurred between the bony surfaces. After about ten days, the stitches are removed and the foot is put up in plaster of Paris in the rectified position; this casing should be kept on for about a month. It may then be removed, and the tendo Achillis and, if necessary, the posterior ligament of the ankle joint, should be divided.

FIG. 42.—METHOD OF SUTURING THE WOUND AFTER CUNEIFORM TARSECTOMY. The upper lip of the wound is folded upon itself about its centre and the adjacent edges sutured together.

*The after-treatment* is that already dealt with in detail when speaking of talipes equinus (see p. 59), the chief trouble being the eversion of the os calcis, which is most difficult to remedy. The patient must be kept under observation and provided with careful mechanical treatment by suitable shoes for at least two or three years, for, even after an operation of this radical nature, a relapse may occur if the treatment be abandoned too soon. Should any tendency to a relapse manifest itself, it may be overcome at an early stage by wrenching the foot and again putting it up in plaster of Paris; but even up to the end of his life the patient should wear specially strong boots with the sole somewhat thickened along the outer border, and the inner side of the boot cut straight and made of very stiff leather so as to prevent adduction of the front part of the foot.

# CHAPTER IV

## CURVED TIBIA AND FIBULA.

CURVATURE of the bones of the leg is one of the commonest results of rickets. A certain amount of curvature of these bones may also occur in syphilis, osteitis deformans, osteo-malacia, and some other diseases. In the ricketty cases the degree and situation of the curve vary considerably. The most usual condition is a uniform curvature of the entire shaft of the bone with the convexity outwards and somewhat forwards, whilst the shaft becomes flattened from side to side, and there is a tendency to an increased production of bone which acts as a support in the concavity. In other cases the bend, which is somewhat more acute, occurs either just above the lower epiphysis or, more rarely, a little below the upper. This may be met with either alone or in combination with the uniform outward curvature. It is also not uncommon to find a very acute curvature forwards immediately above the lower extremity of the bone. In some quite rare cases the tibia may be convex inwards instead of outwards. The conditions met with most frequently, however, are an outward bowing of the limb or an acute anterior curve immediately above the ankle, or a combination of the two.

**TREATMENT.**—This should be partly general and partly local.

**The general treatment** should be that appropriate for rickets, since this disease is the primary cause of the deformity. The whole subject of rickets will be discussed fully in Part III. Here we need only say that its treatment is partly dietetic and partly hygienic. It may be well to append here the table of directions given to the mothers of ricketty children at Paddington Green Children's Hospital. These rules embrace both dietetic and hygienic instruction, and although mainly designed for the use of hospital out-patients may, with a little modification, be applied to private practice.

FOOD.

1. **Between 9 and 12 months.** Give cow's milk warmed and slightly sweetened. Not *Swiss* or any form of condensed milk. If diarrhœa or sickness

comes on, or curds appear in the motions, boil the milk and add one part of lime, barley, or rice-water to two parts of milk.

Give twice a day a meal of milk, thickened with Robb's biscuit or wheat flour, or Mellin's, Ridge's, Savory and Moore's Food. Nestle's Food, which does not require milk, may also be given. All infants' foods should be given in small quantities at first.

2. **At 12 months.** Besides milk, thickened as above, eggs with milk, gravy with bread-crumb, or well-mashed potato may be given; also rice, sago, arrowroot, semolina with milk; gruel and oatmeal porridge.

3. **At 18 months.** Give once a day a little fresh fish, such as plaice, or in addition, finely minced mutton.

Food should still be almost entirely milk and all things made with milk.

*Do not give* cheese, pastry, shellfish, salt fish, unripe fruit, nuts, sweets, tea, wine, beer or spirits.

*Feed at regular times*—not every time the child cries.

4. **Between 9 and 15 months.** Feed, by day, every three hours, and once during the night. Give one and a half to two pints of milk daily—plain, thickened and in puddings.

5. **After that age** feed every four hours by day, and give one pint of milk to drink during the day. Do not feed at night. *On no account* keep the child at the breast after it is nine months old. *Mother's milk* is useless to the child after that age: *and suckling is most injurious to the mother.* It is a mistake to suppose that suckling after this time prevents pregnancy.

## CLOTHING.

They should always wear flannel next the skin.

**By Night:** A long flannel night-gown, fastened below the feet and at the wrists and throat.

Let them sleep in cots by themselves—never in a draught, or between the window or fireplace and the door.

Bed-clothes should be warm and light.

Keep the window open all night in warm weather.

Keep a small fire burning all night in cold weather.

**By Day** (*a*) a flannel vest fitting closely round the neck—loosely elsewhere. All other clothing about the chest should be loose and warm.

(*b*) A well-fitting flannel binder round the belly reaching from just below the hips to the lowest part of the breast bone.

(*c*) *Flannel Drawers* should always be worn. They may be buttoned on to the binder, to which shoulder-straps should be added. The binder will then not slip up or down.

(*d*) In cold weather warm *stockings* or woollen gaiters *reaching to the top of the legs* should be worn.

All under-clothing as well as bed-clothes should be well aired before use.

## GENERAL DIRECTIONS.

1. Keep them out of doors most of the day in fine weather.

Do not let them be carried by other children not much bigger than themselves.

Get a perambulator in which they can lie down.

Wrap them up well, and use as a foot-warmer in cold weather a strong wine-bottle filled with hot water and placed in a thick stocking.

2. Keep them clean. Wash them all over night and morning with soap and warm water. Dry carefully with a soft warm towel. Then with the open hand chafe and rub the limbs from below upwards until the skin is rosy. The limbs should be

rubbed one by one, the rest kept covered meanwhile. The back, if weak, should also be rubbed.

Children will not take cold if they are carefully dried, especially the head and ears, and are well warmed after the bath.

3. Children with bow legs or knock knees should not be allowed to stand, walk, or crawl.

If their backs are growing out, they should be kept lying on their backs.

A perusal of these rules will show that the dietetic treatment consists largely in the avoidance of too much farinaceous food, and—a point of particular importance—the withholding of it at an early period of life. The hygienic treatment is directed essentially to obtaining an unlimited supply of pure fresh air and sunshine. The children should, if possible, be sent away to the country, and of course any other measures for improving the general health that may be found appropriate to any individual case should be adopted. Amongst drugs, cod-liver oil is the most generally useful, and in these cases it may be combined with phosphorus, $\frac{1}{100}$th of a grain of the drug being combined with each dose of the oil.

Vinum ferri (dose ʒi-iij), or syrup of the hypo-phosphites (dose ʒss—ʒj) may also be given. The state of the digestive organs will require particular attention, and especial care has to be taken to prevent the occurrence of constipation.

**Local Treatment.**—1. It is important to bear in mind that, **in the early stages** of the disease, there is a marked tendency to the spontaneous cure of the curvature, and to facilitate this the first essential is to prevent the patient walking, and thus to *take the weight of the body off the feet*, and so to avoid increasing the curve mechanically. Appropriate general treatment must of course not be neglected. In many of the slighter cases, when the patient is properly dieted, put under suitable hygienic conditions, and prevented from bearing weight upon the limb or from lying with the limb on its outer side (which would increase the curve), the bones undergo solidification, and the curve not only ceases to extend, but may actually disappear entirely.

2. **In the more advanced cases** it is necessary to take some active steps to correct the deformity, and, when there is a distinct bending of bones which are still soft (as will be the case when the ricketty condition is active), the employment of suitable *splints*, combined with taking the child off his feet and the administration of suitable internal remedies, will often ensure a perfectly satisfactory result. The best form of splint for this purpose is a straight internal one of wood, made slightly wider than the antero-posterior diameter of the leg. It should extend from just below the internal condyle of the femur to six or eight inches beyond the sole. It requires careful padding above and below opposite the tuberosity of the tibia and the malleolus, so as to avoid the possibility of ulceration from pressure. The splint is made to extend well beyond the foot in order to prevent the patient putting the toes to the

;round. It is important that it should project several inches beyond the ole, and not just an inch or two as is usually recommended; it is quite ›ossible, when the projection is not enough, for the child to point the oes and walk about on them. When the splint has been firmly fixed .bove and below, a broad piece of elastic webbing may be applied ›pposite the point of greatest convexity, so as to draw the limb gradually .nd gently outwards against the splint (see Fig. 43). When the curve is 'ery marked, so that there is a considerable tendency for the splint to lip round, it is a good plan to have a light iron bar screwed to the lower ›nd of the splint and fastened to the heel of the boot so as to prevent otation.

Although a great deal has been written about the influence of splints ›f this kind in straightening these cur-'atures, they are really of more use in ›reventing the deformity from becoming /orse, and thus allowing nature to ›bliterate it as growth progresses, than ı actively bending the bone back into ts normal position. This point is of he highest importance in practice, ›ecause, should the surgeon be under he impression that he is able to bliterate the curve by splints, he is pt to apply so much force as to roduce ulceration at the points of reatest pressure, namely, over the onvexity of the curve or opposite the nee and ankle. It may safely be ıid that unless the bones are so soft ıat they can almost be straightened y the hand, the application of splints ın produce very little real alteration, ıd their usefulness lies entirely in the fact that they prevent the curve om increasing, and thus aid the obliteration of the deformity by the natural ·ocesses of growth.

FIG. 43.—INTERNAL SPLINT FOR BOW LEGS. The projection of the splint well beyond the toes is shown. The bandage over the convexity of the curve may be of elastic webbing if great care be taken not to exert too great a pressure.

In addition to splints it is very advantageous to employ *massage* and *:ctricity*, to allow of which the splint should be removed night and morning. t the same time the limb may be *douched* and attempts made to reduce e curvature by steady *manipulation*; a great deal can actually be done ' the nurse in this direction. The limb should be grasped at the .tremities of the curve, the thumbs applied opposite the point of greatest ·nvexity, and then by steady and gradual pressure—but not sufficient to use the child pain—the bone may be gradually straightened.

The cases that are most rebellious to the treatment by splints are ose in which there is an *acute anterior curvature* immediately above the ankle, the articular end of the bone being carried backwards. Very little purchase can be got upon the lower portion of the bent bone by the application of a splint, and, moreover, as any apparatus of this kind must obviously be applied either to the anterior or posterior surface, it is somewhat difficult to employ one that is quite suitable. Probably the best form is the anterior splint known as *Syme's horse-shoe splint* (see Fig. 44), which will be dealt with more fully when we come to describe Pott's fracture. It consists of a straight piece of wood which is about the width of the transverse diameter of the limb, running down over the crest of the tibia and expanded below, where it is hollowed out so as to form a horse-shoe into which the instep is received. Owing to the fact that the splint lies along the crest of the tibia, it requires extremely careful padding to prevent the development of pressure sores. The best plan is to apply two long firm pads, one on either side of the crest and projecting well above

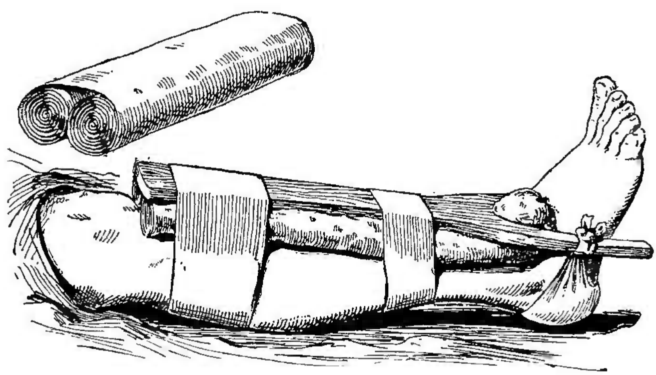


FIG. 44.—SYME'S HORSE-SHOE SPLINT. The sling embracing tbe heel may be made of elastic webbing. The smaller figure shows the method of rolling up lint to make the padding.

it, or else to take a large sheet of lint and roll up the two opposite sides until they meet in the centre, and thus form two rolls of padding connected across the middle; these are applied one on either side of the crest of the tibia. The splint is firmly fastened to the leg opposite the tubercle of the tibia, and an extra large soft pad is placed over the crest of the tibia opposite the point of greatest curvature. The heel is then enveloped in an elastic band, or a suitable piece of elastic webbing, the ends of which are attached to the prongs of the splint, and by which, therefore, a steady pressure, which can be increased or diminished at will, is exercised upon and tends to pull forward the heel. This arrangement is better than a posterior splint, by means of which an attempt is made to push forward the heel whilst backward pressure against the splint is made over the point of greatest convexity. The result of that generally is that too much pressure is exerted upon the heel, and a sore results.

Should the leg be bowed outwards as well as forwards, a second splint must be applied to the inner side of the limb, and these splints nay either be fastened together or, better, should be put on indepenlently. The mechanical treatment of this particular form of deformity s, however, very unsatisfactory, and in most cases operation will be called or after the acute stage of the rickets has passed off. Should the oncavity of the curve be outwards, a straight splint should be applied vith the same precautions to the outer side of the limb and the bones lrawn outwards to it.

In any case the use of the splints must be continued for a very prolonged period. The reduction of the deformity can only be carried out extremely gradually, owing to the risk of producing pressure sores, and several months must elapse before the patient can be allowed to stand or walk; indeed, the splints should not be abandoned until the child is four or five years of age—not, in fact, until all signs of active rickets have disappeared, and the bones have undergone consolidation.

3. **In cases of marked curvature where the bones have undergone solidification** (as is usually the case in children over the age of four or five), and generally in most cases where the curve is an antero-posterior one, some form of *operative procedure* is advisable. The chance of bringing the limb straight by splints is extremely slight under these conditions, and, generally speaking, it is a waste of time and money to persevere with them. The exact nature of the operation will be determined of course by the precise form and extent of the curve; the seat of the operation will also to some extent be determined by the same factors. When there is a general concavity of the tibia inwards, division of the bones should be practised about the centre of the curve. When the latter is distinctly limited to either the upper or lower part of the bone, the point of division should be opposite the point of greatest curvature. In the cases of acute antero-posterior curvature at the lower end, the bone should be divided at the acute angle formed by the curve.

Several points require consideration in connection with the operation. Thus the surgeon may be content either with simply dividing the bone, that is to say, performing a linear osteotomy, or he may remove a wedge-shaped portion from it. It is also important to consider whether the fibula requires division or not. As regards the latter point, it may be said at once that sometimes the fibula is so soft that it is quite unnecessary to divide it; frequently it can be bent without being broken, and at most a greenstick fracture may be produced by bringing the limb into proper position. When either of these procedures can be carried out it is of course of considerable advantage, as there is only a single wound, and a fairly strong bone is left to act as a splint to the other. When, however, the ricketty condition has passed off and the bones have undergone complete consolidation, and more particularly in the case of the antero-posterior curvatures at the lower end of the bone, it may be necessary to divide the fibula as well as the tibia. This is a matter of great simplicity; the bone can be exposed at the requisite spot by a suitable small incision over its outer side, and nipped across by a pair of cutting pliers after the periosteum has been separated by a rugine. This is generally all that is necessary. Removal of portions of the fibula is rarely called for except in some few cases when the curve is very extreme and the bones will not come straight until the ends of the fibula overlap one another; enough must then be removed to bring the ends into contact without overlapping.

The main factor determining the choice between a linear osteotomy and the removal of a wedge from the tibia is to a great extent the amount

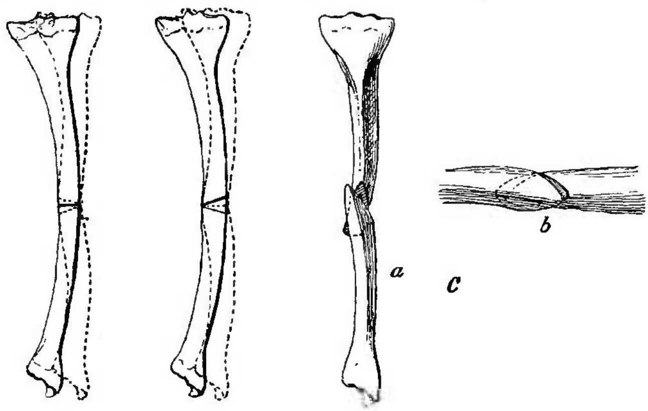



FIG. 45.—VARIOUS FORMS OF OSTEOTOMY OF THE TIBIA.

*A*. SIMPLE TRANSVERSE LINEAR OSTEOTOMY. The thick lines show the original position of the bone and the line of bone section. Tbe dotted ones show tbe position of the fragments when the bone is straightened. It will be seen that a large gap, whicb may lead to non-union is left when the curve is marked.

*B*. CUNEIFORM OSTEOTOMY. It will be seen from the figure how the triangular gap is converted into a linear division when the bone is straightened.

*C*. OBLIQUE OSTEOTOMY. The first figure shows tbe oblique metbod applied to a lateral bending of the hone—in this case a curvature outwards—while the second shows it applied to an antero-posterior curve, the upper border of the figure being the crest of the tibia. The figures also show the metbod of rotation after the section has been made.

of curvature present. When this is not very marked, a *linear osteotomy* will meet all the requirements of the case; when the curvature is extreme, and more especially when it is so acute as to form almost an angle, it is advisable to remove a wedge. This is particularly the case with the antero-posterior curve at the lower end of the bone, to which we have referred, and in which mere transverse division of the tibia will not allow the deformity to be rectified; the only procedure which makes this feasible is the removal of a wedge with the base directed forwards. In the ordinary bow-legged deformity the base of the wedge removed should of course look outwards.

*Cuneiform osteotomy of the tibia.*—The operation is a simple one, and is performed by making an incision down to the bone along the crest of the tibia over the point of greatest curvature for a distance that will ary with the amount of bone requiring removal. The periosteum is eparated on each side by a rugine, and then the bone is either cut lirectly through with a chisel, or a wedge is taken out of it. The wedge nay be easily removed by means of a chisel, though some surgeons refer to use a saw, at any rate for marking out the portion of bone to e removed, the division being then completed with a few strokes of the hisel. This is preferable to using the saw throughout, as there is some langer of injuring the structures of the calf when the posterior surface of he tibia is divided.

After enough bone has been removed to allow the limb to be brought straight, he wound is stitched up and the usual antiseptic dressings are applied. It s seldom necessary to wire the fragments together, but, in cases of marked ntero-posterior bending just above the ankle, it is sometimes of considerable

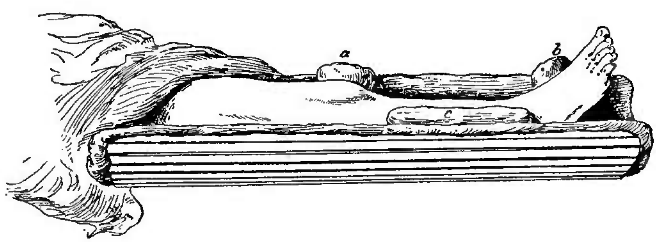



FIG. 46.—METHOD OF PUTTING UP THE LIMB AFTER OSTEOTOMY OF THE TIBIA. For the sake of clearness no dressings are shown applied to the limb. There is one fairly long pad (*c*) applied over the convexity of the curve, and two small thick ones (*a* and *b*) on the opposite side of the limb, between the splint and the inner condyle of the femur above, and the inner malleolus below.

dvantage to do this in order to prevent the foot falling back. In these ases also it is sometimes as well to divide the tendo Achillis, which would therwise have a great tendency to pull the heel back into its faulty osition. Where linear osteotomy is preferred to the cuneiform variety, it s well, if possible, to make the section of the bone as *oblique* as ossible, so as to get a broader surface for union, and in Fig. 45 *C* is illus- rated a method by which this oblique section can be so adapted to lifferent curvatures as to allow the deformity to be reduced with the least eparation of the bony surfaces.

*After-treatment.*—The limb should be put up on a splint, and for this urpose we generally employ a trough of Gooch's splinting (see Fig. 46) or the first few days until the wound has healed and the stitches are emoved. This trough is cut of sufficient breadth to surround rather nore than half the limb, and to extend from the fold of the buttock, here it is cut away obliquely from within outwards and upwards, to ell below the foot. A portion of the splint should be cut out opposite he heel so that no injurious pressure shall be exerted, but in quite small hildren this need not be done; instead, the padding may be so arranged hat the heel is pushed somewhat forward and at the same time does not press upon the splint. The limb is made to fit the splint exactly by means of a number of pads of suitable size and shape packed in on each side and below the limb, which may thus be fixed in any position that is most suitable. It is well to place a special pad over the front of the knee and leg, and by graduating the padding any desired amount of inversion or eversion of the foot can be obtained; generally speaking a large long pad should be applied opposite the point of greatest convexity of the curve that it is required to obliterate, and smaller thicker ones between the ends of the bones and the side of the splint. The latter is then fastened round the limb by broad bandages, and the whole is laid upon an inclined plane to which it may be secured by one or two strips of bandage.

In about a week or ten days the splint may be undone, the stitches removed, and a collodion dressing applied. Any additional correction of the deformity may then be made, if necessary, under an anæsthetic, and the limb put up in the fully rectified position in a plaster of Paris or silicate of potash bandage and left for about six weeks for union to occur; it is of course necessary that the foot should be strictly at right angles. In six weeks' time the old bandage may be taken off and a fresh one applied for a similar period, when the union should be thoroughly firm. For another six weeks the patient is forbidden to bear weight upon the limb, to which massage and passive movement should be regularly applied. At the end of this time, that is to say, in from four to five months after the operation, all treatment may be discontinued and the patient allowed to walk.

# CHAPTER V

## GENU VALGUM: GENU VARUM: GENU RECURVATUM.

### GENU VALGUM.

By the term genu valgum or knock-knee, is understood a deformity of the lower extremity in which the leg is deflected outwards, so as to form with the thigh an angle which is smaller than the normal. It may appear at two periods of life; either quite early, during the first five or six years, or during adolescence.

**CAUSES.**—The ordinary form of the affection arises spontaneously, but a similar deformity may appear under other circumstances. For example, it may follow some injury or disease of the lower end of the femur, which destroys the outer part of the epiphyseal line, so that whereas normal growth takes place on the inner side, it is arrested on the outer, and the leg, therefore, becomes deflected outwards. Some amount of genu valgum is fairly common in association with osteo-arthritis of the knee joint, and it is also met with in connection with Charcot's disease of the knee. It is also a not infrequent sequela of infantile paralysis, and it may result from any accident involving rupture or extreme stretching of the internal lateral ligament of the knee joint. It may sometimes arise after excision of the knee, when the patient is allowed to get about too soon, and the weak union between the bones yields and allows the production of this angular deformity; another cause of its occurrence after excision is that the bone section may have damaged the outer part of the epiphyseal line, and have left the inner part intact, so that growth occurs normally on the inner side, while it is arrested on the outer.

We shall here only deal with those forms of genu valgum which occur spontaneously in infants and young adults without the occurrence of any injury, operation, or paralysis. There has been considerable discussion as to the nature of the deformity in this variety. It is attributed by some to alterations in the rate of growth of the internal condyle, by some to a deficient development of the external condyle, whilst by others again it is attributed to curvature of the shaft of the femur, or of the upper end of the tibia. Considerable difference of opinion also exists as to the causation of the disease. By some it is held to be always due to *rickets*, whilst by others it is attributed (particularly the form occurring during adolesence) to laxity of the internal lateral ligament, which tends to throw increased pressure on the outer side of the joint and so to produce an arrest of development there, whilst increased growth occurs on the inner side. Recent researches, however, in particular the work of Mickulicz, appear to throw considerable light on the true pathology of the affection. It has been shown that neither in the child nor in the young adult is there any change in the epiphyses of the femur or the tibia. In the femur there is no increased length in the internal condyle, and no diminution in the external; the whole change apparently occurs in the diaphysis in the immediate neighbourhood of the epiphyseal line. It has also been shown that these changes are not limited to the femur, but affect the tibia to a corresponding degree, so that in all cases of marked genu valgum the bones of the leg show a curvature as well as the femur. This is a point of the greatest importance to remember in determining the treatment.

In young children, as well as in adolescents, the condition is essentially due to a softening of the bones; in the former, the disease seems to be invariably of a ricketty nature, whilst in young adults it is not improbable that this is also the case, although it is frequently impossible to find any ricketty change, except the softening of the bone. Whether the disease in adolescence be due to rickets or not, the facts remain that, before it can occur, the bones must be soft enough to undergo bending, and, further, that the curvature occurs in the diaphysis immediately above the epiphyseal line. The changes in the femur consist of an outward bending at the lower end of the shaft, and an extension downwards of the diaphysis on the inner side, so that the epiphyseal line is altered in position and runs obliquely from without, downwards and inwards. In the tibia the change occurs in the diaphysis immediately below the epiphyseal line, and results in an outward curvature of the bone at that spot. In addition to the alterations in the immediate neighbourhood of the knee joint, certain other changes are also met with in this condition. In young children, especially, there is a tendency to hyper-extension of the joint itself, whilst the femur becomes rotated outwards, so that in walking the foot may be markedly everted. Flat foot is also very frequently an accompaniment of the affection, and in some cases it may probably be the actual exciting cause of the deformity, the alteration in the foot throwing the line of transmission of the weight of the body somewhat outwards. This diminishes the pressure on the inner part of the lower end of the femur, increases it on the outer side, and thus produces the curvature. The condition is generally bilateral, especially in young children, although it is generally worse in one leg than in the other.

**TREATMENT.**—This is partly general and partly local. The **general treatment** must be directed to the removal of the cause which produces softening of the bones, and as, in the great majority of cases, this is rickets, the general treatment is essentially that of this affection; this has already been referred to more fully in speaking of bow legs (see p. 94), and we need not return to the subject here.

**Local Treatment.**—This will depend primarily on the degree of the deformity. Up to a certain point, divergence of the legs is a condition that may be comparatively easily remedied by manipulations or apparatus. When it gets beyond that point operative interference will be necessary. It is essential first of all to estimate the amount of deformity present, and this is best done by putting the patient flat upon the back upon a table (not a yielding bed), and bringing the femora parallel with one another with the patellæ looking directly upwards, and the internal condyles separated by about half an inch. The distance between the internal malleoli is then measured, and those cases are reckoned as mild ones which can probably be put right by manipulations, etc., in which the distance between these two points is not greater than three, or, at the very outside, four inches. When the separation is greater the case may be reckoned as bad, and when it reaches as much as six inches and upwards it is almost certain that operative interference will be required before the deformity can be remedied. In these bad cases it will also be noted that the patella is very frequently displaced outwards, and no longer lies in the inter-condyloid notch.

(1) **Cases in which the separation between the malleoli does not exceed an inch and a half.** Here there is every probability that the limbs will become straight without any special local treatment, if the child merely be *kept from walking*, and if proper attention be paid to the general treatment. It is, however, often necessary, in deference to the wishes of friends, to employ some local treatment which may possibly do a certain amount of good, and which should take the form of *manipulations and massage*. The limb should be rubbed and massaged twice or thrice daily, and, during the process, the mother or the nurse should fix the thigh, and keep the knee extended with the patella directed forwards, and should then gently and gradually press the leg and foot inwards, and hold it in this position for a few minutes at a time. If this be carefully done, and the child entirely prevented from walking meanwhile, the deformity is most likely to disappear completely without any further treatment, but the restriction as to walking must not be removed until the active period of rickets has passed, until in fact the child is from five to six years old. It is often, however, a matter of extreme difficulty to prevent children from walking or crawling about, and in some cases, doubtless, the general health may even suffer from the constant confinement to the recumbent position. Under these circumstances the rule may be relaxed to the following extent. The child may be allowed to go out into the sunshine and run about in the fresh air, but all walking or crawling about the house is absolutely prohibited. As soon as he comes indoors he should be made to lie down

and the limbs should be rubbed, and the manipulations above indicated for the rectification of the deformity carried out.

When the child is allowed to run about during the day in the open air, the limb should be confined on a *splint* at night. In young children the best form of splint is a Thomas's hip splint, in which an outside bar of iron connects the bands surrounding the thigh and leg (see Fig. 47). The splint is fixed on in the usual manner, the band around the thorax is fastened in position, and the trunk secured to the upper part of the splint by means of a flannel bandage. The thigh and leg are then fastened to the splint, and a broad piece of elastic webbing, well padded opposite the internal condyle, is passed around the knee and fastened to the outside iron band so as to draw the knee outwards. The knee must not be

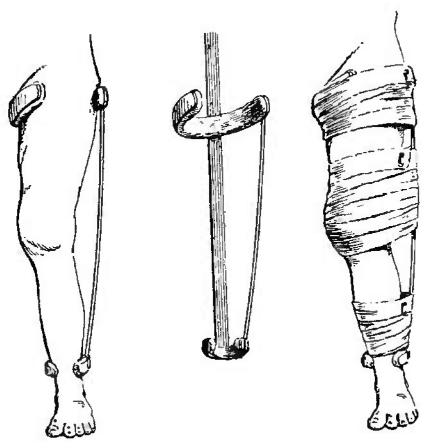


FIG. 47.—THOMAS'S HIP SPLINT, ADAPTED FOR USE IN GENU VALGUM. This is an ordinary Thomas's hip splint to which is added an outside iron bar joining the lateral wings above and below the knee. This iron may be prolonged below the foot so as to prevent the patient from walking. (Modified from *Hoffa*.)

allowed to become flexed, or else the pressure is of no avail in remedying the deformity; care must, likewise, be taken to prevent rotation of the limb at the hip joint, which would render the outward pull upon the knee nugatory. If, however, the leg and thigh be carefully bandaged to the splint before the elastic pressure is brought to bear on the knee, and if the bands of the splint be closely applied to the limb, this is not likely to occur. The splint should be removed in the morning, the limb washed and rubbed, the knee manipulated as before, and then, when the day is warm, the child may be allowed out in the sunshine, to crawl or play about.

(2) **The cases in which there is a separation of from three to four inches between the malleoli.** Here the child should be kept entirely off his feet, and should wear both day and night a *splint* designed to pull

the knee outwards; the best is an external splint furnished with a band around the knee so applied as to pull the latter outwards. The chief disadvantage of a splint of this kind is that the child generally manages to rotate the leg outwards, and thus the band which should bring the knee against the splint is rendered ineffectual. Directly any outward rotation occurs, the band ceases to act upon the deformity, and simply bends the knee. Care should therefore be taken to see that whatever splint be applied this rotation is impossible. In young children the modification of Thomas's splint just described answers very well, and its action may be still further increased by prolonging the lower end of the iron bar downwards for three to four inches beyond the foot so as to present an effectual bar to walking.

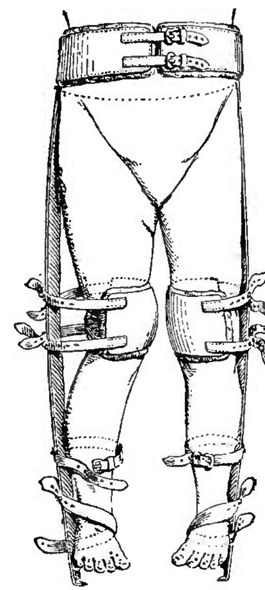


FIG. 48.—SPLINT FOR USE IN GENU VALGUM. As this necessitates the wearing of a boot, it is more suitable for older children. It is more powerful and effectually prevents either flexion of the knee or rotation of the limb. (Modified from *Hoffa*.)

Another splint which answers extremely well and which is more suitable perhaps for rather older children, is one in which there is an outside iron running from a pelvic band above to a slot in the heel of the boot below and which therefore prevents rotation. It, of course, necessitates the wearing of a boot both day and night, but this may be specially designed and is no great objection. When the outside iron is hinged to the heel and fastened in position by means of the pelvic band, the knee is drawn outwards against the splint by means of a broad elastic sling (see Fig. 48).

Children are very often allowed to walk about wearing various forms of *apparatus* which allow the knee joint to be bent and which, at the same time, are supposed to pull the knee outwards, but these are usually extremely inefficient; they are much too heavy for the weakly children who have to carry them, they are very expensive and they do not exert much influence upon the deformity. Indeed, considering the extremely satisfactory results of operative interference and the infinitesimal risks attaching to it, it is very much better to operate at once when it is essential for the child's comfort that he should walk about and when he cannot do so without an apparatus of this kind.

The mechanical treatment of genu valgum, whether in the child or the adult, must be persisted in for a long time. It must not be given up until the active stage of rickets has entirely passed off and the softening of the bones has disappeared. When the rickets is cured, there is not much chance of further increase in the deformity, and this is an additional argument against the view that the softening of the bones is not a necessary part of the deformity. In young children the active period of rickets generally lasts until they are about four or five years of age, and up to this period the deformity will certainly recur if the apparatus be left off, even though it may have entirely disappeared under treatment. Hence, we may say that in all cases of knock-knee treated by rest and mechanical means, the treatment must be persevered with very carefully until the child is at least four or five years of age. At that age the bones will generally be firm enough to prevent any further increase in the deformity.

(3) **Cases in which the separation between the malleoli is greater than four inches, or where, in spite of splints, a marked separation exists after consolidation of the bones is complete.**—In either of these groups comparatively little benefit can be expected from mechanical treatment. As a rule it is found that, in spite of prolonged mechanical treatment and much expenditure of time and money, the deformity will remain imperfectly corrected, and something further will have to be done if the limbs are to be restored to their normal condition. At the same time it has to be remembered that there is no advantage in performing osteotomy while the bones are still soft, because the deformity will almost certainly recur after the operation, when the patient is allowed to walk about. Hence, if for any reason osteotomy should be done before the bones are quite firm, the patient must be kept off his feet afterwards, and the other treatment mentioned above must be adopted, just as if no operation had been employed. We are accustomed to make the rule that, even when there is marked deformity which brings the case within the group we are now considering, the operation should be deferred until the child has attained the age of four or five, or indeed longer if the soft condition of the bones has not then completely disappeared. In the meanwhile, of course, treatment by splints, etc., described above, is carried out, partly with the view of correcting the deformity to some extent, but mainly in order to prevent it from becoming exaggerated. When, however, the child has reached the age of four or five, and there is evidence that the bones are becoming firm, and when there is still a separation of more than three inches between the malleoli, it is quite uselcss to persevere with mechanical treatment, whilst operation furnishes a satisfactory and rapid cure.

In young adults the mechanical measures which are so frequently employed seldom produce a satisfactory result, and it is a sad thing to see these patients going about wearing a cumbrous apparatus, and spending a considerable amount of time and money in attempts to rectify a deformity that can readily bc put right by a comparatively simple operation. In young adults suffering from genu valgum, therefore, we would advise operation in all cases in which the distance between the malleoli is two inches or more, provided that consolidation has occurred in the bones. It is, however, not so necessary to wait for complete consolidation in adults as it is in children. Generally this will occur while the patient is lying in bed after the operation, and if care be taken not to allow the entire weight to be borne upon the limb too soon and if suitable hygienic and other measures be employed, there is little risk of the deformity recurring.

**Osteotomy.**—Various forms of operative procedure have been employed in these cases. Those in which the bone is broken without producing an external wound may be at once dismissed as unsuitable; it is impossible to gauge the amount of injury done, or the exact seat of the fracture produced, while, considering the great safety of the ordinary operation, there is not the least advantage in its use. Amongst the open operations, the following are most frequently performed: division of the shaft of the femur; division of the bone just above the epiphyseal line (known as Macewen's operation); an oblique section through the internal condyle of the femur which is then made to slip upwards (or Ogston's operation); division of the tibia below the upper epiphysis; or division of both femur and tibia. Of these, two, viz., division of the shaft of the femur itself, and Ogston's operation, may at the present time be excluded. Formerly Ogston's operation was a good deal practised, but it is based upon the theory that the essential factor in the production of the disease is an elongation of the internal condyle; this we now know to be wrong, and, as the operation interferes with the knee joint, which is necessarily opened in performing it, it has been found much less satisfactory than the division of the femur introduced by Macewen. We shall therefore here only consider three operations, namely, division of the femur just above the epiphysis, or Macewen's operation; division of the tibia below its upper epiphysis; and the combined operation of division of both tibia and femur (see Fig. 49). From a consideration of the pathological changes present, it is evident that correction of the deformity in bad cases can only be obtained by the combined operation, and it may be laid down as a general rule that when the interval between the malleoli is as much as six inches or more, this is the procedure that should be adopted. In the less severe cases, however, good results may be obtained by dividing either of the bones alone, and as a matter of practice it is found that it is immaterial whether the femur or the tibia be selected for division. Probably a neater result is obtained by division of the tibia. The femur is, however, the bone most usually divided, but the result of this operation (Macewen's) is often to produce a very unsightly bowing outwards and forwards in the lower third of the bone.

(*a*) *Macewen's osteotomy.*—In dividing the femur by Macewen's method, the section is made from the inner side, and the deformity is rectified, partly by squeezing together the bone on the inner side of the femur, and partly by opening out an angle on the outer side. Some surgeons prefer to divide the bone partly across from the outer side, and then to convert this incision into an open angle by producing a green-stick fracture on the inner side; this is certainly the easier operation, and the one that gives the better rectification at the time. In order to perform Macewen's operation, the patient, after he has been fully anæsthetised, should lie upon the back, with the limb abducted and rotated outwards, and supported on a firm sandbag of suitable size. The hip and knee joint should both be flexed. The following is a description of the operation in Macewen's own words:

"A sharp-pointed scalpel is introduced on the *inside* of the thigh at the point where the two following lines meet, one drawn transversely a finger's breadth above the superior tip of the *external* condyle, and a longitudinal one drawn half an inch in front of the adductor magnus tendon. The scalpel here penetrates at once to the bone, and a longitudinal incision

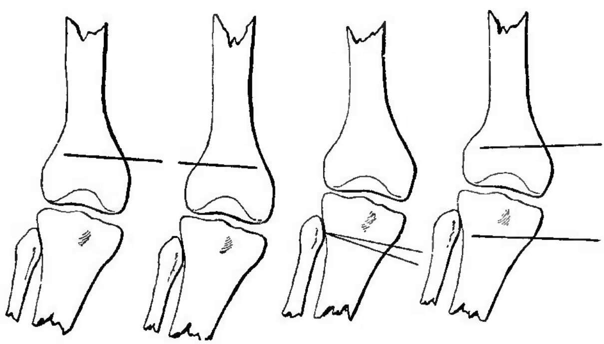



FIG. 49.—VARIOUS FORMS OF OSTEOTOMY FOR GENU VALGUM. *A*. Macewen's operation. *B*. A similar operation, the section being made from the outer side instead of tbe inner. *C*. Division of the tibia below its upper epiphysis; this may eitber be linear or cuneiform. *D*. Division of both femur and tibia. (Modified from *Hoffa*.)

is made, sufficient to admit the largest osteotome and the finger should the surgeon deem it necessary. Before withdrawing the scalpel, the largest osteotome is slipped by its side until it reaches the bone.

"The scalpel is withdrawn, and the osteotome, which was introduced longitudinally, is now turned transversely in the direction required for the osseous incision. In turning the osteotome, too much pressure must not be exerted, lest the periosteum be scraped off. It is then convenient to pass the edge of the osteotome over the bone until it reaches the posterior internal border, when the entire cutting edge of the osteotome is applied, and the instrument is made to penetrate from behind forwards, and towards the outer side.

"After completing the incision in that direction, the osteotome is made to traverse the inner side of the bone, cutting it as it proceeds, until it has divided the uppermost portion of the internal border, when it is directed from before backwards, towards the outer posterior angle of the femur.

"In cutting on these lines, there is no fear of injuring the femoral artery. The bone may be divided without paying heed to this order of procedure, but it is better that the operator should have a definite plan in his mind, so that he may be certain as to what has been divided, and what remains to be done. The writer is persuaded that accidents have happened by not paying attention to this. In using the osteotome, the left hand, in which it is grasped, ought to give, after each impulse supplied by the mallet, a slight movement to the blade—not transversely to its axis, but longitudinally—so as to prevent any disposition to fixity which it might assume.

"After the inner portion of the bone is divided, a finer instrument may be slipped over the first, which is then withdrawn; and even a third, if necessary, may take the place of the second, when the outer portion of the bone comes to be divided. Whether one or more osteotomes be used, depends much on the resistance met with. If the tissue is yielding, one may suffice; if hard or brittle, two or three will effect the division more easily, and with less risk of breaking or splitting the bones longitudinally. In the adult, the dense circumferential layer of bone resists the entrance of the osteotome at the outset, but several strokes cause the instrument to penetrate this superficial dense portion, when it will pass easily through the cancellated tissue.

"After a little experience, the surgeon recognises, by touch and sound, when the osteotome meets the hard layer on the outer aspect of the bone. If it be considered desirable to notch or penetrate this outer dense part of the bone, in doing so the osteotome ought to be grasped firmly by the left hand, the inner border of the hand resting on the limb, so as to check instantly any impetus which may be considered too great. It is better to snap or bend this layer than to cut it.

"When the instrument is to be altered in position, it ought not to be pulled out in the ordinary way, as it is then liable to be removed from the wound in the soft parts, as well as from the bone. Instead, let the left hand, with its inner border resting on the limb, grasp the instrument, while the thumb is pressed under the ridge afforded by the rounded head, and gently lever the osteotome outwards by an extension movement of the thumb (see Fig. 50). In this way the movement may be regulated with precision. It is desirable to complete all the work intended by the osteotome before removing it from the wound.

"When the operator thinks that the bone has been sufficiently divided, the osteotome is laid aside and a sponge saturated in 1-40 carbolized watery solution is placed over the wound. While the surgeon holds the sponge, he, at the same time, employs that hand as a fulcrum; with the other he grasps the limb lower down, using it as a lever, and jerks if the bone be hard, or bends slowly if the bone be soft, in an inward direction, when the bone will snap or bend as the case may be."

An Esmarch's bandage is not necessary during the operation, and no bleeding points require ligature. The line of section is everywhere above the ligaments of the joint, and no damage is likely to be done to the popliteal or femoral vessels, which are carried well out of the way of the osteotome, partly by the flexion of the knee, and partly by observing the directions given for the division of the bone. The only artery at all likely to be divided is the anastamotica magna, but that generally lies above and behind the incision. The superior internal articular artery is also avoided if the above directions be carefully observed. It is very rarely necessary to enlarge the wound in order to tie bleeding points; should a vessel spout, it will generally stop partly from its own contraction and partly as the result of pressure.

There are one or two points in the operations to which we may call special attention. In the first place it is well to employ Macewen's special osteotome (see Fig. 51), which differs from the ordinary chisel in that its cutting edge is bevelled on both sides instead of only on one; an ordinary chisel is apt to crush the bone upon one side instead of dividing it evenly. In children the osseous section may be completed by one osteotome, but in adults it is advisable to have two instruments of different size for the purpose, as, should the larger instrument become locked, it can be withdrawn and a smaller one slipped into its place and the section completed; the former should be about two-thirds to three-quarters of an inch in width, whilst the latter should be about half an inch wide. When dividing the bone from the inner side, it must be remembered that the line of section must run more or less parallel with that of the epiphysis, and should not therefore be transverse to the long axis of the lower extremity. As a result of the displacement of the epiphyseal line, which is an essential factor in the production of genu valgum, the chisel may become buried in the external condyle if it be held transversely to the long axis of the limb, and thus serious damage to the epiphyseal line may occur.

FIG. 50.—METHOD OF HOLDING MACEWEN'S OSTEOTOME. The instrument, grasped in the hand, is steadied by resting the ulnar border of the hand upon the thigh and the thumb pressed beneath the head of the chisel serves to lever it gently out when it is desired to disengage it.

(*b*) *Through an incision on outer surface of thigh.*—Some surgeons prefer to divide the bone from an incision on the outer side of the limb, and this is the operation that we have ourselves most frequently done; it somewhat facilitates the rectification of the deformity. The incision should be made just above the external condyle, and, after all the structures down to the bone have been divided, the osteotome is slipped in along the blade of the knife and then turned transversely to the long axis of the bone. The line which the osteotome should follow should run somewhat obliquely downwards and inwards; care must of course be taken not to direct it so far downwards as to injure the epiphyseal line. It is generally best to make the osteotome first of all cut through about half of the cancellous bone in the centre of the diaphysis; it should then be withdrawn and reinserted so as to divide the dense anterior surface, and finally it may be again withdrawn and reinserted so as to divide the dense bone on the posterior aspect. All these incisions should be carried about half way through the bone, when the osteotome may be finally withdrawn, a sponge placed over the wound and the remainder of the bone fractured by bending the leg inwards.

(*c*) *Of the tibia.*—In dividing the tibia the best plan is to make a vertical incision commencing at the tubercle and running downwards along the crest for about an inch. This incision should be carried down to the bone, and it is as well to separate the periosteum on each side of it with a rugine. The bone is then divided transversely by an osteotome, special care being taken to see that the inner side is completely cut through. The leg is then brought forcibly inwards, and if sufficient rectification be not obtained in this way the limb may be bent outwards again so as to fracture the outer side completely, when, on bringing the limb inwards once more, rectification can easily be obtained.


FIG. 51.—MACEWEN'S OSTEOTOME.

(*d*) *Of femur and tibia combined.*—The best rectification is obtained by dividing both the tibia and the femur, and in bad cases this is necessary if the most satisfactory result be desired. It is a matter of considerable difference of opinion as to whether the two bones should be divided simultaneously or at intervals. We are rather inclined to think that it is better to perform the operation in two stages; in the first place the tibia should be divided, and, subsequently, after the lapse of about six weeks, the femur if necessary. There is less danger of re-fracturing at the second operation the bone divided at the first if they be performed in this order, whilst a more perfect rectification can be obtained if one bone be allowed to undergo consolidation before the second is divided.

*After-treatment.*—After the completion of the operation one or two sutures should be inserted, an antiseptic dressing applied, the limb brought straight and put up on a suitable splint, which we are accustomed to make from a roll of Gooch's splinting properly padded; the method of cutting it has already been referred to (see p. 101), but in the cases under consideration it is well to cut away a space for the heel so as to obviate all fear of pressure upon the os calcis. In applying the padding special care must be taken to have a large pad over the internal condyle, and others over the outer side of the foot and ankle, so as to press the leg inwards and keep it in good position. Another special pad must be placed in front of the knee so as to prevent flexion of the joint (see Fig. 52). After the splint has been applied the limb should be laid upon an inclined plane.

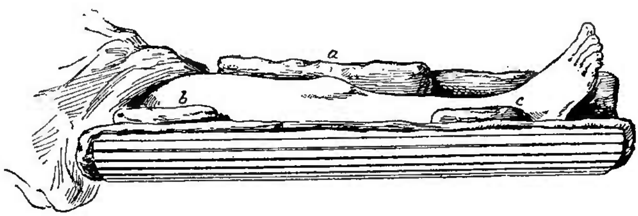



FIG. 52.—LIMB PUT UP IN SPLINT AFTER OSTEOTOMY FOR GENU VALGUM. The large pad (*a*) over the inner condyle on the one side, and the two thick ones (*b* and *c*) over the outer malleolus and the great trochanter respectively, on the other side, are shown. The large pad over the front of the knee to prevent flexion is not shown, while, for the sake of clearness, the dressing to the osteotomy wound has been omitted.

In about a week or ten days the dressing may be taken off, the stitches removed, a collodion dressing applied, and the limb put up in a plaster of Paris or silicate bandage. In small children, and in any case where there is much curvature of the femur, it is well to continue the bandage up around the pelvis, as otherwise the casing may fail to get a sufficient hold upon the thigh. After about six weeks, union will generally be firm and the splint may be left off, but the child should be kept in bed for two or three weeks longer, and allowed gradually to recover the full range of movement in the knee. During this time the leg should be massaged and rubbed, so as to improve the circulation and the tone of the muscles. Walking may be permitted in about ten weeks, and, should the ricketty condition of the bone have completely passed off, no further apparatus will be required.

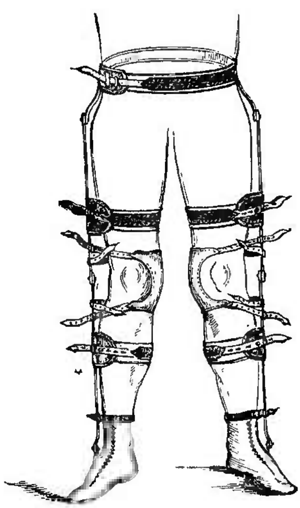


FIG. 53.—OUTSIDE IRONS FOR USE AFTER OPERATION FOR GENU VALGUM IN ADULTS. (*Erichsen*).

When the osteotomy has been done upon a young adult in whom there is some doubt as to whether or not the bones have become firmly consolidated, it is well for the patient after the operation to wear one or other of the forms of apparatus which are usually employed to exert mechanical pressure upon the deformity; this generally consists of an outside iron fastened to the pelvis above and the heel of the boot below, and furnished with hinges opposite the hip, knee, and ankle joints (see Fig. 53); there is also generally a band or sling which tends to draw the knee outwards against the iron.

This apparatus can be made of quite light material, and should be worn for two or three months after the operation.

Those forms of genu valgum arising in connection with diseases other than rickets must be treated on the lines laid down for the treatment of the particular disease to which they are due. Should genu valgum occur after excision of the knee, the choice will lie between a fresh excision, or Macewen's operation; in most cases the latter is a less severe and an equally satisfactory method. Should genu valgum occur in connection with infantile paralysis, the usefulness of the limb will have to be taken into consideration; in some cases it may be found best to perform excision of the knee joint, so as to give the patient a firm and fixed point of support, whilst in others where the muscles are fairly healthy, a Macewen's operation, or any of the other operative procedures which we have mentioned, may be employed.

## GENU VARUM.

This condition is the converse of the one just described, the lower part of the thigh and leg being bowed outwards to a greater or less extent, so that when the feet are placed together the two limbs form an ellipse, or, in very severe cases, almost a complete circle. The affection is essentially due to rickets, although a somewhat similar deformity may occur after excision of the knee, from damage done to the inner side of the epiphyseal line; it is also found in those who have constantly to assume certain positions, such as, grooms, etc., who are constantly riding. If the patient be quite young, the deformity when once started may attain a very marked degree; when it originates in adult life, however, it is seldom serious enough to call for any active treatment.

The patient usually walks with the toes turned in, and in bad cases the patella is dislocated inwards; flat-foot is not uncommonly associated with it, but the functional troubles in genu varum are usually much less marked than in genu valgum. The condition is generally bilateral, although sometimes children are met with suffering from genu valgum on the one side, and genu varum on the other, in which case the deformity has been supposed to be due to the child always being carried upon one arm so that the legs are pressed towards each other; one limb is thus forced into a condition of varus, and the other into a condition of valgus.

**TREATMENT**.—This should be carried out on lines similar to that for genu valgum. In the milder cases splints should be applied to the inner side of the leg and the patient kept off his feet, while at the same time the general treatment suitable for rickets should be employed. In the severer cases, and in those in which the bones have become consolidated, osteotomy is necessary. The orthopædic apparatus consists essentially of an **internal splint** which should extend on the inner side of the limb from the perineum to well beyond the foot, and which should be especially thickly padded opposite the ankle. As in the case of curved tibiæ, these splints should be made to project two inches at least below the toes when the latter are fully pointed, so as to prevent any possibility of the child walking upon tip-toe. The limb may also be drawn inwards towards the splint by means of broad elastic bandages around the knee. The force exerted by these bandages must be carefully watched so as to prevent the formation of pressure sores. The same remark applies to the points of contact of the limb with the splint at the ankle and the thigh, where the pressure is considerable. As we have remarked in dealing with curved tibiæ, a moderate amount of pressure is quite sufficient to produce a rectification of the curvature in the only cases in which the application of splints is likely to be of much benefit, that is to say, in those who are young and have very soft bones.

In the more advanced cases, and in those in which the active stage of rickets has passed off, operative interference is often desirable. Here again, some surgeons fracture the bones by means of osteoclasts, but, as in the case of genu valgum, the procedure is not at all to be recommended, for the exact position and nature of the fracture cannot be accurately gauged and considerable damage may be done to the soft parts and to the ligaments of the knee joint. The only operative treatment to be recommended is **osteotomy**, and when the deformity is very marked the bones may require to be divided at more than one spot. Division of the tibia is more important than division of the femur, and the bone should be cut through just below the knee; the fibula is bent or broken, or if it be too firm, it may be divided, but as a rule it yields quite readily.

The division of the tibia is best done by an *oblique osteotomy*. The bone is exposed by a vertical incision over the crest, and chiselled through from above obliquely downwards and backwards (see Fig. 45 C); it is then bent into position. In many cases it is also necessary to divide the tibia lower down at the point of greatest curvature, and this may be done at the same operation. In very bad cases it may be necessary to divide the bone a third time just above the ankle joint before the whole of the curvature can be obliterated. The limb should be put up in Gooch's splint (see p. 113), and after a fortnight a plaster of Paris bandage should be substituted and kept on until union is complete.

In bad cases it will also be found necessary to divide the femur at a later date. The osteotomy should be practised immediately above the lower end, and, should the curvature be extreme, a second one may be necessary higher up the limb. In bad cases several osteotomies may have to be done before the bones can be got satisfactorily straight; Macewen has even done as many as ten in one patient. Two or even three of these may be carried out at the same time, but it is better where several have to be performed to do them at intervals so as to allow union to occur in one before the next fracture is made. Should the bone be divided in several places at the same time, there is a risk of the fragments not uniting properly, or if they do, it is difficult to insure that they unite in perfect position.

## GENU RECURVATUM.

This condition is usually congenital and is comparatively rare; in it the leg is hyper-extended at the knee joint. It is met with in connection with congenital dislocations of the knee, and also in some cases of congenital dislocation of the hip. Sometimes, however, it occurs without any other deformity, apparently as the result of weakening or stretching of the ligaments of the joint, particularly the posterior. It is occasionally met with as the result of infantile paralysis, and it may also occur in connection with diseases of joints; for instance, it is not uncommon after longstanding tuberculous hip-joint disease, where the posterior ligaments of the knee have yielded during extension as a result of the deficient nutrition of the limb. In Charcot's disease also it is not at all uncommon.

**TREATMENT.**—The congenital cases are usually the only ones which call for vigorous treatment; the deformity is very seldom excessive in the others and can generally be rectified by putting up the limb for a prolonged period in a slightly flexed position and then employing an apparatus furnished with a hinge opposite the knee joint, fitted with a stop to prevent hyper-extension.

In the congenital cases, however, it is often very difficult to obtain a satisfactory result. In them it is not uncommon for the patella to be absent; in any case it is usually very small. The treatment should be directed in the first place to straightening the knee and afterwards an attempt should be made to obtain flexion by the use of apparatus. The following procedure may be adopted. A posterior splint which runs down as far as the popliteal space is fixed to the thigh, and the limb is laid upon an inclined plane which terminates just above the knee. Extension by weight and pulley is then applied to the limb; at first this should be in the line of the thigh, so as to merely stretch the ligaments. After two or three weeks the pulley may be gradually lowered so as to produce an increasing amount of flexion, the thigh remaining fixed in the elevated position. In very bad cases, however, these attempts to obtain flexion may fail, while if they be made too energetically a true anterior dislocation of the leg may occur. As a rule, when the muscles and ligaments are shortened, only operative interference will overcome the trouble.

The operative measures consist in the division of the quadriceps extensor, which should be done through an open incision about four inches above the knee joint. A curved incision with the convexity upwards is made, a flap turned down, and the muscle divided in a V-shaped or zig-zag manner, by the method described in Chap. XV.

for lengthening muscles. At the same time all dense fibrous structures interfering with the proper flexion of the limb are divided by a tenotomy knife.

The treatment is, of course, a prolonged one, and when the patient begins to walk he must be fitted with an apparatus designed to prevent over-extension at the knee joint. This consists essentially of irons running down the inner and outer sides of the thigh and leg, fastened to a pelvic band above and the heel of the boot below, and furnished with joints opposite the hip, knee and ankle joints, the knee joint in addition being furnished with a stop to prevent over-extension.

# CHAPTER VI.

## CURVATURES OF THE NECK OF THE FEMUR.

### (COXA VARA.)

Of late years a good deal of attention has been paid to certain deformities which result from an alteration in the normal curvatures of the neck of the femur and which are now for the most part grouped together under the term Coxa Vara; this term is, however, misleading, since only a certain proportion of the cases show a deformity to which the term *varus* is strictly applicable. We prefer therefore to speak of them merely as curvatures of the neck of the femur.

**CAUSES.**—These deformities are met with at two periods of life; in infants or quite young children of about three or four years of age, and in young adults between the ages of thirteen and eighteen. It is said that the affection is sometimes congenital, and it is possible that some of the cases met with in early infancy are of this nature. There is still considerable uncertainty as to the exact etiology of the disease; it is possible that the deformity occurs in infants as the result of some malposition *in utero*, as it is difficult to account for it on the ground of any faulty position assumed by the child while lying down or being carried in arms. There can, however, be no doubt that the deformity, as met with in young children, results in the great majority of cases from softening of the bones due to *rickets*. It is also highly probable that a large proportion of cases in young adults owe their origin to the condition that goes by the name of "*rachitis adolescentium.*" In some of the adult cases, however, no signs of rickets are to be traced, and these have been attributed variously to rheumatoid arthritis, to osteitis, or to causes unknown; it is certainly the fact that the affection may supervene upon a mild attack of rheumatism. The deformity generally occurs in those whose occupations involve continuous and prolonged standing or carrying of heavy weights. By some it is held that the disease is more common in young adults than in infants, but this is very doubtful; certainly, since our attention has been directed to the point, we have found a large number of cases in young children who are the subjects of rickets.

**PATHOLOGICAL CHANGES.**—The direction of the abnormal curvatures in the neck of the femur is not invariably the same, but it is most frequently of such a nature as to produce marked outward rotation of the lower limb. The angle formed by the neck with the shaft of the femur is always considerably diminished, and the trochanter is therefore elevated and the limb shortened. Generally also there is a bowing forward of the neck of the bone so that the trochanter is thrown too far back-

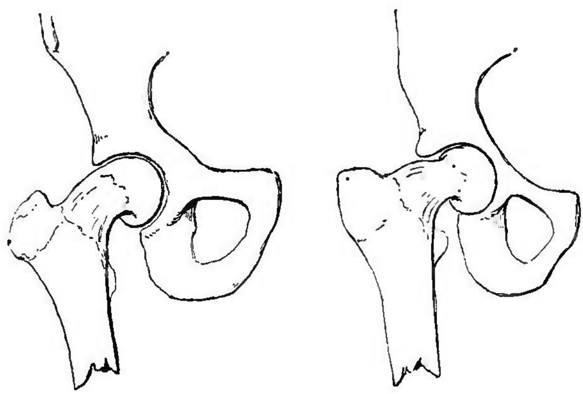


FIG. 54.—ALTERATIONS IN THE CURVATURE OF THE NECK OF THE FEMUR. These outline sketches are taken from skiagrams, and show both the elevation of the trochanter and the bowing forward of the neck of the bone.

wards and external rotation of the limb results (see Fig. 54). In some rare instances there is marked inward rotation, whilst in others again rotation is unaffected, although the shortening, due to the elevation of the trochanter, is well marked.

As seen in young children, the affection generally has the following characters: the trochanter is raised above Nélaton's line (sometimes very considerably), and there is marked outward rotation of the whole lower extremity. The limits through which the limb can be rotated are on the whole smaller than normal, for, while the range of outward rotation is considerably increased, that of internal rotation is proportionately more diminished. The result is that when the child lies flat upon the bed and the limb is rotated inwards as far as it will go, the patella at best can only be made to look directly upwards and cannot be directed inwards at all; indeed, in the majority of the cases, even this amount of inward rotation cannot be effected. On the other hand, the limb can be rotated outwards until the patella looks almost directly backwards. There is also as a rule considerable alteration in the range of abduction and adduction; when the outward rotation is marked, abduction to the normal extent is impossible, and, unless the limb be in the abducted position, the power of flexion may also be interfered with. If, however, the limb be abducted and rotated outwards, full flexion can be obtained, and the patient may actually be able to make the feet meet behind the head (see Figs. 55 and 56). The feet are frequently kept rotated outwards at right angles to the

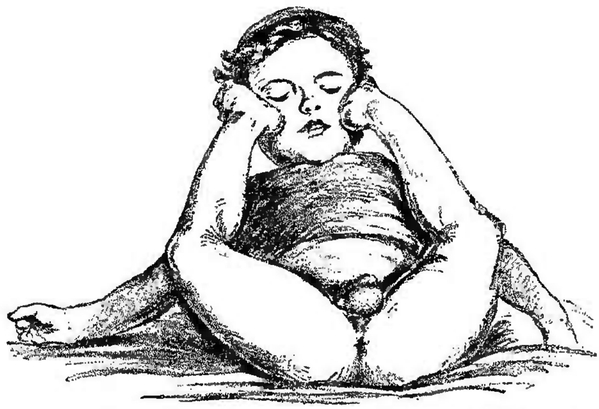


FIG. 55.—COXA VARA. This is the same child as in Figs. 56 and 60. For a description of the case see Fig. 56.

antero-posterior plane of the body, with the knees somewhat bent, and the child can neither stand upright nor walk.

When the affection is met with in adults, in addition to the deformity, it is common to find them complaining of a sensation of fatigue in the

FIG. 56.—COXA VARA. The sketches (55 and 56) are from photographs of a case shown at the Clinical Society in Nov. 1893. The child could not even stand unaided. There were no signs of rickets or infantile paralysis; there was no congenital dislocation of the hip. This case is the one referred to in the text in whicb subtrochanteric division of one femur was performed, and the result of which is seen in Fig. 60.

early stages of the affection, and of pain about the hip-joint, which gets more severe as the disease progresses. Later on the patient begins to limp, while ultimately he experiences difficulty in stooping, and notices that the movements of the hip-joint are restricted and abnormal. It is this condition of pain, restriction of movement and limping that usually makes him resort to the surgeon.

If the case be left to itself the ultimate result is that the bone undergoes consolidation in the faulty position and the deformity is thus permanent; the patient is compelled to limp about with the feet turned out and suffers considerably from interference with the free movement of the hip-joint.

**TREATMENT.**—(1) **In young children.**—This is a question of the greatest difficulty, and we shall here only describe the treatment which we ourselves are accustomed to carry out. While the child is quite young and the bones are very soft, it is worth while to make an attempt to rectify the abnormal curves by means of extension and manipulations.

(*a*) **Mechanical.**—It is not easy to devise an apparatus to maintain steady pressure upon the bone in a direction such as to restore the normal curvature of its neck, but the following arrangement (see Fig. 57) is

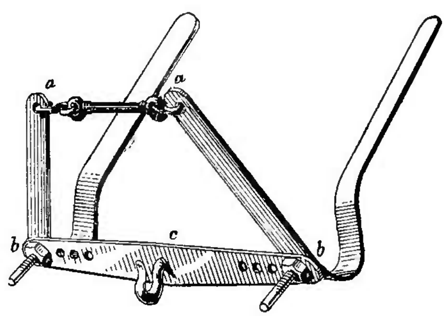



FIG. 57.—EXTENSION APPARATUS FOR COXA VARA. The anterior ends of the foot-pieces are approximated by the india-rubber spring attached to the hooks *a*. The amount of abduction is regulated by the transverse bar; the limbs can be approximated or separated by passing the pivots *b* through the different holes in the transverse bar *c*. These holes are made large enough to allow the limb to rotate inwards easily when in the abducted position. Extension is made from the hook in the centre of the transverse bar.

worthy of a careful trial. Two strips of malleable iron of suitable length are applied along the back of each lower limb. They should reach from the centre of the thigh above and should be accurately adapted to the middle line of the back of the thigh and the calf, being bent round behind the heel and up along the centre of the sole, projecting for several inches beyond the tips of the toes and ending there in a hook (*a*). Opposite the under surface of each heel there is a pivot (*b*) over which passes the perforated end of a transverse bar (*c*) which can be lengthened or shortened at will, and from the centre of which extension of both limbs can be made simultaneously by a weight and pulley at the end of the bed. This transverse bar is designed to keep the limbs in the requisite position of abduction during extension, while its extremities provide fixed points about which the limbs can be rotated so as to overcome the rotation outwards. This is done by fastening to the hooks (*a*) an elastic door spring of suitable strength which thus pulls the toes together while the heels remain separated by the transverse bar (*c*). In order to get the full effect of the apparatus, the splint must be firmly incorporated with the limb, and this is best done by plaster of Paris which is put on over a bandage of boracic lint, and in the layers of which the posterior iron bar is included (see Fig. 58). The weight used for extension should be three or four pounds to commence with, according to the size of the child; this may be increased later.

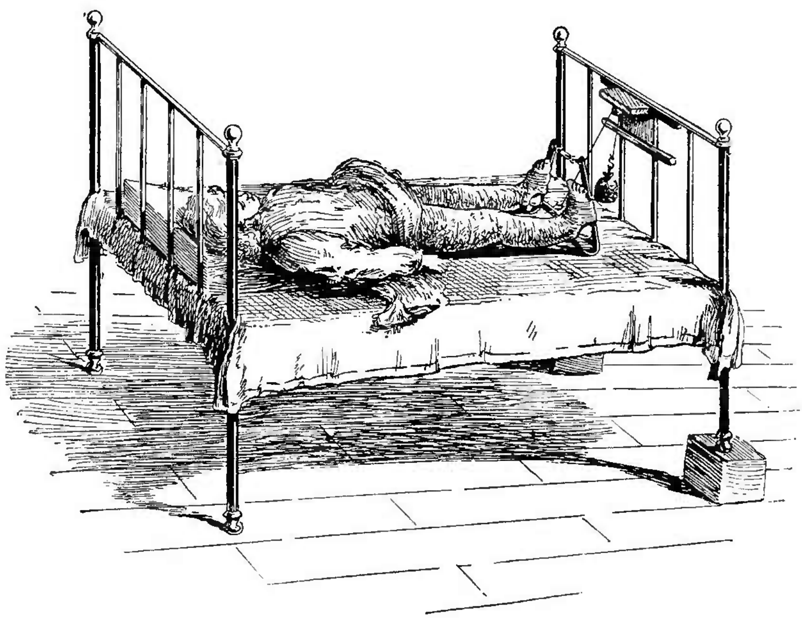


Fig. 58.—Extension Apparatus for Coxa Vara applied. The iron bars are incorporated in the layers of a plaster of Paris bandage so that the limbs are immovably fixed to them. Extension is made with the limbs abducted and well rotated inwards. The extension is applied in a somewhat upward direction to avoid the friction caused by the heavy splint lying flat on the bed.

The apparatus will require renewal fairly frequently, as it is very liable to become soiled with urine; it should be taken off about once a fortnight and a fresh one applied. When the casing has been removed, the limb should be well washed and the whole extremity massaged; in addition to this, it is well to practice repeated manipulations, such as inversion, flexion, and adduction, before the splint is again applied.

(*b*) **Operative.**—Should no improvement result after a careful and prolonged trial of this method, the time will come as the child grows older and attempts to walk, when some form of operative procedure designed to overcome the excessive outward rotation will have to be considered. Of these the surgeon has the choice between two alternatives, either of which will allow the limb to be rotated inwards, namely: (1) transverse division of the shaft of the femur below the lesser trochanter; and (2), removal from the neck of the femur of a wedge of bone with its base directed forwards and upwards. At first sight the latter plan seems the more promising; in young children, however, it is difficult to perform it satisfactorily and even more difficult to ensure that the limb is kept in proper position while union is taking place.

*Sub-trochanteric division of the femur.*—In children we have obtained extremely good results by dividing the femur below the trochanters.[1] The operation is done as follows: an incision is made commencing just below the upper border of the great trochanter aud running vertically downwards for three or four inches. It should be carried directly down to the bone, which is then cleared with a rugine and divided transversely just below the lesser trochanter with a fine-bladed saw. The great trochanter is then pushed as far forwards as it will go, while the leg and

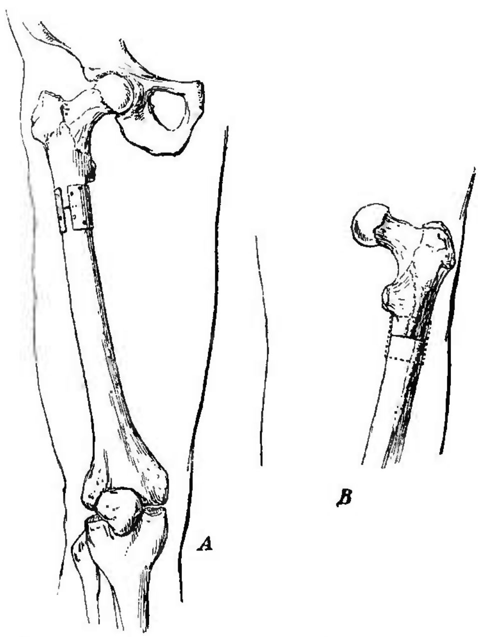



FIG. 59.—SUB-TROCHANTERIC DIVISION OF THE FEMUR FOR COXA VARA. This is the operation described in the text. The application of the aluminium plate is shown diagrammatically from the front in A. The view in B is from behind, and shows the alteration in position of the linea aspera. Here the aluminium is represented by the dotted outline.

the lower part of the femur are rotated inwards until the limb lies in a position of complete internal rotation. In order to obtain accurate union with the limb in this position and to prevent the possibility of outward rotation recurring, we have fastened the bones together by means of

[1] *Clin. Soc. Trans.*, 1894, Vol. XXVII., p. 297, and *Brit. Med. Jour.*, Feb. 18, 1899.

an aluminium plate secured in position by tin-tacks. A piece of sheet aluminium about half an inch wide, long enough to encircle about three-quarters of the femur, and sufficiently thick to be firm though flexible, is drilled with holes in several places, curved so as to embrace the femur, and applied to the bones half above and half below the point of division (see Fig. 59); it is then nailed to the two fragments by ordinary tin-tacks which have previously been nickeled. The plate when thus fastened holds the bone securely in its new position until union is complete. After it has been fixed, the wound is closed without a drainage tube, the usual antiseptic dressings applied, and the limb put up upon a back splint which is best made of a trough of Gooch's splinting (see p. 101); this is then laid upon an inclined plane at an angle of about 45° with the bed. Splint and limb should be rotated inwards so as to maintain the leg in a position of internal rotation. The body is fixed by a sheet passed over it and kept in position by sandbags on either side of the trunk.

The dressing need not, as a rule, be changed until bony union is complete, which will be in about six weeks' time; the bandages, will, however, require tightening from time to time, and it is well to rub them over with a starch solution in order to prevent them from slipping. After six weeks the stitches are removed and the limb may be taken out of the splint, but it is well to keep the patient in bed for two or three months, because in these ricketty subjects, although union readily takes place, a considerable time is often required for thorough consolidation, and should the patient be allowed to bear weight upon the limb too soon, bending may occur. After two or three months the patient may begin to walk, and it will be found that in a very short time he is able to do so quite well.

The rationale of this proceeding is that the hip joint is left undisturbed, whilst the rotation of the foot, as far as walking is concerned, is completely corrected, for, although the trochanter does not rotate as far forwards as it should, the foot is in its normal position when it is rotated inwards as far as it can go. On the other hand, when the trochanter is rotated outwards to its extreme limit, the foot is usually in the position of normal external rotation.

The *results* of these operations are, as far as our experience goes, extremely satisfactory, and surprising benefit has followed in two directions. In the first place, when only one leg has been operated upon, we have found that very marked improvement has taken place in the rotation of the other limb, in fact, in both the cases mentioned in the *British Medical Journal*, although we intended to operate upon the second limb after a due interval, we found that the spontaneous improvement in it was so marked, after the patient had walked about for some months, that the second operation did not appear necessary (see Fig. 60). Why this improvement in rotation should occur is somewhat difficult to explain, but it seems probable that when the patient begins to walk with one leg in a good position, the tendency is to swing the other forward into a similar position, and thus there is a constant attempt on the part of the muscles aided by the weight of the limb to undo the curvature of the neck on the side not operated upon. However this may be, the fact remains that improvement in this respect has followed in both our cases. Notwithstanding

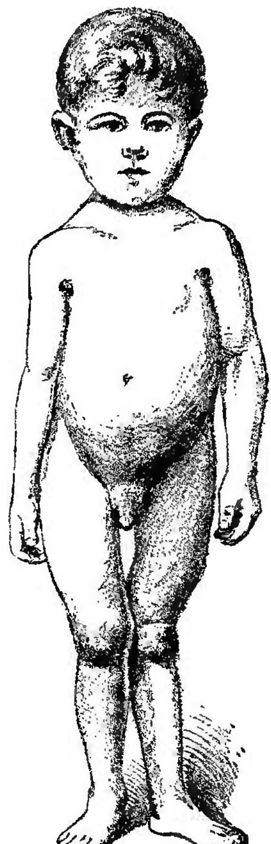


FIG. 60.—RESULT OF SUBTROCHANTERIC DIVISION OF THE FEMUR IN A CASE OF COXA VARA. This is from a photograph of the same child as that in Figs. 55 and 56, and was taken nearly a year after the operation referred to in the text, *i.e.* subtrochanteric osteotomy of the femur and the application of an aluminium plate to keep the fragments in position after the lower limb had been fully inverted. The right foot is in a fairly normal position, while the left leg (which was not operated upon) remains in its original position. The child could walk and run well. (See *Clin. Soc. Trans.*, vol. xxvii., p. 299.)

this improvement in rotation, however, the shortening of the limb and the elevation of the trochanter on the side not operated upon has progressed; we would therefore strongly advise that both legs should be operated upon in spite of this somewhat favourable result.

The second improvement noted, apparently as the result of the operation, is that the progress of the disease on the side operated upon has come to a complete standstill. In the cases referred to there was comparatively little shortening of the limb at the time of the operation, the trochanters on both sides being about on a level with Nélaton's line, or only very slightly raised above it. At the present time, two and a half years after the operation in one case, and more than four years after the other, the trochanter, on the side operated upon, still remains practically on a level with Nélaton's line, whilst, on the side not operated upon, this part of the deformity has progressed until there is shortening of half an inch or more from elevation of the trochanter. Thus, not only has the operation brought the limb into good position and thus enabled the patient to walk with ease, but it has also apparently led to the consolidation of the neck of the bone, and thus to a complete arrest of the progress of the deformity. The reason for this improvement is not at all clear, but two explanations seem probable: in the first place, the consolidation occurring about the fracture produced by the operation may have extended upwards into the neck; or else the process of consolidation of the neck may be to some extent associated with the diminution in the vascular supply brought about by the operation, the upper branches of the nutrient artery being of necessity divided. However that may be, our experience is that division of the bone below the trochanter, during the active progress of the disease, has led to its complete arrest, to great diminution in the outward rotation of the other leg, and to complete restoration of the patient's power of walking.

(2) **In young adults** the treatment should at first be carried out on similar lines until the bones become firm; massage and manipulations, rest in bed with extension of the limb, as above described, being employed. There is, however, very little chance of obtaining much reduction of the deformity by these means, and in the early stages the treatment aims rather at preventing the deformity from getting worse until such time as the bones have become consolidated, and operative measures may be undertaken with advantage. In addition to these local measures, it is well, therefore, to employ general treatment with the design of building up the patient's strength and facilitating solidification of the bones; careful massage of the limb, good hygienic conditions, plenty of nourishing food, and the administration of cod liver oil, phosphorus, etc., are valuable auxiliaries.

**Excision of a wedge from the neck of the femur.**—When the patient's general condition has undergone improvement and sufficient time has elapsed from the commencement of the disease, an operation may be advantageously employed if the degree of deformity be such as to render the patient unable to walk without it. In young adults where ossification is complete and the size of the parts is considerable, the best results will be obtained by the removal of a wedge from the neck of the femur (see Fig. 61); it is probable also that the sub-trochanteric division of the femur described above would be useful, but we have not tried it in these cases. The operation, which has been specially recommended by Kraske, may be performed as follows: an incision is made commencing above and a little in front of the top of the trochanter and running downwards on the anterior and outer aspect of the limb. The cellular interval between the sartorius and the tensor vaginæ femoris is opened after division of the fascia lata, and the soft structures are pushed inwards and held out of the way by retractors. This exposes the outer part of the neck of the femur, from which a wedge is removed with a chisel and hammer; in cases where there is external rotation, the base of the wedge should look forwards and upwards, the apex pointing downwards and backwards. The limb should then be rotated inwards until the sides of the wedge-shaped cavity thus made are in contact, and it is well, in order to keep the limb in proper position after the operation, to make a second small incision over the outer surface of the trochanter, and drill through it into the proximal portion of the neck, an ivory peg being driven into the track thus made so as to keep the cut surfaces in firmer apposition. After the operation the limb should be put up in plaster of Paris in the fully corrected position and kept there for about six weeks; the best form is a spica bandage extending from below the knee up around the pelvis. In about six weeks union will be complete and passive movement may then be begun.

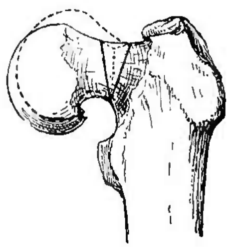


FIG. 61.—V-SHAPED OSTEOTOMY OF THE NECK OF THE FEMUR FOR COXA VARA. To show diagrammatically the extent and direction of the wedge removed.

# CHAPTER VII.

## CONGENITAL DISLOCATION OF THE HIP.

THE hip joint is the one most commonly the subject of congenital dislocation, and the affection is apparently more frequent in females than in males. It is also not unusually associated with some other congenital defect, and in a considerable number of cases the children are congenital idiots. The deformity may be unilateral or bilateral; probably it is more often bilateral.

**PATHOLOGY.**—The displacement commonly met with is dislocation upon the dorsum ilii, the head of the bone being situated higher up and further back than normal. The head of the bone also undergoes considerable alteration in shape, being enlarged and flattened, and in some cases assuming almost a mushroom-like form. The acetabulum is always imperfectly developed, and frequently consists of little else than a slit in the innominate bone; any such cavity as exists is almost entirely filled up with soft tissue, whilst the remains of the anterior ligament of the joint are adherent over it. The ligamentum teres is represented by a thin elongated cord or is entirely absent.

When the dislocation has lasted for some time, contraction of the muscles and tendons surrounding the joint is very apt to occur, and this not only prevents the articular surfaces being brought into their normal positions but also interferes greatly with the power of walking. The muscles most affected are the adductors; by their action the affected limb is drawn inwards towards the middle line, and in some cases, where the contraction is extreme and at the same time bilateral, a condition of cross-legged deformity may be produced. There is also a considerable tendency to flexion of the hip joint which increases as the child grows older, and with this there is also a marked lordosis, most apparent on standing. The flexion may eventually become so great as to entirely prevent walking. If the affection be unilateral, there is generally some amount of lateral curvature.

In the early stages it is generally possible, at any rate during the first two or three years of life, to bring the head of the bone nearly, if not quite, into its normal position by steady extension, and it is often possible while doing this to feel a definite slight click as the head comes down over the edge of the imperfect acetabulum. On the other hand, it is also generally possible to push the head of the bone up to a higher level than it usually occupies. As the patient grows older the tissues around the joint become firmer and less yielding, so that, by the time adult life is reached, this mobility of the head of the bone in the vertical direction is not nearly so free. The gait is marked by a peculiar waddling movement which is due to the sliding of the head of the femur over the surface of the innominate bone, and in addition to this there is the lordosis and adduction to which reference has already been made. The condition is, of course, one of considerable gravity on account of the increasing difficulty in progression as age advances. It is commonly found that a patient who was able to run about easily as a child becomes quite unable to walk or even stand as adult life is reached.

**TREATMENT.**—Many different methods of treatment have been employed for the cure of this deformity, but up till recently very few have met with any success. Some have treated the affection by dividing all the tight structures around the joint (more particularly the adductors and the fascia lata on the front of the thigh), and have then confined the patient to bed or to a couch for a considerable time—two years or more. Extension is applied to the limb during the whole of this period with a view of keeping the head of the bone in proper position whilst the soft parts around it are being allowed time to contract and to become sufficiently firm to prevent recurrence of the sliding movement of the head of the bone. These attempts, however, almost invariably end in disappointment and are not at all to be recommended. Other surgeons have contented themselves with employing some form of apparatus designed to enable the patient to walk; this consists essentially of a band around the pelvis connected by an iron rod with a leather splint tightly grasping the thigh, and supposed to prevent the upward thrust of the femur in walking. It is, however, quite futile.

At the present time there are two methods of treatment which seem to offer good results, and for which we are chiefly indebted to the work of foreign surgeons, mainly to that of Lorenz, Hoffa, and Paci. Their object is to replace the head of the bone in the rudimentary acetabulum and, with or without an open operation, to form a new one. Although these methods show a distinct improvement in many ways upon the older ones, they are, nevertheless, frequently unsatisfactory to a certain extent. We shall describe first the treatment for cases in early infancy before the child has reached the age when walking is attempted. After this will come the non-operative method which is now carried out chiefly by Lorenz, and which is based upon the work of Paci; it is most suitable for children who are three or four years old and who have learnt to walk. Finally, we shall describe Lorenz's operative method which may either be employed when the non-operative one has failed or when the child is too old for it to be likely to succeed. These methods are chiefly applicable to children between the ages of two and seven years. Before and after that time little can be done beyond the employment of apparatus. It may be possible to obtain a good result by operative means in children over seven years of age, but it is rare.

**Treatment in early infancy.**—A point of some practical importance in connection with the treatment of congenital dislocation is that at the present day the existence of the deformity has become so well known that it is very often recognized in earliest infancy; the nurse calls the doctor's attention to something wrong with the hip joint, and most practitioners are easily able to recognize the existence of a congenital dislocation. The question then arises as to what immediate steps are to be taken. An essential point in the method to be described immediately consists in the patient being able to walk, and therefore it is seldom advisable, or indeed possible, to practise it until the child is from two and a half to three years old. The patient's parents may, however, insist on something being done at this early period, and, indeed, it is advisable that some sort of treatment should be undertaken from the time the case is recognized.

Probably the best plan is to employ suitable **massage and manipulations** during the time that must elapse before the child is of a fit age for the treatment recommended below. In early infancy there is, as a rule, no difficulty in bringing the head of the bone down into proper position, and this can be done several times daily by the nurse, and will serve to prevent shortening of the muscles. When the head of the bone has been pushed down completely, the other manipulations practised by Lorenz, namely, outward rotation with abduction and hypcr-extension of the limb may be carried out; extreme care must be taken to perform all these movements with the utmost gentleness, and none of them should cause pain or provoke resistance. If treatment of this kind be persisted in steadily two or three times daily, there is no fear of the occurrence of any contraction sufficient to interfere with the subsequent reduction of the deformity. Some surgeons prefer to put the child up in an extension apparatus for the same purpose, but this is not nearly so satisfactory as the method we have described; because, in the first place, it is impossible to fix an infant up properly, and, in the second place, extension does not stretch the muscles in the various directions that are necessary; the movements of abduction, over-extension, and outward rotation, modelled on those of Lorenz, must be carried out regularly, and should be employed until the child arrives at an age at which the more radical treatment can be undertaken.

**Lorenz's non-operative method.**—The object of Lorenz's procedure is to bring the head of the femur down into position over the rudimentary acetabulum, to keep it there and then to cause it, by its constant pressure and friction as the child walks, to enlarge and deepen the rudimentary cavity until a more or less normal acetabulum is formed. The first essential for success is that the patient should be quite young; at the same time it is of primary importance that the child should be old enough to have learnt to walk. After the age of seven years the chances of bringing the head of the femur successfully down over the acetabulum without an open operation are very slight, because of the shortening of the muscles, ligaments, and soft tissues generally, and therefore, if non-operative treatment is to succeed, it must be employed before this age. In young children it is generally fairly easy to bring the head of the bone down into position without even dividing the capsule, but, when attempts are made to push it into the small cleft that represents the acetabulum, this is found to be a very difficult matter, partly because of the tension on the front part of the capsule, and partly because the flattened head of the femur is too large to be received into the cleft. If, however, the anterior part of the capsule be stretched or divided, it is not uncommon to find that the head of the bone will go into the rudimentary acetabulum, and, if the limb be then strongly abducted, the head hitches against the under side of the upper margin and remains in place. Directly, however, the limb is adducted, the head slips out at once and the deformity recurs. The following are the stages of the procedure as described by Lorenz.

First of all, the head must be brought down to the level of the acetabulum; this manœuvre is called reduction. Secondly, the rudimentary acetabulum must be enlarged; this Lorenz calls the formation of an acetabulum. The next step is to implant the head of the bone in this enlarged cavity, termed reposition, and lastly, the joint thus artificially formed must be made sufficiently stable to enable the patient to walk without danger of the head of the bone slipping out of place. We shall here describe the treatment suitable for a case in which the dislocation is unilateral; although the steps of the treatment are the same both for the unilateral and bilateral forms, the former condition is much the more easy to treat because the patient possesses one sound limb on which to support himself at a later stage when walking is necessary.

(1) **The reduction of the head of the bone.**—This is much more difficult of accomplishment without operation than where there is an open wound, because in the latter case the portions of the capsule opposing reduction can be readily divided and removed. Extension is useful in the first instance; although the head of the bone cannot be brought into position by it alone, it serves to stretch the tightened structures, and thus the necessary manipulations can be carried out afterwards with greater freedom. When the child is over four years old, preliminary extension may be employed for two or three weeks in order to stretch the resistant structures, and the weights used for extending the limb should be as heavy as the patient can bear; it is well to begin with four or five pounds, which are afterwards added to. In many cases, however, more particularly in younger children, it is better to attempt reduction at one sitting in the following manner.

The child is placed under the influence of an anæsthetic, a well-padded perineal band is applied and fastened to the head of the bed, and pulleys are attached to the leg above the ankle, or, in bad cases in which much force will be required, to the thigh above the knee, so as to diminish the chance of fracture of the femur. Extension is then gradually and steadily made so as to bring the head of the bone downwards, and it should be continued until the top of the trochanter is slightly below Nélaton's line; should this procedure be difficult, it may be considerably facilitated by pressing, squeezing, and kneading the tense muscles, especially at their points of attachment to the bone (see Fig. 62). The perineum should be

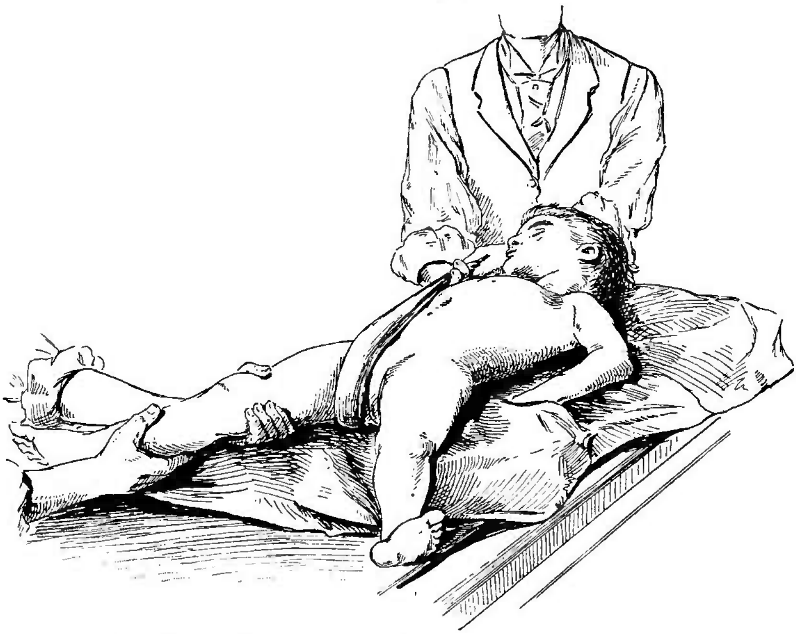


FIG. 62.—LORENZ'S NON-OPERATIVE METHOD FOR CONGENITAL DISLOCATION OF THE HIP. *First Stage.* While an assistant makes counter-extension by a perineal band, the surgeon forcibly pulls down the head of the bone until it is opposite the acetabulum. The traction is made outwards as well as downwards, so as to stretch the adductors. In a very young child the pulleys mentioned in the text are not necessary.

watched to see that no injurious pressure is exerted upon it, and it is well to relax the extension from time to time. Besides employing downward extension, it should be altered in direction from time to time so as to strongly abduct the limb; by this means the adductors and the tense structures on the inner side of the thigh are stretched. It is also well to over-extend the hip joint. The point of primary importance is that extension should be carried out steadily, smoothly, and gradually, and not violently or in jerks; if it be roughly done serious damage may be caused, and the femur may even be fractured.

(2) **Formation of an acetabulum, and reposition of the head of the bone.**—After extension has been carried out for some time, and the trochanter

got below Nélaton's line, an attempt is made at the same sitting to introduce the head of the bone into the acetabulum. The obstacles to this procedure have already been indicated; they are mainly, that the acetabulum is only represented by a mere cleft of the bone, that the head of the femur is flattened and too large to enter it, and that the anterior part of the capsule covers in the acetabulum, and is very often adherent to it. It is, of course, impossible to enlarge the acetabulum or to alter the shape of the head of the femur at the first sitting, but it is possible to peel off the capsule from the front of the former, and thus to a certain extent to enlarge the acetabular cavity anteriorly. The object of the second series of manipulations (which should be carried out immediately after the first) is, therefore, to open up the acetabulum as much as possible, by detaching the anterior part of the capsule from its surface, and to place the head of the femur in such a position that the portion which is not flattened shall be applied to the cleft

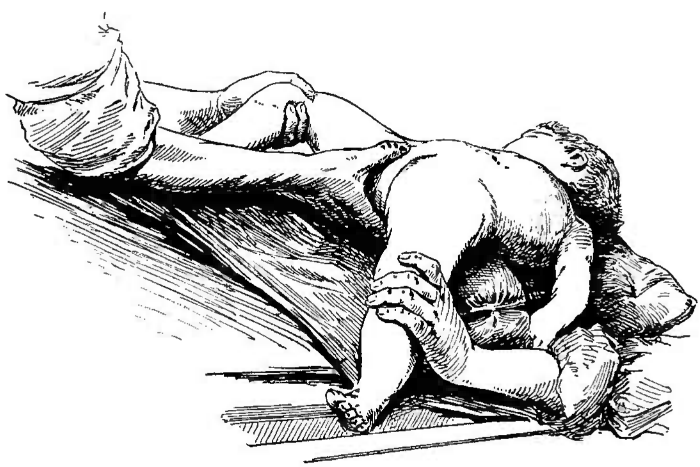


FIG. 63.—LORENZ'S NON-OPERATIVE METHOD FOR CONGENITAL DISLOCATION OF THE HIP. *Second Stage.* The limb is rotated outwards and abducted to its fullest degree after the head has been brought down over the acetabulum. The adductors require much kneading by the surgeon's fingers, as is shown in the drawing. The hip joint is also fully extended.

in the innominate bone. The perineal bands and the pulleys are therefore removed, and first of all the hip joint should be thoroughly flexed when, by pushing the limb downwards, the head of the bone can generally be brought down opposite the acetabulum; this procedure serves to relax of the flexed thigh must be carried out very gradually, and with the greatest care, so as to avoid the risk of fracturing the femur. This movement is the chief agent by which the anterior portion of the capsule is stripped from the acetabulum. When it has been done it is generally possible to actually feel the head of the bone slip into the cleft of the acetabulum, and, by forcibly rolling the limb outwards, the front part of the capsular ligament is stretched to its utmost limit; this object is also facilitated by forcibly extending the abducted limb (see Fig. 63). These manipulations must be repeated several times.

(3) **Fixation of the limb.**—With the successful reduction of the dislocation by these manipulations the first part of the procedure comes to an end, but the second part, namely, the prevention of further dislocation, is not in any way attained, for, on any attempt to adduct the limb, the head of the bone at once slips out of place. As a rule, in bad cases, the least diminution of the abduction from a right angle is followed by the immediate reproduction of the deformity, and it is therefore evident that, in order to prevent this, the limb must be kept for a considerable time with the head of the bone pressed inwards against the acetabulum, and abducted almost to a right angle. If the manipulations above described, namely, flexion, abduction, inward and outward rotation, and over-extension, be carried out repeatedly at this first sitting, it will often be found that after a short time, as the soft parts become more detached and stretched, re-luxation does not so readily occur as it did when adduction was first attempted, and it will, therefore, be possible to diminish the abduction to a slight extent. This is of importance, for the position of complete abduction

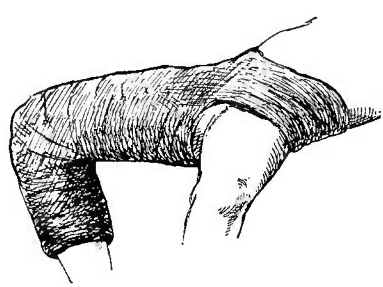


FIG. 64.—LORENZ'S NON-OPERATIVE METHOD FOR CONGENITAL DISLOCATION OF THE HIP. *Third Stage.* The limit of stability of the joint having been found in the last stage, the lower extremity is put up in the above position, the knee being flexed.

is extremely irksome to the child if maintained for a long time, and, therefore, to diminish it even by only a few degrees, is of distinct advantage.

Hence, at the end of the sitting, the exact degree of abduction necessary to keep the head of the bone in place should be tested; after this has been ascertained and the head of the bone brought opposite the acetabulum, the limb is kept abducted to this extent, or rather beyond it, rotated strongly outwards, and moderately over-extended. The whole limb and the pelvis are then put up in a plaster of Paris spica, so as to fix the parts firmly. Extreme care has to be taken while doing this to see that the head of the bone remains in place, for should it slip out the whole procedure would be futile. The knee should be flexed and included in the plaster (see Fig. 64).

When the plaster has set, the patient is allowed to come round from the anæsthetic, and is put back to bed. At first the child generally cries a good deal, and complains of much pain, but this usually wears off in two or three days, and there are no further complaints. At this stage it is well as a matter of routine to have a skiagram taken (through the plaster casing) so as to ascertain whether the head of the bone remains in place. Should it have slipped out of position, as will also be shown by the re-appearance of lordosis, the deformity should be rectified and the limb put up as before. The plaster case is removed in from ten to twelve weeks; should it become sodden with urine or fæces, as not infrequently happens in young female children, the apparatus must be re-applied, but otherwise no further change in the position of the limb should be made till after the lapse of that time. If there be any doubt as to the recurrence of the deformity, a skiagram will settle the question. During the time that the limb is in the first plaster casing, the parts are becoming consolidated after the rough usage to which they have been subjected, the abductors become gradually shortened, and the tissues around the joint contract, so that when the plaster is removed it will often be found that the limb retains its abducted position for some little time.

(4) **Formation of the joint by pressure.**—After the lapse of ten or twelve weeks the degree of abduction required to keep the head of the bone in place will generally not be nearly so great, and therefore the limb can be got into a position in which it is possible for the patient to put the foot to the ground; in fact, the object now is to bring the limb into a position suitable for carrying out the second part of the treatment, namely, the formation of a stable joint by the pressure exerted by the head of the bone in movement against the acetabulum. After the plaster is taken off, the abduction is gently and gradually diminished, as long as the head of the bone does not slip out of position. Directly a point is reached when the head of the bone is obviously becoming unstable, the limb is slightly more abducted, and a plaster of Paris spica again applied as before. The limb should be still somewhat over-extended and rotated outwards, the main difference between the new position and the old one being that the degree of abduction is now less.

This position should be maintained for another ten or twelve weeks, and, if the position obtained at this second sitting be one in which the patient can put the foot to the ground, walking may commence immediately. A pad or patten about one inch in height is fixed to the boot of the sound limb, and the patient is taught to walk with the limb abducted. Every time the weight is borne upon the affected limb the head of the bone is pressed against the acetabulum, and the more the child stands upon the leg the longer is this pressure maintained, and the more quickly is the acetabulum increased in depth. Hence the child should never be discouraged from walking, and, in order to facilitate it the plaster should not be continued below the knee at the second sitting if the abduction can be sufficiently diminished to permit of walking. The leg is thus left free for movement, which both helps to maintain its nutrition, and also greatly facilitates walking. At first probably the child will only be able to walk with the aid of crutches or some mechanical support, but he soon learns to do without them, and can get about freely. It is always possible to take note of recurrence of the displacement by observing whether or not lordosis is present; should it appear, it may be inferred that the dislocation has recurred, and the apparatus should at once be taken off and the limb put into the proper position.

After the second plaster case has been removed, that is to say, at the end of six months from the commencement of treatment, no further apparatus is necessary, the soft parts having become sufficiently shortened through their prolonged rest in the abducted position to keep the head of the bone in place. Indeed, it is common to find that attempts to fully adduct the limb cause pain, and the patient naturally keeps the limb somewhat abducted. The head of the bone will usually remain in position without the assistance of any apparatus. Treatment must now be directed to strengthening the muscles about the hip joint, especially the abductors, so that they may prevent the head of the bone from slipping out of position again. This is done by massage, and by the use of suitable exercises and passive movements. The exercises best calculated to do good are those in which abduction is carried out against resistance. The patient should lie down and attempt to abduct the limb, whilst the attendant gently opposes the movements; this serves to strengthen the abductors, which are the main factors in keeping the parts in position. Adduction can be guarded against by raising the heel of the boot on the sound side. At first an increase of about one inch will be sufficient; as time goes on this may be reduced, and ultimately it may be done away with.

In cases of *bilateral dislocation* the outlook is not nearly so favourable, but the treatment is carried out simultaneously and in a similar manner in the two legs. At the end of about twelve weeks abduction may be so far reduced that the patient can use both legs in walking. The results, however, in these bi-lateral cases have so far not been particularly satisfactory.

**Lorenz's operative method.**—The other method consists in some form of open operation, and, so far, the results obtained have been disappointing, even in the hands of Lorenz and Hoffa, who have done the largest number of these cases; on the whole they do not seem to be superior to, if, indeed, they are as good as those obtained by the bloodless method just described. When, however, children have reached the age of seven years and upwards before they come under observation, the manipulative methods are entirely useless, and the only chance of benefit lies in the performance of an open operation; considerable benefit at least will be obtained, if the extreme flexion and adduction of the limb which is often present can be overcome, and proper fixation of the head of the bone effected.

The operation is done as follows. The patient is put under an anæsthetic, the limb is purified with the most scrupulous care, and any tight structures which resist the reposition of the head of the femur in the acetabulum are first of all divided subcutaneously; those generally requiring division are the adductors close to their origin, the fascia lata of the thigh, and sometimes the muscles attached to the anterior superior iliac spine, and even, in bad cases, the ham-string muscles at their origin from the tuber ischii. When these various structures have been divided, manipulations designed to stretch the parts and get the limb into proper position are vigorously carried out. An incision is next made, so as to freely expose the

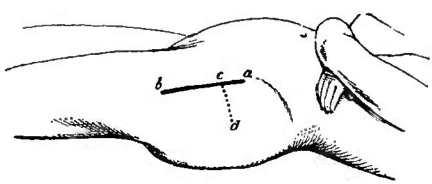



FIG. 65.—INCISION FOR THE OPERATIVE TREATMENT OF CONGENITAL DISLOCATION OF THE HIP. The line *ab* runs in the interval between the sartorius and the tensor vaginæ femoris muscles, from which there is easy access to the hip-joint. The dotted line *cd* shows the second incision, if more room be required.

joint and its capsule; this may be the ordinary anterior incision employed for excision of the hip, which runs downwards and slightly inwards from just beneath the anterior superior iliac spine over the interval between the sartorius and the tensor vaginæ femoris and to which may be added a horizontal one running outwards from about the centre of the first incision, so as to facilitate access to the deeper structures (see Fig. 65). This horizontal incision divides nothing of importance except the fascia lata and the tensor vaginæ femoris. Some surgeons prefer a posterior incision, but the one described will usually give satisfactory access to the joint. The head and neck of the bone are exposed through the incision, the attachment of the capsule to the neck of the femur is divided, and all the tense parts of it are cut through. In bad cases the capsule may be so much shortened that it is necessary to strip off the periosteum around the trochanter, along with the muscles attached to it, in order to effect reduction of the dislocation. The femur is next rotated inwards, so that the head of the bone is turned well backwards out of the way, and the acetabulum is enlarged by scraping and cutting away the soft tissues and portions of the cartilage with a sharp spoon or a suitable gouge until an acetabulum of suitable size has been made; it is necessary not only to deepen the cavity, but to enlarge it sufficiently for the head of the bone to enter it easily, as the head itself is usually considerably altered in shape. The main enlargement of the cavity should be made at its posterior and upper part, and, should the head of the femur be markedly flattened and mushroom-shaped, enough of it should be pared away with a chisel or gouge to make it of a more convenient shape and size for reception into the new acetabulum. This is a much better plan than making the acetabulum sufficiently large to receive the enlarged head.

The head of the bone is next got into position by extending and rotating the limb outwards; the latter is kept abducted and fully extended with a moderate degree of outward rotation. In sewing up the wound it is well to attempt to stitch together the remains of the fascial tissues over the head and neck of the bone so as to lay the foundation of a new capsular ligament. After the wound has been sutured and the usual cyanide dressings applied, the limb is put up in a plaster of Paris spica in the position above mentioned, and it should be kept in this for about six weeks, at the end of which time the stitches are taken out and careful passive movement is commenced, the patient being kept in bed meanwhile. After the lapse of a week or ten days, a second plaster of Paris casing may be applied, with the limb in a position of slightly less abduction than before, and the case may now be treated on lines exactly similar to those for the second stage of the bloodless method (see p. 136).

**Results.**—The results of these operations are not very good; there is some improvement no doubt, and a much more stable limb is obtained, but, although at first promising, the final result is by no means perfect, and there is often a gradual increase in the deformity.

Mr. Arbuthnot Lane tries to replace an insecure joint by a firmer one which is fashioned from beneath the anterior inferior spinous process of the ilium. A preliminary tenotomy of any tight structures should be practised, and the shortened tissues stretched by suitable manipulations. A free vertical incision is made over the great trochanter, and if more room be required it is obtained by a cut carried horizontally backwards from the first at about the level of its upper border. The soft parts are retracted, the capsule opened, and a cavity gouged out from the innominate bone immediately beneath the anterior inferior spine. The head of the bone, trimmed, if necessary, to a better shape, is placed in this, and the anterior portion of the capsule, which has been previously separated from the acetabulum, is sewn to the fibrous structures around the anterior inferior spine and the origin of the short head of the rectus femoris. The results of this operation are, however, so far as we have seen, in no way superior to those of the other operations; it is perhaps more likely to be successful in bi-lateral cases than in unilateral ones, as its principal aim is to remedy the lordosis by carrying the axis of rotation of the pelvis horizontally forwards.

**Summary of Treatment.**—We recommend, therefore, that when the case is seen in infancy the treatment by manipulation (see p. 131) should be employed until the child is two or three years old, and then Lorenz's bloodless method (see p. 131) should be carefully carried out. It is only in the event of complete failure of this method, or in cases which do not come under observation until the child is seven or eight years of age, that the open operation should be resorted to. The latter is a very serious matter when performed on very young children. The operation is prolonged, and there is, therefore, great risk from shock, and a considerable amount of blood is lost; further, accidents, such as prolonged suppuration and general septic infection, have also happened. Although, of course, these ought not to occur, it must be admitted that, the operation being a very prolonged one, it is easy for accidental infection to occur during its course, and, moreover, since it is in the immediate vicinity of the perineum, the wound is very apt to become soiled subsequently, and, therefore, the risks of sepsis can never be entirely ignored.

# DIVISION II.

# SURGICAL AFFECTIONS OF THE TISSUES.

## CHAPTER VIII.

### THE SURGICAL AFFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUES.

#### BLISTERS, CORNS, WARTS, AND TUBERCULOUS AFFECTIONS ELEPHANTIASIS.

BESIDES wounds and ulcers, which have already been described, there are certain other surgical affections of the skin requiring mention.

#### BLISTERS.

These as a rule are of very little moment, especially if properly treated, but they often give rise to great inconvenience when they occur on the feet, and they may completely prevent the patient from walking; this occurs more especially in the case of soldiers, policemen, etc. On the feet they occur about the heel, the instep, or the toes. A blister is of importance partly from the physical pain caused in walking by the irritation of exposed nerve ends, and partly from the susceptibility to septic infection, lymphangitis, cellulitis, etc., that has always to be reckoned with in these cases.

**TREATMENT.**—The **prophylactic treatment** in the case of soldiers and others subject to blisters must not be neglected; it mainly consists in observing scrupulous cleanliness of the feet, and avoiding tight boots or undue pressure or friction on any one particular part; a further precautionary measure, which it is well to employ before a long march, is to rub the feet well with fat or tallow. They may also be bathed in methylated spirit or whiskey.

**When blisters have occurred** the best plan is to puncture them at their most dependent part so as to allow the fluid they contain to escape, and then to take suitable measures to prevent any further friction so that the separated epithelium may remain in contact with the raw surface beneath and protect it against external sources of irritation. If possible, rest should be enforced, and some simple antiseptic application, such as dilute boracic ointment (one-fourth of the B.P. ointment), should be employed. Where the patient is compelled to get about, some form of hollow pad designed to keep the pressure off the blister should be provided. Where it is merely necessary to prevent the surface of the blister from being irritated by the clothes, etc., a very useful method in parts other than the feet is to protect the raw area by means of a perforated convex

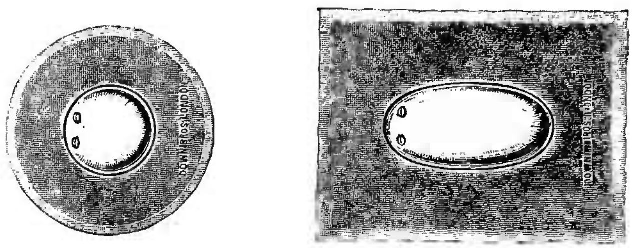


FIG. 66.—CELLULOID SHIELDS. The shield is inserted in the centre of a sheet of adhesive plaster, by means of which it is applied to the limb. In the figures two holes are represented in each shield; these are to permit of evaporation.

celluloid shield (see Fig. 66) fastened over the part by strapping. These shields are of various shapes and sizes; the dressing to the blister lies in the shield and is kept in place by it.

## CALLOSITIES.

These are more or less indurated, prominent yellowish portions of skin, shading off at their edges, and consisting essentially of thickening of the horny layer of the epidermis. They are due to repeated friction and they may or may not be preceded by blisters. Cessation of the pressure will lead to disappearance of the callosity, but while it lasts it is often extremely painful, and a bursa may form beneath it and become inflamed or suppurate.

**TREATMENT.**—When the callosity is causing pain, it is well to shave off as much of the thickened epidermis as possible, after softening it by prolonged soaking in water as hot as can be borne, and then to apply *salicylic collodion* (100 grains of salicylic acid to the ounce of flexile collodion) and to repeat this application night and morning. This should be combined with the use of a *hollow pad* to prevent pressure, which may consist of a corn-plaster or of the thick so-called "elephant plaster"; the plaster, which is spread on thick felt, should be of sufficient size to overlap the thickened area in all directions for three-quarters of an inch, and a hole corresponding in size to the callosity should be cut in its centre. This treatment will usually lead to the disappearance of the affection.

## CORNS.

Corns are small localized hypertrophies of the epidermis, the peripheral part consisting of a number of layers of parallel epidermic cells, and the central portion being formed by a dense mass which presses on the papillæ and the dermis, and causes more or less atrophy of these structures. Not infrequently a small bursa forms beneath the centre of the corn, and if the irritation persist, inflammation and suppuration may occur in it, and the condition thus produced is known as a suppurating corn. Corns are met with where there is long-continued pressure, and are frequently found between the toes.

**TREATMENT.**—Absolute cleanliness must be insisted upon. The part must be kept dry, and pressure on any prominent points avoided. Pointed shoes must be especially eschewed as they compress the feet, and constantly lead to the occurrence of corns both between the toes and over the more prominent points, especially the outer side of the little toes. When a corn has formed, all pressure should be taken off from it, and not infrequently the mere *avoidance of pressure* alone is sufficient to lead to the separation of the dense core and to a complete disappearance of the trouble. Pressure may be avoided in various ways; when the corn is situated between two adjacent toes, a piece of boracic lint inserted between their tips so as to prevent the two sides pressing on one another, will relieve the pressure and so bring about a cure. In the sole, pressure is best relieved by a *hollow ring-pad*, the corn being made to occupy the centre of the ring. The disappearance of the corn may be much accelerated by *shaving down the dense core* with a razor, after the toe has had a prolonged soaking in hot water. In paring down the thickened epidermis care must be taken not to go deep enough to injure the living tissues, because the epidermis of a corn often contains much septic material which may be introduced through the incision in the skin and lead to very serious infection.

As a rule, after the source of pressure has been removed and the corn has been shaved down several times, it is not difficult to pick out its core with a needle, when, if pressure be carefully avoided, the skin of the part will very soon resume its normal appearance. When the corn is large, it is well after shaving it to apply the *salicylic collodion* (*vide supra*) once a day, repeating the shaving if necessary about once a week; if the corn be situated between the toes care must be taken to keep the latter well apart until the collodion is thoroughly dry. Some arrangement for preventing pressure subsequently must, of course, be also employed.

When the case is one of a **suppurating corn** the patient should be made to lie up, and the *abscess opened.* The best method of opening it is to make an incision through the centre of the corn by means of a Syme's abscess knife. The pus usually forms in the bursa beneath the base of the corn, and though only small in amount may, from the tension of the parts, cause exquisite pain and suffering long before it gives rise to fluctuation or any other characteristic sign of an abscess. When the corn is cut through, and the drop or two of pus let out, the relief is immediate. The entire corn, which is undermined by the abscess, can then be clipped away with scissors, and warm boracic fomentations, which are changed as often as necessary, should be applied and continued until all acute symptoms have subsided, when dilute boracic ointment should be substituted. This small operation, which ends in the permanent cure of the corn, is best done under nitrous oxide; freezing the part is not to be recommended.

## INFLAMMATORY AFFECTIONS.

Of these, multiple acute abscesses, boils, and carbuncles demand consideration; there are in addition various specific inflammatory conditions of the skin which must be noticed. The more diffuse inflammatory affections, such as acne, lichen, etc., do not properly belong to this group of surgical affections of the skin.

**MULTIPLE ACUTE ABSCESSES OF THE SKIN AND SUBCUTANEOUS TISSUE** are not uncommon in infants and young children. They probably occur in connection with the sebaceous glands, and are principally due to dirt, eczema, scratching, etc. In infants they are often the result of the clothes not being changed sufficiently often, so that dirty flannel is in constant contact with the skin, and, as the child wriggles, the dirt from it is rubbed into the orifices of the glands. In the infant the skin is thin and soft, and sloughing does not so readily occur as in the harder skin of the adult subject, and hence acute inflammation of the skin in them leads to the formation of acute abscesses, which take the place of boils in adults.

The **treatment** follows the same lines as that of abscesses generally. Any abscesses present should be freely opened with full antiseptic precautions (see Part I., p. 26), and the further spread of the trouble should be provided against by thoroughly cleansing the skin generally, and disinfecting it with special care in the vicinity of the abscesses. The use of clean underlinen or flannel must of course be insisted on.

**BOILS** are closely related, as far as their seat of origin is concerned, to acne and impetigo, the latter being a pustular eruption of the skin in connection with the hair follicles, and a boil being a circumscribed gangrenous inflammation of the skin which probably occurs in connection with the sebaceous glands of the same structures. Boils are small conical tumours, hard and painful, which usually suppurate and give exit to a soft slough, in which are the remains of the hair and the sebaceous structures. They chiefly occur where the hairs are coarse and the sebaceous glands are numerous (with the exception of the hairy scalp), and they are especially frequent on parts which are subject to friction. The organism usually found in them is the staphylococcus pyogenes aureus.

In the early stage of a boil there is a small swelling, in the centre of which appears a vesicle containing rusty-coloured fluid; from the middle of this a hair generally protrudes. In three or four days the boil develops into a bright red, somewhat conical swelling, which may at this time abort; if it does not, it increases in size, the apex becomes yellow from the presence of pus, and finally perforation occurs, and the pus escapes. At the bottom of the opening thus formed a white slough is seen, and this is usually cast off about the eighth or tenth day. As soon as the slough separates, healing rapidly occurs.

The **prognosis** is usually favourable except where some grave constitutional disease, such as diabetes, is present, or where the affection occurs on the face or the lip, when it may be followed by the most serious septic troubles. In any case, lymphangitis and inflammation of the neighbouring glands are very common, whilst phlebitis, septicæmia, pyæmia, and erysipelas occasionally follow, especially in the case of boils on the face. It is very common for one boil to be followed by others in the vicinity; this is the result of local infection, the pus from the original boil spreading over the skin and being rubbed in by the friction of the clothes.

**Treatment—Local.**—In carrying out the local treatment the points mentioned at the end of the last paragraph should be borne in mind, and, with the view of preventing the appearance of fresh boils, steps should be taken in the first place to *purify the skin in the vicinity* of the boil, so as to get rid of the infective material which may have soaked into it. The skin around the boil should be shaved and thoroughly disinfected, and then some 10% oleate of mercury should be smeared over it so as to destroy the cocci that have got on to the skin. The latter should be frequently (once or twice daily) and thoroughly cleansed subsequently with soap and sublimate solution (1-2000), and the application of the oleate should be renewed after each washing. Friction by the clothes should be carefully avoided. When the boil is on the neck, for example, collars should be left off and soft shirts worn. It is also well in the case of boils on the body or limbs to have the underclothing changed daily, and to see that the underclothing left off is thoroughly boiled.

As regards the treatment of the boil itself, if care be taken in the early stage it may abort; the chief point in the treatment is that the boil should be left alone and shielded from injury. The skin should be carefully disinfected, the surface of the boil painted with *flexile collodion* every day, and friction avoided, if necessary, by the employment of a *shield*. The best form of shield is one made of celluloid (see Fig. 66), of sufficient size to protect the inflamed area completely without pressing on it. If there be much pain, warm boracic fomentations may be easily applied beneath the shield. At the same time, general treatment (*vide infra*) should be employed.

If the boil is not going to abort, and is extending, as will become evident about the fourth or fifth day, and if it is causing much pain, the use of *antiseptic compresses* (such as boracic lint dipped in hot boracic lotion, and covered by a large piece of guttapercha tissue) applied warm and frequently changed, often gives great relief; but if the pain continues, and is very severe, *early crucial incisions*, dividing the brawny tissues completely across, will give more relief than any other plan. It must not be supposed, however, that much quicker healing will be obtained by early incision, unless means be taken to get rid of the slough at the same time. Whether incisions be made or not, the slough will not separate and be cast off before about the eighth day, but the advantage of the incision is that it ensures relief of the pain and a diminution of the inflammatory trouble. When a boil is bad enough to call for incision, the best plan, if the slough be at all loose, is to *scrape it out* by means of a sharp spoon, and then to apply a little *undiluted carbolic acid* to the cavity left.

**After-treatment.**—If the slough be got away completely, the best dressings afterwards are *antiseptic ointments*, such as the eucalyptus, or strong boracic ointment, changed twice a day, the wound and the parts around being thoroughly washed with a 1-2000 sublimate solution each time the dressing is renewed. If portions of the slough still remain adherent, *boracic fomentations* should be employed till they have entirely separated.

At the same time, the methods already spoken of under prophylaxis should be employed for the skin round about, so as to prevent the appearance of fresh crops of boils.

The **general treatment** must also be attended to. The *urine must be tested* for sugar or albumen, and, if either be present, suitable constitutional treatment must be adopted. The *bowels* should be kept freely open by one of the usual saline aperients, such as Hunyadi or Friedrichshall water or a seidlitz powder, and *iron* should be given frequently. The tincture of perchloride of iron in doses of 15 to 25 minims in a considerable quantity of water every six hours, or Blaud's iron in 10-grain capsules three or four times a day, are the best forms in which to administer it.

**A CARBUNCLE** is a gangrenous inflammation of the skin and subcutaneous tissues affecting a considerable area, and is essentially a number of boils aggregated together. In the initial stage there is a large brawny rusty-coloured swelling in the skin, looking just like an exceedingly large boil, but on the third or fourth day small pustules begin to appear in numerous places on the surface of the carbuncle, and in two or three days more the pustules burst and leave openings exuding pus; at the bottom of each of these a white slough is seen. If the case be left to itself and the patient survive, the skin between these various openings sloughs to a greater or less extent, and a sufficiently large aperture is obtained to allow of the escape of the deeper-seated slough. During this process, however, the constitutional disturbance is often severe, and patients are very liable to become a prey to one of the various septic diseases.

Carbuncles occur most frequently in males over forty, and usually in parts where the skin is thick, as on the back. They are due to the same organism as boils, and often originate in connection with some local irritation, such as friction by the clothes, or want of cleanliness. In carbuncles the general condition plays a greater part in their production and course than in the case of boils, and they occur chiefly in cachectic or half-starved people, in drunkards, and notably in those suffering from diabetes. As regards the latter affection, it may be mentioned that during the course of a carbuncle sugar may appear in the urine, and may subsequently disappear when convalescence takes place. It is important, therefore, not to mistake this temporary glycosuria for true diabetes. The carbuncle in the diabetic is most often situated on the back of the neck, and is a very grave disease, as the patient often dies from diabetic coma, and is also especially liable to septic infection elsewhere. This form of the disease is sometimes slow and insidious in the early stages, and there is not the violent swelling seen in the ordinary form, the pain and the fever being only moderate in degree. If the case be left to itself, and the patient live, it usually takes at least two months before the wound heals.

The **prognosis** of a case of carbuncle depends on the size of the local affection, and the complications which co-exist with it. In large carbuncles the prognosis is, on the whole, exceedingly bad; from 8% to 30% of those attacked generally die.

**Treatment.**—(a) **General treatment.**—This consists, in the first place, in the use of *opiates*. The object of their use is partly to enable the patient to obtain sleep, and partly also, where diabetes is present, to diminish the amount of sugar. In the latter case, *codeine* is better than opium, and it may be given in doses of a quarter to half a grain every four or six hours. In addition to opium or codeine, *tonics* should be administered, especially a large quantity of *iron*, either in the form of reduced iron in pills of about three grains, or the tincture of the perchloride of iron, in doses of fifteen to twenty-five drops, three or four times a day in half a tumbler of water. Every care must be taken to keep up the strength of the patient by the free admistration of *liquid food;* from three to four pints of milk should be given daily (if sugar be absent from the urine), along with raw meat juice, Bovril, Carnrick's beef peptonoids, etc. When the patient is passing into a typhoid state, as is very often the case, the free use of *stimulants* is indicated.

The greatest attention must be paid to the state of the urine, and, if sugar be present, not only should *codeine* be given, but the patient should be dieted as far as is consistent with keeping up the strength. Perhaps in the severe cases, when there is very great weakness, it will not be judicious to restrict the diet materially, but as far as possible the use of sugar and starchy substances should be limited, and, as time goes on and the patient improves, the diet may be made more strict. For a diet suitable for diabetics, see Part I., p. 76.

(b) **Local Treatment.**—Before the appearance of the pustules on the surface of the carbuncle, and before the symptoms are very severe, warm **fomentations** may be employed in the hope that the inflammation may subside, or at any rate that its extent may be limited by their use. But where suppuration is evidently occurring, something in the way of operation must be done. The operative procedures are excision, incision combined with scraping, or free incision alone.

(1) **Excision.**—The best treatment for carbuncles of moderate size, is to administer an anæsthetic, to make an incision completely encircling them, and to dissect them out cleanly, using the ordinary antiseptic precautions. Nothing is lost by excision, because the skin over the carbuncle is of little or no use in the subsequent healing, whilst the deeper parts and the subcutaneous tissues will certainly slough, so that there is no extra loss of tissue. On the other hand, by early removal the whole trouble may be cut short, and the patient freed on the one hand from the pain, and, on the other, from the danger of extension of the disease, and the risk of general septic infection. The excision must be quite clean, and must be well beyond the limit of the disease, or else local recrudescence is almost certain.

In order to diminish the risk of infection of the wound it is well to sponge the surface of the skin to be removed with undiluted carbolic acid. The incision generally requires to be carried down to the deep fascia; the amount of blood lost is not great, the oozing that occurs being readily stopped by pressure. After removing the affected area and arresting the oozing, it is well to sponge the surface of the wound with undiluted carbolic acid, and then to apply the ordinary cyanide gauze dressings. As soon as it is certain that the raw surface has not become infected, and is granulating healthily, *skin-grafting* should be employed.

(2) **Incision and Scraping.**—When the affection is very extensive, and when the patient is so enfeebled that the loss of blood entailed by excision would be serious, the foregoing method is not advisable, and free crucial incisions must be made into the carbuncle instead. These incisions should extend right across the affected area, from the healthy skin on one side to the healthy skin on the other, and must divide the sloughs throughout their entire depth. These should then be clipped and dissected, or scraped away as thoroughly as possible, and if the whole slough can be removed in this manner, the chief risk of the disease will be at the same time disposed of. All the perforated and undermined skin should also be cut away: it can do no good, and only forms a possible source of fresh infection of the wound afterwards. When the slough has been got rid of as thoroughly as possible, the bleeding should be arrested, and the raw surface thoroughly impregnated with *undiluted carbolic acid.* The object of this is to disinfect any portion of the slough that may remain, and to kill any organisms that may have penetrated into the tissues beyond the sloughing area, for, in scraping a

carbuncle, there is a certain risk that the organisms may be pressed into the cellular tissue and the lymph spaces around, and thus set up fresh trouble. The skin around the affected area should be disinfected both before the operation is commenced and also after the part has been scraped out, because the sloughs and pus from the interior are otherwise certain to re-infect the skin. When the slough has been got rid of, and the raw surface remaining thoroughly swabbed with pure carbolic acid, the wound should be packed with *moist cyanide gauze* sprinkled with a small quantity of *iodoform*. Care must be taken not to use too much of this drug, because it is readily absorbed and may give rise to toxic symptoms; curiously enough, surfaces which have been impregnated with undiluted carbolic acid absorb iodoform more readily than those which have not been so treated.

*Sulphur* (flowers of sulphur) is also a good application, and may be dusted over the wound before it is packed with the gauze. If this method be employed, the dressings should be changed in 24 or 48 hours, and, if there should be any signs of the disease spreading, fresh sulphur may be applied. The sulphur forms a slough smelling strongly of sulphuretted hydrogen, and varying in depth with the length of time it is allowed to act; its action is perfectly painless. Of these two methods we prefer the former.

The *after-treatment* will consist in renewing the gauze packing as often as may be necessary, probably in most cases every 24 hours, until the wound is healthily granulating. When this has occurred, skin-grafting (see Part I., p. 50) should be employed. If the surface be not skin-grafted it will take a very long time to heal, especially if the carbuncle be situated on the back of the neck; in the latter situation the destruction of tissue may lead to inconvenient contraction if ungrafted.

*Where sulphur is used* the dressing is changed every 24 hours, and if there be any sign of recrudescence of the affection—as shown by brawny swelling about the edges, or throbbing pain—either more sulphur is dusted thickly on, or the gauze packing is impregnated with it. If the process has come to an end, hot boracic fomentations are applied until the sloughs have completely separated, when ordinary gauze dressings may be used till granulation is complete, after which the area may be skin-grafted.

(3) **Free incision alone** without scraping, such as it is possible to do without an anæsthetic, is not nearly so good a practice as either of the methods just described, and while great relief is no doubt given to the patient by promoting the escape of discharge and the relief of tension, the septic process is not arrested, and the length of time occupied in healing will be very considerable, during all which time the patient remains liable to an attack of general septic disease. On the other hand, if the carbuncle be got rid of in one of the ways described, and skin-grafting be subsequently employed, the duration of the affection is very much reduced.

## MALIGNANT PUSTULE OR ANTHRAX.

Anthrax is a disease of the lower animals, especially of sheep and cattle, but it sometimes affects man, and comes under the notice of the surgeon in the form known as malignant pustule. The disease is due to the bacillus anthracis, which grows in the dermis and subcutaneous tissues, but has a great tendency to pass into the blood-vessels and cause general infection. It occurs especially in those, such as tanners, mattress-makers, butchers, etc., who are brought in contact with the skins and hair of infected animals, and it is caused probably in all cases by direct inoculation through lesions of the skin or mucous membrane.

Inoculation is followed by a period of incubation, then by the appearance of a red spot, and subsequently of a vesicle. When the condition is fully developed there is a central black area which is a slough, and outside this there are one or more circles of small vesicles, and outside that again there is an œdematous and erythematous condition of the skin. In advanced cases there is enormous swelling and brawniness of the parts, and wide extension of the œdema, which, in certain situations, as in the neighbourhood of the upper air passages, may in itself be a very serious danger. This is accompanied by enlargement of the nearest lymphatic glands, and, if the case be left to itself, it usually goes on to extension of the gangrene, phlebitis, lymphangitis, internal complications, and death. As regards the general symptoms there is from the first a very small feeble pulse, a dry skin, a temperature up to 104° F., and subsequently bloody urine, the patient passing into a typhoid condition in which death occurs.

**TREATMENT.**—(a) **Prophylaxis.**—In the first place, if there be any suspicion that the animal or the hair is contaminated with the anthrax bacillus, precautions must be taken at once to disinfect any accidental cut or scratch that may occur in those that work in contact with it. Any wound should be thoroughly cauterized, first of all with a red-hot iron, and then with undiluted carbolic acid. The skin around should be disinfected with the strong mixture, and antiseptic dressings applied. When the pustule has developed, very few patients recover unless the local treatment be early and vigorous.

(b) **Local.**—In the **milder cases** the best treatment is to completely *excise* the swelling whenever the size and situation of the pustule is such that it can be done safely, and then to thoroughly *cauterize* the wound left with a red-hot iron and afterwards to apply *undiluted carbolic acid* to the cauterized area. The application of *chloride of zinc* paste (see p. 164) to the raw surface left by the excision is often practised. It is, however, not so reliable as the application of the actual cautery, and gives rise to much more pain afterwards. The progress of the affection is so rapid that if the whole of the disease be not destroyed at the first sitting there is not much chance of the somewhat tardy action of the chloride of zinc overtaking it. Before excision, the pustule and the portion of skin to be removed should be sponged with undiluted carbolic acid. The skin around should also be cleansed with the strong mixture, and the usual antiseptic dressings—cyanide gauze and salicylic wool—employed, the wound itself being packed with cyanide gauze. During the operation it is advisable to use swabs of salicylic wool instead of sponges. There would be considerable difficulty in disinfecting the sponges afterwards, owing to the resistance of the spores of the bacillus anthracis to antiseptics.

**In more advanced cases** the brawny swelling should be *laid freely open*, the slough cut away, and the raw surface thoroughly destroyed with the *actual cautery*, and subsequently soaked with *undiluted carbolic acid.* In place of or in addition to these measures, some recommend in severe cases, where there is much œdema, injections of carbolic acid into the tissues all around the pustule. For this purpose a 1% watery solution is employed and two or three drops are injected hypodermically at numerous points in a circle all around the area of redness. As a rule, however, unless it be possible to get well beyond the disease by excision, the best method of treatment is free incision and cauterization, although this is by no means certain in its action. If the treatment prove successful, a granulating wound is left which must be treated on the lines already laid down in speaking of carbuncle (see p. 149).

(c) **General.**—The general treatment of the affection—by the administration of large quantities of nourishing and easily digested food—must be carefully attended to. Stimulants—alcohol, sal volatile, and even ether—will be called for, sometimes in large quantities, and quinine in 5 to 10-grain doses every four hours, or Warburg's tincture in doses of a drachm at similar intervals is also useful. Powdered ipecacuanha, in doses of 40-60 grains given every four hours as long as the patient can retain it, has been highly recommended; we have no personal knowledge of its use, but in any case it should only be tried as an adjunct to vigorous operative treatment.

## TUBERCULOSIS.

This affection occurs in four forms: (1) Tuberculous ulceration; (2) Tuberculous warts; (3) Lupus; and (4) Tuberculous nodules in the subcutaneous tissue, termed *gommes scrofuleuses* by the French.

**TUBERCULOUS ULCERS.**—These occur on the skin or mucous membranes either primarily, as the result of direct inoculation from the outside, or secondarily from infection from beneath, as after rupture of tuberculous abscesses. In phthisis, tuberculous ulcers are comparatively common on various mucous membranes, especially in the intestine, the tongue, and the throat; they are probably due to direct inoculation of the part by the bacilli contained in the tuberculous sputum. Elsewhere, the ulceration generally results from the bursting of deeper seated abscesses, but it may also be due to external inoculation. The tuberculous ulcers are often multiple, and form sores of various sizes with sharply cut and undermined edges. The base is usually not indurated, the granulations are greyish and imperfect, and a sort of sero-pus, which has a great tendency to form crusts, is secreted from the surface. As a rule the ulcers are not painful, except when they are situated on the lip, or about the anus, etc., when they may cause very considerable pain.

**Treatment.**—**Excision.**—Tuberculous ulcerations of course require local treatment; the best is wherever it be possible to excise the sore as soon as its tuberculous nature is determined. The wound left is generally quite small, and it will be found feasible, by a little undermining of the skin in the vicinity, to bring the edges together, or, if this be impossible, skin-grafting may be employed. Excision is the best of all methods of treatment for local tuberculosis; it should of course be done with full antiseptic precautions.

**Scraping and cauterization.**—Where excision is not feasible, scraping and thorough cauterization of the raw surface with nitric acid (see Part I., p. 80), is indicated. In tuberculous ulcerations of mucous membranes, excision is seldom practicable, and here it will be necessary to be content either with scraping the ulcer, with the application of various substances to its surface, or with a combination of the two methods. Perhaps the most useful application is a 1% solution of *chromic acid* in water, brushed over the part daily or every other day, and at less frequent intervals later if there be delay in the healing. A single application of pure chromic acid melted on a probe may also be used. *Pure lactic acid* is also much used in ulceration about the throat and larynx. For relief of pain, dusting with *orthoform* powder two or three times a week is the best treatment.

**Division of undermined edges.**—When the skin or mucous membrane is undermined, and the patient will not agree either to excision or scraping, the thin undermined edges must be divided; they are stretched and thin and will never develop into healthy tissue. They need not necessarily be cut away, but several incisions should be made through them radiating from the centre of the ulcer well into the healthy skin beyond. As a result of this, the skin between the incisions contracts, and a number of tags are left which will readily adhere and form new centres for epithelial growth. As a rule, however, if a presentable scar be desired, it is better to clip away all these tags at their junction with the sound skin. This can be done under cocaine or after freezing.

The treatment of tuberculous ulcers of the skin, secondary to tuberculous abscesses, depends of course on the treatment of these abscesses, and will be referred to in speaking of tuberculous sinuses in connection with joints, etc.

**TUBERCULOUS WARTS** or **LUPUS ANATOMICUS** have been already referred to in Part I., p. 192. They occur in *post-mortem* porters, or those who do much *post-mortem* work. They form irregular papillomatous elevations, and between the bases of the papillæ fissures are very often found. As a rule they are indolent, the surrounding skin is normal, they are benign and slow in their course, and the glands do not usually enlarge. In some cases of lupus anatomicus, however, the course of events may be much more acute, and there may be enlargement of the glands, disease of subjacent joints, or even phthisis.

**Treatment.**—This is practically the same as that of lupus, and where the disease is not too extensive the best plan is to completely excise the group of warts.

**TUBERCULOUS LUPUS.**—This disease is characterized by the presence of nodules which, under the microscope, are found to consist of a collection of tubercles. These nodules tend to spread at the margin of the patch while healing often occurs at its centre. In some cases the epidermis remains unbroken, and the nodules present a yellowish translucent apple-jelly-like appearance, or the epidermis is slightly thickened and scaly, the nodules are dull, and there is a slight congestion of the skin around; in other cases there is ulceration. Lupus may be met with in any part of the body, but it is most frequent about the cheek, the nose, and the back of the hands. There are two great clinical groups of tuberculous lupus, termed lupus non-exedens and lupus exedens respectively.

(*a*) **Lupus non-exedens.**—In this form of the affection the tubercles tend to dwindle after a time, leaving a soft violet-coloured cicatrix. The tubercles are often very small and form brown or apple-jelly-like nodules, usually with a considerable amount of inflammation around them. In other cases, however, the nodules may be much more numerous, and may run together and form patches with a prominent edge, while at the centre they disappear, so that there is a cicatricial centre surrounded by an elevated nodular mass. This condition is spoken of as *hypertrophic lupus.*

(*b*) **Lupus exedens.**—Here the tubercles are soft and red and soon ulcerate, and thus give rise to large ulcers which fungate and are covered by granulations bathed in pus. The ulceration tends to heal, and when it does so the scar often causes very considerable contraction and deformity; in the cheek, for example, the scar pulls on the lower eyelid, causing great eversion or ectropion of the lower eyelid. This form of lupus is especially destructive; when it occurs on the nose it spreads first from the skin to the cartilage and destroys it, then it spreads on to the mucous membrane, and may thus completely destroy the soft parts of the nose, leaving, however, the bones intact. The course of the disease is, as a rule, exceedingly slow, and years may elapse before any marked destruction is caused. Lupus exedens may, however, suddenly spread with great rapidity, and it is then termed "**lupus vorax.**" This form may destroy the nose and a large portion of the face in a very few weeks; in reality a rapidly growing epithelioma has become grafted upon the lupus, and the case is really one of true epithelioma.

**Treatment.**—It is necessary to consider the treatment of these different forms of lupus separately. The disease is a local one, although it occurs very often in patients who have an hereditary tuberculous taint, or who are suffering from tuberculosis elsewhere. Hence, although **general treatment,** such as has been already recommended in Part I., Chap. XIV., is advisable in all cases, the disease will not, as a rule, disappear without local interference; this consists essentially in the removal of the diseased tissue as thoroughly as possible. Of late years considerable improvement has been reported under the internal administration of thyroid extract in doses of from three to five grains daily after food, or at longer intervals and in smaller doses according to the effects produced; the drug is not, however, much to be depended upon.

The methods of **local treatment** depend largely upon the particular form of the disease that has to be dealt with.

(1) In a case of **lupus non-exedens,** where there is little or no ulceration, and where the nodules are isolated and tend to form cicatrices, it is often a very difficult matter to get rid of the affection entirely. The ideal treatment of lupus is of course to *excise* the whole of the diseased area, but where the non-ulcerating form of lupus covers a large surface, and where the nodules are pretty wide apart, excision would mean a very extensive operation, and would involve considerable deformity, and therefore it is well to try some other plan, at any rate at first.

The best treatment for extensive lupus non-exedens is the application of *Unna's salicylic and creosote plasters*, containing 15 and 30% of pure salicylic acid respectively; the creosote is added to relieve the pain which follows the application of the plaster. The effect of salicylic acid applied in this way to a patch of lupus is to cause the lupus nodules to break down, while the healthy skin in their vicinity is quite unaffected by it. The plasters are applied as follows. If ulceration be present, the crusts must first be got rid of by poulticing for 24 hours, or fomenting the part with hot water. When there is much desquamation the epidermic scales are removed in the same way. The strong plaster, which is bought ready-made, is then applied to the affected area, and changed every day. The result of the application is that at the end of the first day the lupus nodules are seen to be softened, and in the course of two or three days they begin to ulcerate, and as the use of the plaster is continued the ulcer becomes deeper, until eventually the lupus tissue is completely destroyed by the action of the acid.

These strong plasters are continued for about three weeks, if the patient will bear them; in some cases, however, they cannot be persisted in for so long, because, in spite of the combination of creosote with the salicylic acid, it must be confessed that a great deal of pain is often caused. After three weeks have elapsed, plasters of half the strength are substituted for the stronger ones, and, as a rule, if all the tubercular tissue has been destroyed, the sores will cicatrize under this. If they do not, it means in most cases that all the lupus tissue has not been got rid of; in some cases, however, where the tissues are particularly susceptible to irritation, it may merely mean that healing will not occur while a plaster of that strength is used. If, therefore, after about a week or ten days, there be no sign of healing under the weaker plaster, it should be left off, and some non-irritating ointment, such as the quarter-strength boracic ointment, substituted for it. If cicatrization still does not occur, it must be inferred that lupus tissue is still present and the strong plaster must be re-applied, or some other method of treatment adopted.

If there be any doubt as to the freedom of the scar from the presence of nodules after healing has occurred, the strong plaster can be again applied, and if any lupus nodules be present, the salicylic acid very quickly finds them out, and causes their destruction. If, on the other hand, after using the strong plaster for a few days, it is found to cause no ulceration, it may be safely inferred that there is no lupus present in the scar.

A 10% *pyrogallic acid* ointment, used in a very similar manner, is highly spoken of by several leading dermatologists; it is, however, a very painful application. It must be borne in mind that neither of these methods should be employed where excision is feasible.

(2) In **lupus hypertrophicus**, especially when there is a thick ridge all around a more or less completely cicatrized area, and when the patch is too large for complete excision, the best treatment is to *excise* this ridge of lupus. An incision is made well beyond it—half an inch to an inch—and another is made through the cicatrical tissue about the same distance on the opposite side of the ridge. The whole of the tissues between these incisions, along with a considerable amount of subcutaneous fat, are then dissected away; in most cases it is advisable to place a number of skin-grafts on the raw surface. Should there be any question as to whether the scar tissue left has again become infected by lupus it can subsequently be tested with a strong salicylic plaster in the manner described above.

(3) **Lupus exedens** may also be treated on the same principles, but as a rule, a considerable amount of time is saved if other measures be adopted from the first. The most thorough of all methods of treatment for lupus is *excision*, and where there is only a small patch, this is the one to be recommended in preference to all others. The excision is, of course, carried out antiseptically. The affected part is enclosed in an incision of the necessary shape, which, if possible, should be oval, and which is carried through the skin for quite half an inch beyond any visible lupus nodules. The skin with the subcutaneous tissue is then dissected out, and the edges of the incision brought together—if necessary, after undermining,—and the resulting scar will, after a few months, be hardly visible. If the lupus be situated on the face, buried stitches, as described in Part I., p. 154, may be used. This plan of excision is the only one in which there is anything like permanent freedom from recurrence; all the other plans, whether by the use of salicylic plasters, scraping, etc., are usually followed by a certain amount of local recurrence.

Hence excision should be employed as far as is consistent with the appearance of the part, and the surgeon should not refuse to excise a patch of lupus, because it is impossible to bring the edges of the skin together afterwards. *Immediate skin-grafting* produces an excellent result. The grafts usually adhere readily and completely, and as there has been no granulation before their application the subsequent contraction is very slight, and as time goes on they gradually assume the appearance of more or less normal skin. The method of applying these grafts has been described in Part I., p. 50. Grafts as large and as broad as possible should be employed, because, although the body of the graft itself very soon resembles normal skin, the lines along which the different grafts come into contact are very apt to remain raised for a considerable time, and to assume a sort of keloid condition, which may produce a very ugly deformity. The broader the graft, therefore, and the fewer the lines of junction, the better is the appearance of the scar. It is possible in this way to excise a patch covering the greater part of the cheek, and the small amount of subsequent contraction makes it all the more advisable to do this, in spite of the somewhat pale and scarred appearance which the cheek retains for some months after the operation. With any other method of treatment, the contraction that almost inevitably results if the wound be allowed to heal by itself, often leads to very grave deformity, especially when it pulls on the lower eyelid, and leads to ectropion.

In other cases, however, where either the face is covered with lupus, and the surgeon is not prepared to remove the skin of the whole face, or where, for example, the nose is affected, excision is not advisable. In such cases, if the salicylic plasters be not employed, the best treatment is to *scrape* the lupus, and subsequently to *cauterize* the surface with nitric acid. In scraping lupus, the scabs should first be cleared off, and the parts disinfected as thoroughly as possible, and then, with a fairly large spoon, the whole surface of the lupus is carefully gone over, and all the soft tissue scraped away. The indication that the lupoid tissue has been entirely removed is that it is not possible to scrape away anything more. By means of a sharp spoon the dermis may be pared off to some extent, and it is also possible to scrape some of the fat away; but it does not come away in the same manner as the soft lupus tissue does. Hence the scraping is carried on until resistant tissues are met with, and until it is certain that no soft tissue remains. It is well to go over the part with a smaller spoon afterwards, such as is used for clearing out Meibomian cysts, for example, in case any small lupus nodules have escaped. Having in this way got rid of all the tubercular tissues, the bleeding is next arrested. This is best done by pressure and cold douching, the pressure being applied by sponges outside protective as has been described for arresting hæmorrhage in skin-grafting (see Part I., p. 51).

When the bleeding has stopped, the whole of the raw surface should be thoroughly cauterized by means of a glass brush dipped in pure nitric acid.

The acid very often starts the bleeding again, and this interferes with its caustic action. Should this occur it is necessary to take great care that the blood does not flow over the skin and carry the nitric acid with it, lest the skin should be burned. Any bleeding points should therefore be temporarily compressed, and, in the meanwhile, the application of the nitric acid should be made to any other parts which are free from blood. In this manner it is generally possible to soak the whole surface of the wound with the acid, and there should be no undue hurry in neutralizing its action, as it does not penetrate deeply into the tissues, and there is no need to fear any excessive destruction from its use.

After five to ten minutes the acid should be neutralized by pouring a solution of carbonate of soda over the wound. A handful of washing soda, which can usually be obtained in any house, is placed in a tumbler of water, and the solution is poured over the raw surface. The first effect is to cause the liberation of carbonic acid, and consequently ebullition, and this goes on as long as any free nitric acid is left. When the latter is all neutralized, the ebullition stops, so that in this we have a definite test as to how long it is necessary to continue pouring on the soda solution. When the action has ceased, a piece of boracic lint dipped into a 1–2000 sublimate solution is the best application. After about twelve hours, when the bleeding has quite stopped, this may be left off, and half- or quarter-strength boracic ointment substituted for it. If the wound be large, and subsequent contraction probable, it is well, as soon as granulation has occurred, to employ skin-grafting (see Part I., p. 50).

When there are only isolated nodules and small ulcers, the treatment is more difficult, but here a small sharp spoon should be used to scrape out the little nodules thoroughly, and the cavities thus made should be filled up with nitric acid, and this subsequently neutralized with carbonate of soda. The thermo-cautery or galvano-cautery may also be employed to destroy very small nodules.

(4) In the case of **lupus vorax**, complete excision is essential, whatever be the part affected; where the resulting wound is large, immediate skin-grafting may be resorted to.

**SCROFULOUS GUMMATA.**—The fourth form of tuberculosis of the skin and subcutaneous tissues is that spoken of by the French as "gommes scrofuleuses" or *scrofulous gummata*. Here nodules form in the skin or subcutaneous tissue, which are at first hard, but which in time tend to soften and break down, and lead to the formation of abscesses. Thus there are multiple chronic abscesses about the body which burst and give rise to tuberculous ulceration of the skin, with a sinus extending into the deeper tissues. This condition occurs chiefly in infants, in whom the nodules are subcutaneous; in adults it is rarer, and the nodules are in the skin. On examination, the nodules are found to be tuberculous tumours.

**Treatment.**—The nodules should be excised as one would excise cystic tumours, without opening them; if fresh ones form they should also be excised. These nodules are very chronic in their course as a rule, and incision and scraping are not nearly so rapid or certain in their results as excision.

## ELEPHANTIASIS.

**DEFINITION.**—Elephantiasis is an affection characterized by an enlargement of parts due to inflammatory œdema, especially connected with the lymphatic vessels. It differs from the common œdema, in which a simple serous fluid is poured out into the tissues, because in elephantiasis, the fluid is fibrinous and coagulable. In addition to the distention of the tissues with this fluid, there is hypertrophy of the skin and subcutaneous tissues, and not uncommonly of the other structures of the limb as well.

**CAUSES.**—Elephantiasis, as a rule, is due to some form of lymphatic obstruction. For example, tuberculosis of the lymphatic vessels and glands will sometimes bring about the condition. It seems probable that the condition is not due merely to lymphatic obstruction, but that a local inflammatory state of the tissues must also co-exist. The most usual cause of the endemic form of elephantiasis, or, as it is called, "elephantiasis arabum," is the *filaria sanguinis hominis.* Here the parent filariæ are deposited in some large lymphatic vessel, and lead to its permanent blockage, and there results from this a varicosity of the lymphatics below, and subsequent elephantiasis of the part. The parts usually thus affected are the legs and the external genitals in both sexes.

**COURSE.**—The endemic form is generally characterized by an acute onset, which often takes place after fatigue or injury, with the occurrence of lymphangitis, a certain amount of fever, headache, vomiting, redness and swelling of the parts, etc. This subsides, and after an interval further attacks may occur, and so it goes on until the condition of elephantiasis is established. In the leg, the condition is generally unilateral, and the foot is usually most markedly affected, but it may reach up the limb as far as the groin. It does not cause much inconvenience, except from the weight of the enlarged part, which, however, may in time reach an enormous size. In the external genitals, the parts chiefly affected in men are the prepuce or the scrotum: chylous hydrocele may sometimes be present. In women the labia majora, and more rarely the clitoris are the chief parts involved.

**TREATMENT.**—Very little can be done in the way of a cure for the disease. There is no way of reopening the lymphatic vessels, and thus getting rid of the obstruction to the lymphatic flow. Hence the treatment consists either in an attempt to reduce the swelling and hypertrophy of the parts, or in undertaking their actual removal. As regards the attempt to reduce the swelling, the most obvious methods, and those which do best, are compression and massage. *Pressure* is best employed by means of an elastic bandage applied fairly firmly, and should be supplemented by *massage* night and morning. The result is, however, very imperfect. *Ligature* of the main artery of the limb has been suggested, but is of very doubtful value. Compression of the femoral artery has also been used, with a similar want of success. *Punctures* have been made into the part, but naturally without any result beyond exposing the patient to great risks, because erysipelas is very apt to develop after slight injuries to parts affected by elephantiasis.

In most cases the question of *excision* of the enlarged part arises, and though this is not often necessary in the case of an extremity, it is frequently required when the scrotum, the prepuce or the external genitals are affected. The details of these operations, and the general treatment for the affection, will be described under the diseases of the genitals.

# CHAPTER IX.

## THE SURGICAL AFFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUES (*Continued*).

### *TUMOURS OF THE SKIN.*

#### SEBACEOUS CYSTS.

THE most common tumours of the skin are probably sebaceous cysts. They consist of a cavity lined with squamous epithelium, and containing epidermic scales, sebaceous matter, and cholesterin. They originate from a blocking of the orifice of the sebaceous duct and dilatation of the gland behind; it is usual to find in the centre of a cyst of this kind a small pit which corresponds to the blocked orifice of the duct. The sebaceous tumours are situated in the skin itself, and are therefore distinguished from dermoid cysts which occur in the subcutaneous tissue. The tumours are at first flattened, and then become spherical; they are closely connected with the skin, and consequently move with it. They generally occur in parts, such as the scalp, where there is hair.

**TREATMENT.**—The cyst is encapsuled, so that if the wall be defined it can be shelled out without difficulty; the cyst-wall is very tough and firm in parts where the skin is thick and coarse, whereas it is thin and easily torn where the skin is thinner, as on the face. In this situation the cyst-wall is apt to tear if pulled upon, whereas in the scalp the cyst can be pulled out, if the skin be divided freely enough, the wall being so firm that it does not tear even on considerable traction. If any part of the wall be left behind the cyst will re-form.

**Sebaceous cysts of the Scalp.**—The hair must be shaved for at least half an inch around the tumour. Patients often object strongly to this, but it must be done. The skin and hair around are rubbed over with turpentine, thoroughly scrubbed and washed with strong mixture, and the hair converted into an antiseptic mass by rubbing into it double cyanide of mercury and zinc powder made into a paste with a 1-20 carbolic acid solution; this is rubbed in until the hair is thoroughly impregnated with it. A narrow-bladed knife is then inserted through the skin on one side of the cyst and pushed right through its centre until the point emerges at the corresponding spot on the opposite side, when the surgeon cuts upwards, dividing everything and bringing the knife right out (see Fig. 67). In this manner the upper half of the sebaceous cyst is cut through, and on pushing aside the skin the divided wall can be readily seen after its contents have been squeezed out. By catching hold of this wall and gently pulling upon it, it is generally easy to enucleate the whole cyst. The only difficulty in the scalp is when inflammation has occurred and the cyst is adherent to the skin; if this be the case it is necessary to cut away the adherent

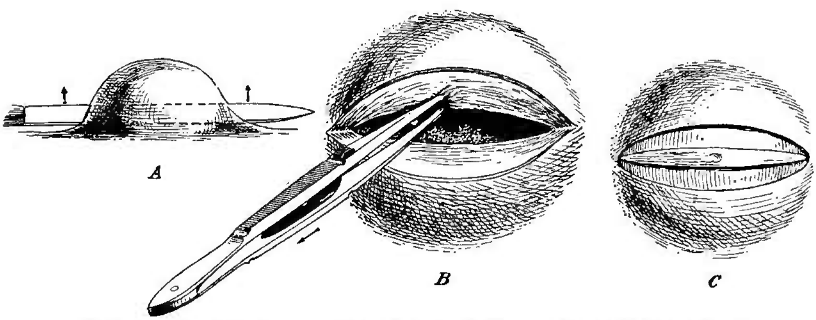



FIG. 67.—METHODS OF REMOVAL OF SEBACEOUS CYSTS. In *A* and *B* are shown the stages of the removal when the cyst wall is thick and firm, *e.g.* on the scalp. The cyst is first cut across by transfixion, and its contents squeezed out; then, as shown in *B*, the wall is laid hold of by catch-forceps and traction exerted. The wall pulls out and only a mere touch of the knife is required. In *C* the cyst is dissected down upon from outside, a portion of the thinned skin being included in the elliptical incision; this method is most suited to the thin-walled cysts on the face.

portion of the skin as well as the cyst. It is not uncommon to get considerable inflammation in sebaceous cysts of the scalp owing to the friction of the hat or to other forms of irritation.

After the bleeding has been stopped, the wound is stitched up, gauze dressings, so arranged as to form a pad which presses the superficial and deeper parts together applied, and a mass of salicylic wool and a firm bandage put on over them. These should be removed in about three days, the stitches taken out, and the surface of the wound and the hair around covered with fresh cyanide paste. No other dressing is necessary, and the hair can be combed over the wound and the patient allowed to go about without anything being noticeable.

**Sebaceous cysts of the Face.**—In the case of sebaceous cysts on the face and other parts where the skin is thin, it is better to proceed differently, dissecting down upon the tumour from without inwards, and enclosing in the incision an oval piece of skin corresponding to the thinnest part. If this be not done, too much skin will be left, and the portion that is dissected off may lose its vitality; besides this, to dissect off the skin from the top of the sebaceous cyst is a very difficult matter. After making this oval incision, it is generally easy to shell the tumour out of its bed. The edges of the skin can then be brought together by two or three fine horsehair stitches, care being taken not to allow the thin edges of the skin to become inverted.

### DERMOID CYSTS.

These tumours have already been referred to (Part I., p. 272). They are very frequently met with in the subcutaneous tissues about the angles of the orbits or in the neck, in connection with imperfectly obliterated branchial clefts. The lining wall of the cyst closely resembles normal skin in structure, and is furnished with sebaceous glands, and often with distinct follicles bearing hairs. The contents of the cyst is generally a thick pultaceous material often containing masses of hair and sometimes teeth or even bone. They are not adherent to the skin unless they have been subjected to irritation, and they often extend deeply between muscles and other structures.

**Treatment.**—Complete *excision* is the only method likely to be successful; unless the entire wall be removed the cyst will invariably re-form, or a persistent sinus will result. When they are adherent to the skin a portion of this structure must also be excised. Dermoids are usually quite easily separated from the surrounding structures, but when they run deeply amongst muscles, etc., the dissection required for their complete removal is often tedious and difficult; this point will be referred to again when we deal with cysts of the neck. In these latter cases especially the most strict regard must be paid to asepsis; any failure in that respect may entail the most serious results.

### FIBROMATA.

These tumours of the skin may occur either in the form of dense, *hard fibromata*, or, more commonly, as the soft pedunculated variety on the surface of the skin. The *soft fibromata* may be solitary, but are usually multiple—the condition known as molluscum fibrosum.

**MOLLUSCUM FIBROSUM.**—In this there are soft pedunculated pendulous tumours, which form small tags or large masses. Sometimes the whole body may be more or less covered with these growths; sometimes only a few large pendulous masses may be present. They are not dangerous to life, but they are often unsightly; sometimes they get abraded and become the starting point of some septic trouble, and give rise to a great deal of pain.

**Treatment.**—When the pendulous masses are solitary they may be simply snipped off, and a collodion dressing put over the small wound left. When the body is more or less covered with them, it is obviously inadvisable to remove them all; only those which are situated where they cause inconvenience should be snipped off.

When pendulous masses are present, a wedge-shaped portion may be cut out, or even the whole mass may be excised, according to its size and situation, and the edges of the skin brought together. The hard fibromata are simply shelled out of the skin by means of a suitable incision parallel to the long axis of the tumour.

**MOLES.**—A mole is a soft fibromatous thickening of the skin, with or without hypertrophy of the hair follicles and the pigmentary layer; it may or may not be pigmented.

**Treatment.**—The danger of pigmented moles is that they may become the starting point of melanotic sarcomata as the patient gets older, and, therefore, if there are only one or two isolated pigmented moles present it is best to excise them whether they are causing disfigurement or not. Hairy pigmented moles on the face are very unsightly, and should be cleanly and completely excised wherever possible. Even in the most extensive cases, excision followed by immediate skin-grafting will give a very good result. When grafting in these cases it is important to try to cut one single graft broad enough to completely cover the raw surface, as otherwise the lines of junction of different grafts may be a source of subsequent disfigurement.

When there is a very large hairy mole, whose size forbids excision, for instance on the forehead, the plan suggested by Mr. Horsley may be put into practice with great benefit. A flap containing the mole is turned downwards, and then the deeper part is shaved away until the hair follicles are completely removed. The flap can then be replaced and no further growth of hair will occur; the pigmentation of course remains.

**PAINFUL SUBCUTANEOUS TUMOUR.**—This is a form of fibrous tumour involving a nerve trunk or one of its branches. It is generally very small, intensely tender to the slightest touch, and sometimes, apart from pressure, gives rise to neuralgic pain, which radiates from the point where the tumour is situated towards the periphery of the limb, and may be accompanied by muscular spasm.

**Treatment.**—Where it is diagnosed and localized, the treatment is to extirpate the tumour; but usually these patients become highly neurotic, and it is necessary in addition to employ treatment suitable for hysteria.

Various other tumours of the skin such as **angiomata, lymphangiomata,** etc., have already been referred to (see Part I., p. 264).

## CANCEROUS TUMOURS.

These may occur under three forms, namely, Sarcoma, Rodent Ulcer and Epithelioma.

**SARCOMATA** of the skin, with the exception of the melanotic form, are not common, and when met with must be treated on general principles, viz.: complete excision, and the removal of recurrent nodules should they occur (see Part I., p. 262).

**RODENT ULCER** begins insidiously, very often on some pre-existing lesion, such as a mole, or a scar, and leads to the formation of an ulcer with a reddish base devoid of granulations, indolent, and with very little thickening, either about the base or the edges. Sometimes the latter are sharply cut and occasionally the epithelium makes an attempt to spread over the surface of the ulcer. The condition is a true cancer, the cells, however, not being squamous epithelium but smaller elongated cells, and the tumour tends to break down and ulcerate almost as fast as it grows. The disease goes on steadily if left to itself, and gradually destroys all the tissues that it encounters in its spread; its rate of growth is exceedingly slow. It may occur on any part of the body, but its most common seat is the face. The glands do not become affected.

**Treatment.**—The best treatment of rodent ulcer wherever feasible is excision of the growth. This should be particularly free; it is remarkable with what readiness the disease recurs. The incision for its removal should not, unless in quite small ulcers, be less than an inch beyond its margin in every direction, and should also extend well beneath the under surface of the growth. When it is possible to excise a rodent ulcer at quite an early period, the result is very satisfactory. In the later stages, however, especially when the ulcer is about the eye, it may be impossible to excise it completely, or to get far enough beyond it, and then recurrence takes place immediately. When complete excision is impossible, it is best to remove as much as is feasible and to destroy the rest with caustics, such as chloride of zinc paste or sulphuric acid.

The *chloride of zinc* is made into a paste by mixing one part of the drug, four parts of flour, and a twentieth part of extract of opium with sufficient water to make a stiff paste; the opium is added to relieve pain. The paste is then rolled out into a cake of suitable size to cover the raw surface to which it is to be applied, and about a quarter of an inch in thickness. It should be left on for from twenty-four to forty-eight hours if the patient can tolerate it; in that time it will destroy the soft parts over the area to which it is applied for a depth varying from half an inch to an inch and a half. After the caustic action has ceased, hot boracic fomentations are applied until the slough has separated; boracic ointment of full strength is then employed until granulation is complete, when the quarter-strength ointment should be substituted until cicatrization has taken place. If the sore left be large, it may be skin-grafted after granulation is complete. Should any points have escaped the action of the chloride paste, they may be attacked by packing firmly over them small pieces of moist gauze covered with the solid chloride. Although this caustic is most efficacious in its action, the pain it gives rise to is often almost intolerable, and the patient frequently requires to be kept fully under the influence of morphine.

*Sulphuric acid* is also a rapid and efficient caustic, and is valuable in the smaller and more superficial varieties of rodent ulcer that cannot be satisfactorily excised; its action is more rapid and more localized than that of the chloride of zinc, and the pain is not so intense. It can either be applied by means of a glass brush to the surface, but, used in this way, its action is very slight and a much better method is to convert the pure acid into a paste by mixing it with one-third of its weight of powdered asbestos and spreading this with a glass rod or spatula over the sore. The after-treatment is the same as when chloride of zinc is used.

**EPITHELIOMA.**—Two forms of this affection are met with in the skin, namely, the flat superficial form and the tuberous variety. The **flat epithelioma** is a superficial hardness of the skin, a kind of parchment induration usually beginning in an old sebaceous nodule or a small mole, and generally occurring in old people. It is not particularly malignant, and may exist for a considerable time before enlargement of the glands takes place.

**Treatment.**—This is particularly satisfactory; by excising the indurated area, the disease is generally put a stop to, and, as the incision thus made is quite small, a few stitches generally suffice to bring the cut edges together. As a matter of fact, excision should be at once practised in old people who come with any enlarging nodule about the face, especially an old sebaceous patch or a mole that has existed for many years and has recently begun to increase in size. It will generally be found, under the microscope, that the nodule is epitheliomatous, but that the epithelioma is limited to the surface of the skin.

The **tuberous epitheliomata** are much more malignant, and give rise, at a comparatively early stage, to infection of the glands. They must, of course, be excised, and the extent of the operation will depend on the situation of the growth; a description of the operations will therefore be left until we come to deal with the regions in which they occur. The glands, if enlarged, should also be excised. The question of interest is whether the nearest lymphatic glands should be removed at the first operation. The condition here is different from that of the axilla, where we have only to do with a single group of glands; with the cases under consideration, it is not always easy to be sure which glands will enlarge first, and therefore, unless the glands be obviously enlarged, the best treatment is for the surgeon to content himself with excising the primary growth. The glands should be subsequently cleared out as soon as any enlargement is noticed. One other point is also of importance, namely, whether it is necessary to excise the lymphatic vessels and fat, lying between the primary tumour and the glands, as is so strongly to be recommended in breast cancer. It seems, however, that in most cases of the kind which we are now considering, it is not necessary. The lymphatic vessels very seldom become infected in their course from the primary tumour to the glands. Why this should be so is not very clear, but it is a clinical fact and the condition differs from that in breast cancer, where the lymphatic vessels become infected very early.

## KELOID.

The keloid condition of scars has already been mentioned (Part I., Chap. XI., p. 224), but we may here refer to the **true or Alibert's keloid**, which is supposed to arise spontaneously. These tumours are chiefly situated in front of the sternum and begin as small tubercles which slowly increase in size, sometimes by the coalescence of neighbouring nodules, until they form a firm, more or less prominent tumour with an unequal surface, an irregular shape, and edges of a rosy or violet colour running out in the form of ridges.

**TREATMENT.**—This must be on lines similar to that for false keloid (see Part I., Chap. XI., p. 224). Excision is equally unsatisfactory in both, the scar tending to become keloid again. At the same time it is possible that, by excision, a large broad tumour may be converted into a linear one.

# CHAPTER X.

## THE SURGICAL AFFECTIONS OF THE NAILS.

VARIOUS anomalies of growth and degenerations of the nails occur, but of these it is hardly necessary to speak, because there is no special treatment applicable to them.

### HYPERTROPHY.

Hypertrophy of the nails is not uncommon, the nails becoming thickened and marked by transverse depressions, while the tip of the nail becomes unduly curved. In old people the nail of the great toe and sometimes, to a lesser extent, those of the others may assume the shape of a horn, the point of which turns over towards the sole or curves round and threatens to grow into either the nail matrix or the free end of the toe. This affection is often a result of inflammation or injury, and is called **onychia gryphosa.**

**Treatment.**—For these conditions there is no special treatment. In onychia gryphosa, when the nail assumes the shape of a horn, it must be carefully pared, as otherwise its tip will grow into the matrix and cause ulceration. When the horn is very massive and dense the entire nail and its matrix may require removal.

### INJURIES.

**CONTUSIONS.**—Among injuries of the nails contusions call for mention, as they are often followed by separation of the nail from its bed. The effect of the contusion is usually to cause hæmorrhage between the nail and the matrix; when the latter has been badly contused, and blood is seen as a black mass beneath the nail, separation of the nail can sometimes be prevented by making a hole through it over the hæmorrhage so as to allow the blood to escape. This is easily done by scraping with a piece of glass or the edge of a knife until the nail is thin enough to permit of the introduction of one blade of a pair of sharp-pointed scissors. The operation is quite painless; a small antiseptic dressing should be applied to prevent the occurrence of suppuration beneath the nail.

**FOREIGN BODIES** lodged beneath the nail should be removed at once, because they not only cause much pain at the time, but are very apt to lead to suppuration, and possibly irregular destruction of the matrix and consequent deformity of the nail. After extraction of the foreign body it is always a good plan to snip away the portion of the nail beneath which it lay by means of a sharp-pointed pair of scissors, and then to apply a small boracic fomentation for 24 hours. Unless this be done there is considerable danger of septic trouble, as, should the wound suppurate, there is little chance of the septic products escaping freely.

## INFLAMMATORY AFFECTIONS.

**ONYCHIA.**—The most important affections of the nails are those which are grouped together under the name onychia. This term is applied to inflammations of the soft parts around the nail, or of the matrix beneath it; there are several forms of onychia.

**Acute traumatic onychia** is the ordinary inflammatory condition under, or at the side of, a nail, which is usually caused by the presence of a foreign body, as for example a splinter of wood. This is followed by suppuration, and small collections of pus form under the nail and open in front or at the side of it, and the result may be that the nail is lost.

**Treatment.**—The foreign body must, of course, be removed at once if it can be recognized, but if not, the pus should be evacuated by gently detaching the nail from the matrix until the abscess is reached, and then clipping away the detached portion. This can sometimes be done by freezing with a local anæsthetic such as anestile, but when the affection is too painful for this, a general anæsthetic, such as nitrous oxide, should be employed. When the small drop of pus is evacuated, and the nail over it cut away, the inflammation quickly ceases under the application of wet boracic dressings (see Part I., p. 48). The affected portion of the matrix will recover, and the nail will grow quite well afterwards.

**Ingrowing Toe-nail.**—A second form of onychia which gives rise to a great deal of trouble is that known as lateral onychia, or as it is commonly called, from the fact that it exclusively affects the toe, "ingrowing toe-nail." In this condition there is inflammation of the matrix and skin at the side of the nail, generally on the outer side of the great toe. It usually occurs in young male adults of the working class, who have much walking to do, who do not keep the feet clean, who wear badly-fitting boots, and cut the great toe nail so short that it does not project beyond the soft parts. The result is that the nail is pressed down and irritates the lateral fissure or, what comes to the same thing, the soft parts of the toe are pressed up against the nail; hence as a rule the affection occurs near the free end of the nail. It begins with slight pain and swelling, which impede walking, and then abrasion and ulceration soon occur and spread backwards along the lateral groove. In bad cases the suppuration is abundant and fœtid, there is a good deal of swelling, and the granulations are exuberant. The condition is often a serious one, on account of the pain and lameness it induces, and also on account of the risk of lymphangitis.

**Treatment.**—This will vary according to the stage of the disease, but in all cases what may be termed the **hygiene of the foot**, should be carefully attended to. The nails should be cut square, and their edges should project slightly beyond the soft parts; the feet should be kept thoroughly clean, the socks changed frequently, and the patient should wear well-fitting shoes or boots. If the case be seen before any ulceration has occurred, it sometimes suffices to introduce a minute pad of boracic lint beneath the nail so as to take off the pressure of its edge, the other points as to the hygiene of the foot being carefully attended to. This procedure is most likely to succeed when the nail is thick and well-developed; when it is thin and papery it is of little use. If, however, ulceration has taken place, this plan will not suffice.

In the later stages, various other methods are resorted to, but all, with one exception, are more or less ineffectual. Some surgeons content themselves with *cauterizing* the prominent granulations, either by the application of nitrate of silver or by dusting them over with crystals of nitrate of lead, and interposing a pad of dressing, a piece of tin-foil, etc., beneath the edge of the nail; others clip away the portion of the nail which is pressing on the skin—an exceedingly bad plan, as it really aggravates the trouble in the end—and others again *remove half or the whole of the nail.* If it be desired to remove the whole or one half of the nail, the patient is put under an anæsthetic—gas is generally sufficient—and then if one *half* of the nail is to be removed, one blade of a pair of sharp-pointed scissors is passed down in the middle line between the nail and the matrix right to the root, the nail is split down the centre, and the half on the side affected torn away by forceps. If the *whole* nail is to be removed, it is detached and torn off by forcible traction with a special pair of forceps termed "onychia forceps," one blade of which is thrust down between the nail and the matrix, well to the root of the nail in the middle line, and then on closing the blades the nail is firmly grasped between the blades and wrenched from its bed after being loosened by turning the forceps forcibly, first to one side and then to the other.

None of these methods, however, are quite satisfactory. After removal of half or the whole of the nail recurrence of the trouble is very apt to take place as the fresh nail grows, and nothing short of the destruction of the matrix on the affected side of the toe is sufficient to prevent it. In some cases this may be done effectually after removal of the nail by carefully paring away the matrix with a knife, but it is very uncertain, as portions are apt to be left behind. In order to make sure of a successful result, the following simple operation is the best. The patient being under an anæsthetic, a lateral flap (see Fig. 68) is cut at the side of the toe by entering the knife vertically at the base of the nail just outside the ulcerated area. The point of the knife as it comes against the ungual phalanx is carried around it, immediately outside the bone and in contact with it, and, finally, the point may be protruded on the plantar surface of the toe

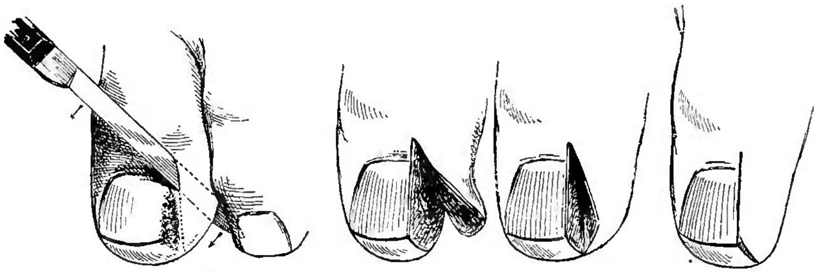



FIG. 68.—OPERATION FOR INGROWING TOE-NAIL. In *A* is shown the method of cutting the lateral flap. In *B* the flap has been cut, the portion of the nail removed and the matrix beneath cut away. In *C* is shown the second method of performing the operation without forming a flap; a deep wedge-shaped gap is produced. *D* shows the final result in both cases, when the parts are brought together.

at the point opposite to the one at which it was entered. A lateral flap is then made by carrying the knife straight forward and bringing it it out beyond the nail. It is not always necessary to make a wound on the plantar surface. If the cut be carried well downwards in front the flap can generally be turned aside without making any incision on the under surface of the toe. The nail is now split down by scissors from the free edge to the base a little to the outer side of the centre, and the portion on the affected side is pulled away by forceps. The matrix beneath the portion thus removed is then completely dissected away. Care must be taken to remove it right back to its extreme limit, for it must be remembered that the matrix extends backwards beneath the skin for about a quarter of an inch; if any portion be left behind it will give rise to fresh growth of nail. When this has been done, there is a flap at the side of the toe and a raw surface corresponding to what was previously the outer portion of the nail. The flap is then made to cover this raw surface, and is fixed in position by two or three stitches.

The result of this operation is that no nail grows on the side operated upon, and, as the edge of the remaining portion of the nail is on a higher level than the skin, the soft parts cannot be pressed up against it, and no recurrence can therefore take place, even though tight boots be worn, or even though the affected toe be on the top of the one next to it. The wound usually heals by first intention, and after a fortnight no further dressings are necessary, and the patient may be allowed to walk about. The disinfection of the toe before operation must be carried out with the minuteness required for all operations in this situation; micro-organisms are very abundant in the folds about the toes and nails.

**Syphilitic Onychia** may either develop in the nail itself, when it is called ungual onychia, or around it, in which case it is said to be of the peri-ungual variety.

(a) **Ungual onychia.**—The first form of syphilitic onychia chiefly affects the nails of the hands, which become friable and often partially detached. It is a condition closely resembling psoriasis, and occurs about the same time as the squamous syphilides on the skin.

*Treatment.*—This is mainly that for secondary syphilis (see Part I., p. 231). In addition, the finger should be wrapped up in mercurial plaster or unguentum hydrargyri, or a 5% oleate of mercury may be rubbed into and beneath the nail.

(b) **Peri-ungual onychia.**—The more common and troublesome form of syphilitic onychia is that in which the parts around the nail are attacked; the affection may be of two forms—dry or ulcerating. The *dry form* is really a papular or papulo-squamous syphilide occurring at the fold of the nail. The inflammation is, however, pretty severe, and at first sight it may be thought to be of a suppurative character; no suppuration or ulceration however takes place. This condition is treated similarly to the last.

At a somewhat later period of secondary syphillis *ulceration* is met with, and this is chiefly due to the presence of condylomata about the base of the nail, and is most frequent on the toes. The result is that a fungating ulceration, with an abundant fœtid sero-purulent secretion, occurs about the nail; it may entirely surround the latter, or it may only affect one side; in the former case the nail falls off, and the condition is more tractable. In some cases it extends deeply, and may lead to disease of the bone.

The *treatment* of this form of syphilitic onychia is essentially that of secondary syphilis. The application of mercurial ointment, a 5% oleate of mercury, or a dusting powder of calomel and starch (1 to 3) to the part, are of considerable use, and, in addition, it is advisable to remove the whole nail; it is rare for the disease to be cured until this has been done. The unhealthy ulcerated surface should then be thoroughly cauterized with nitrate of silver or acid nitrate of mercury, and the mercurial preparations above-mentioned applied to it. As a rule, the affection subsides rapidly under this treatment, combined with that appropriate for secondary syphilis in general, and the new nail grows again without any particular deformity.

**Tuberculous onychia.**—The fourth form of onychia is tuberculous onychia, which is more often termed **onychia maligna**. This is a disease which occurs in infancy or adolescence, and is probably always of a tuberculous nature. In scrofulous people a traumatic onychia frequently develops into this form, instead of getting well, as would be the case were the patient healthy. The disease, which may involve several fingers, gives rise to a livid swelling, at first at the base of the nail and later on spreading around it. This swelling ulcerates and fungates, the nail becomes black and soft, and falls off; or the condition may begin with an abcess beneath the nail, which falls off and leaves an ulcerating surface beneath.

**Treatment.**—The nail should be removed, the softened tissue thoroughly scraped away, and the part sponged over with undiluted carbolic acid. The best dressing to use at first is wet iodoform gauze sprinkled plentifully with iodoform, with a piece of mackintosh outside, which keeps it moist, and forms a wet antiseptic fomentation. Subsequently, when the parts assume a healthy aspect, the dilute boracic ointment (one quarter the pharmacopœial strength) may be substituted. In addition to this local treatment, the general principles of treatment for tuberculosis, which have already been referred to in Part I., p. 245, must be attended to.

## TUMOURS.

**Sub-ungual exostoses.**—This is the term applied to little tumours which grow beneath the nails. In some cases, however, they are not really exostoses, but are softer tumours of a fibromatous or papillomatous nature, and indeed are not infrequently sarcomatous. They press up the nail and cause a good deal of pain, and the **treatment** is to remove the nail and cut or gouge away the tumour; if there be a suspicion that the growth is malignant, amputation of the toe should be performed.

# CHAPTER XI.

## THE SURGICAL AFFECTIONS OF THE LYMPHATIC VESSELS.

### INJURIES.

**WOUNDS** of the lymphatic vessels only come under notice when the larger trunks are injured. Should this happen in an open wound there is a free escape of lymph from the injured vessel, and the condition known as **lymphorrhagia** is produced. This may lead to the occurrence of a fistula from which lymph escapes, and which is very difficult to heal. As a rule, however, although in many operations a large number of lymphatic vessels are divided, there is very little trouble of this kind. The discharge of lymph may be copious at first, but, as it is mixed with discharge from the wound, it is usually looked upon as serum; it quickly diminishes, and in about eight days the vessels become sealed and the wound heals.

In some cases where there has been extensive interference with the lymphatic return from a limb, as, for example, after removal of the contents of the axilla in extensive cases of cancer of the breast, the obstruction to the lymphatics which occurs during healing may be so great as to cause considerable and very obstinate **œdema** of the limb.

Under these circumstances the best **treatment** is to elevate the limb on every possible occasion, and to employ gentle rubbing and upward squeezing so as to help onwards the flow of lymph, and to bring about dilatation of the collateral channels. As a rule, the œdema is found to subside gradually after two or three months, and ultimately it may completely disappear.

**Wound of the Thoracic Duct.**—It is only when the very largest trunks are injured that much trouble is met with. For example, in cases of injury to the thoracic duct, there may be a great deal of difficulty in getting the wound to heal and the lymphatic circulation restored. We ourselves have only had to do with two cases in which such an accident has happened. In one the wound was made during the excision of a mass of very adherent tuberculous lymphatic glands at the base of the posterior triangle of the neck. In the other case the vessel was injured in the course of an extensive second operation for malignant glands in the posterior triangle, where, as the result of a previous operation and the subsequent contraction of the scar, the thoracic duct had been pulled quite out of place. In both cases there was a free flow of chylous fluid which could be seen welling up into the wound. In the first case no attempt was made to close the wound in the vessel; in the second the incision into it was oblique, and the tissues were stitched together over it. In both cases the skin wound was tightly sutured, and firm pressure applied outside. On removal of the dressing ten days later, there was little or no swelling in either case, and the wounds had healed, but, after the pressure was left off, swelling very rapidly occurred, and a large soft fluctuating tumour formed in the lower part of the neck. In the first case the swelling increased greatly in size, until ultimately it reached the dimensions of the closed fist, and at one time looked as though it would burst through the scar. After some weeks, however, it suddenly subsided and entirely disappeared, and the patient had no further trouble. In the second case the swelling did not increase in size to such a marked degree, and after about a couple of months it also had entirely disappeared; so that, from these cases, it may be seen that even the dreaded injury to the thoracic duct did not in these two instances cause any permanent trouble. The conclusion to be drawn from these and other similar published cases is that, if a large lymphatic trunk be injured, the skin should be closely stitched up, and healing by first intention aimed at, a large sponge or sponges being incorporated with the dressing, so as to maintain pressure upon the part; this pressure should be reinforced by an elastic bandage applied outside the dressing. The thoracic duct has also been tied in cases where it has been completely divided, and the patient has recovered.

## INFLAMMATORY AFFECTIONS.

**ACUTE LYMPHANGITIS.**—The acute form of lymphangitis is practically always a septic disease, and represents the reaction of the walls of the lymphatic vessels to contact with irritants absorbed by them from some seat of primary infection. Generally, the affection is due to the organisms themselves; sometimes, however, inflammation may arise from the irritating products of the organisms alone. Acute lymphangitis is never a primary disease; it is always secondary to some focus of infection, which may be either an external wound, or some inflammatory condition such as a boil. Among external wounds, the most serious are those inflicted during *post-mortem* examinations, especially of septicæmic cases; here the infection is often of extreme virulence, and the condition very soon passes beyond a mere lymphangitis. Conditions of ill health, such as alcoholism, starvation, diabetes, and so forth, especially predispose to the more severe forms of lymphangitis.

**Pathological Changes.**—In acute lymphangitis the walls of the vessels become inflamed and thickened, and inflammation also occurs in the tissues around, giving rise to the condition known as **peri-lymphangitis**. When suppuration takes place, the pus is usually present outside the vessels as well as within them; this suppuration is localized and generally occurs at intervals along the lymphatics, more especially about the valves. The organism producing this condition is usually the streptococcus pyogenes, and lymphangitis plays a very important part in the multiplication of abscesses in diffuse cellulitis, and also in septicæmia and pyæmia.

**Symptoms.**—The symptoms of lymphangitis may be very severe, and often commence within twenty-four hours after the injury, with shivering, headache, loss of appetite, high temperature, and the presence of red lines running from the wound or primary focus of inflammation, towards the nearest lymphatic glands. These red lines are generally broader than the lymphatic vessels beneath, and are accounted for by the presence of peri-lymphangitis; very often it is possible to ascertain the position of the valves by the red patches at intervals along these tracts. At these points, abscesses may form as the result of the escape of micro-organisms from the vessels into the tissues around. In all cases of lymphangitis, the character of the fever, though at first of the acute sthenic form, soon assumes the typhoid type, and in the severe forms the patient may die in from one to four days.

**Varieties.**—There are various forms of acute lymphangitis. The simplest is where the organisms are not arrested in the course of the vessels, and there is merely a primary seat of inoculation or focus of inflammation, with red lines spreading from it, and swelling of the nearest lymphatic glands. When the virus is very potent, the lymphangitis may be only very slightly marked, and the organisms may pass on through the lymphatic vessels, and reach the blood stream, and set up rapid and very fatal septicæmia. Another particularly bad form of the affection is that known as *gangrenous lymphangitis*; it occurs especially in diabetics. Here there are at first the ordinary symptoms of the severe acute form, and then, in the course of two or three days, bullæ and gangrenous patches appear along the course of the vessels. The patient rapidly passes into the typhoid state, and usually dies.

Among the **complications** of this condition may be mentioned diffuse cellulitis, phlebitis, erysipelas, abscesses, and purulent affections of bursæ or joints, when the lymphatics pass over or are in the immediate neighbourhood of these structures.

**Treatment.**—(a) **Prophylactic**—Careful attention must be directed to cleansing wounds of all kinds. In *post-mortem* wounds more especially, thorough disinfection with undiluted carbolic acid, as recommended in Part I., p. 190, should be systematically carried out as soon as possible after infliction of the wound.

(b) **Curative.**—When lymphangitis is established, it is necessary to treat the primary source, the local affection itself, and the constitutional condition. **The primary source** should be carefully looked for; if it be a wound this should be thoroughly cleansed and well sponged with undiluted carbolic acid; if a localized inflammation, such as a boil, it should be freely incised and scraped out, and the raw surface thus left swabbed over with the acid in a similar manner.

**The local affection** itself is best treated in the early stages by fomentations (see Part I., p. 12). Sometimes, when the lymphangitis is very acute, it is advantageous to use fomentations of a warm watery solution of carbolic acid (1-40). Cyanide gauze soaked in this solution and not squeezed very dry is placed over the affected area, and outside it is laid a large piece of mackintosh cloth or gutta-percha tissue overlapping it in all directions. In this way heat and moisture are obtained, while at the same time the carbolic acid may be absorbed by the skin, and, passing along the same lymphatic trunks as the poison itself, may produce a direct action upon the organisms. This can hardly effect a true disinfection, but by its means an attenuation of the virulence of the organisms may possibly be brought about. If carbolic fomentations be employed, care must be taken not to cover too large an area with them, as otherwise a poisonous amount of the drug may be absorbed. It is further important to remember that carbolic acid should not be used when kidney disease is present. In any case, the urine should be examined for carboluria, and if this or any other sign of carbolic acid poisoning be detected, the fomentations should be changed for those of boracic acid.

When *abscesses* form or diffuse cellulitis occurs along the course of a lymphatic vessel, incisions must be made at once, and the treatment proper for acute abscess and diffuse cellulitis adopted; this has been already described (Part I., Chap. II.). In the *gangrenous form* of lymphangitis free incisions should also be made. They should extend through the whole length of the gangrenous patch and well into the tissues on either side of it; as in diffuse cellulitis, they cannot be too free. They should also be sufficiently numerous to allow of the escape of all exuded material as far as possible. Unfortunately, in these cases of gangrenous lymphangitis the probability of saving the patient is comparatively slight. Amputation is not of any use.

**The constitutional treatment** must also be carefully attended to. The strength of the patient must be kept up, and stimulants should be freely given, with quinine in doses of five grains every four hours until symptoms of quinism set in. The patient should have plenty of nourishing food, and the bowels should be attended to. The general treatment in fact is that already described for acute inflammation (see Part I., p. 13).

It is well also to mention the *antistreptococcic serum* as a means that may be employed in treating these cases. Its use is more especially indicated if it can be demonstrated by examination of the blood or of the discharges from the wound that the streptococcus pyogenes is the actual causal agent at work; if this be the case the serum should be used without delay. In its present strength (as supplied by the Jenner Institute of

Preventive Medicine) 20 c.c. should be injected under the skin of the abdomen as a first dose; within the next twelve hours another 20 c.c. should be given, and then two or three further injections of 10 c.c. each should be made at intervals of twelve hours. The method of injecting these antitoxic serums is quite simple, the point of primary importance being to ensure that everything used is aseptic. A special syringe is sold for the purpose, consisting of a glass tube which can be unscrewed and in which works a piston made of metal and asbestos, so that it can be safely disinfected by heat. The syringe is boiled for at least a quarter of an hour and then rinsed out with a 1-20 carbolic acid solution, and the skin at the proposed seat of injection is also thoroughly scrubbed with the same solution. After the injection has been made, the syringe should be washed out with water, boiled, and subsequently allowed to lie in a 1-20 carbolic acid solution until it is again required.

**CHRONIC LYMPHANGITIS** occurs in the course of various other diseases, the lymphatic vessels being the principal channels by which infection enters the body. In *simple* lymphangitis the cause of irritation is not of a suppurative character, as in want of cleanliness about the genital organs. Lymphangitis may occur in *gonorrhœa* when it is supposed to be due to the gonococcus, but in this form there are none of the symptoms characteristic of the acute form of the disease. In *soft chancres*, lymphangitis sometimes though rarely occurs. It commences about the eighth day, and is characterized by red lines along the dorsum of the penis and the presence of a hard knotted cord, accompanied by œdema of the prepuce; an abscess may form in the course of the lymphatic vessels, and may lead to an obstinate ulcer with inoculable pus. Again, in *syphilis* we may have affections of the lymphatic vessels in any of the three stages. In the primary stage it occurs in a considerable proportion of cases; the lymphatic vessels of the dorsum of the penis may be felt as indurated moniliform cords without any pain or redness of the skin. In secondary syphilis thickened lymphatics may be found in various parts of the body, and they may also be met with in the tertiary stage.

In *tuberculosis* also there is a tuberculous lymphangitis, in which the vessels leading from the tuberculous lesion, especially if in the skin, are thickened and nodular, and these nodules may develop into scrofulous gummata (see p. 157). This condition may also extend to the thoracic duct, and it then leads to general tuberculosis.

Chronic lymphangitis plays an important part in the development of elephantiasis, chronic œdema of the limbs, etc.

**Treatment.**—The treatment of all these conditions is essentially that of the primary disease that induces them; in syphilis, the only treatment necessary is to administer remedies appropriate to the syphilis itself; in the gonorrhœal or chancrous form, fomentations may be used, and the condition treated on the lines of acute inflammation, but the main consideration is the treatment of the primary disease. The treatment of tuberculous lesions of lymphatic vessels, especially of the so-called scrofulous gummata, has already been alluded to (see p. 157). It consists essentially in excision of the tuberculous nodules wherever possible.

Apart from the removal of the cause, the various methods suitable for chronic inflammation may be used, especially counter-irritation and pressure. In the extremities massage, bandaging and elevation of the limb should be vigorously employed, with the view of combating the œdema (see Part I., Chap. I.).

## LYMPHANGIECTASIS.

This is a varicose condition of the lymphatic vessels. It may follow upon inflammations which obliterate or strangulate the main vessel, or upon pressure from bandages, cicatrices, etc., but in these cases the vessels seldom attain any great size, and do not become markedly varicose. The most common cause of the typical varix of the lymphatic vessels is the presence of the *filaria sanguinis hominis*, and this condition is most usually met with in the scrotum, where it is known as **lymph scrotum**, and in the groin, where it is termed **lymphadenocele.**

**PATHOLOGICAL CHANGES.**—In lymphangiectasis there are distended tortuous tubes which may be both felt and seen, and the affected area becomes swollen and somewhat œdematous. When the lymphatics of the skin are attacked, vesicles may appear over the course of vessels, and these often burst and lead to an exudation of lymph, sometimes in very large quantity. Lymphadenocele is generally bilateral, and is characterized by the presence of a soft fluctuating swelling in the groin.

**TREATMENT**—(a) **Lymphatic varix.**—This is extremely unsatisfactory. Excision of the varicose trunks, as is done in the case of varicose veins, is not at all to be recommended. The varicosity is due, not to the pressure of a column of fluid or to inflammation of the vessels, but to actual obstruction, and the removal of the lymphatic trunks will not remedy this; on the contrary, it is very apt to lead to lymphorrhagia. Hence the treatment must be more or less palliative, and should consist in careful **support** and **compression** of the part by the use of elastic bandages or strapping, the method depending of course entirely upon the seat of the trouble.

(b) **Lymphorrhagia.**—In cases where there is lymphorrhagia, and the loss of fluid is great,—a condition which is injurious from its tendency to produce anæmia,—it may be permissible to **excise the affected area** if it be limited, and thus to aim at obtaining healing by first intention. Where this is successfully done, enlargement of the subcutaneous lymphatic vessels generally occurs. If the operation be undertaken, the great point is to ensure rigid asepsis of the wound, because, if septic material gain access to the vessels, acute and very often fatal lymphangitis is very likely to ensue.

(c) **Lymphadenocele.**—Here the inguinal masses must on no account be excised or incised; if this be done, the case will probably result in the occurrence of lymphorrhagia or a lymphatic fistula which can never be closed; and there would also be a great probability of erysipelas or some other form of septic infection gaining access to the wound thus left. In these cases **pressure**, by means of a pad and an elastic spica bandage, should be employed.

## TUMOURS.

**LYMPHANGIOMA** has already been referred to in speaking of tumours (see Part I., p. 271). It is not uncommon for **CANCER** to occur in the lymphatic tracts leading from the primary disease to the nearest lymphatic glands, and special reference will be made to this point in treating of cancer of the breast.

# CHAPTER XII.

## THE SURGICAL AFFECTIONS OF THE LYMPHATIC GLANDS.

### WOUNDS.

Wounds of lymphatic glands are rare and unimportant, and the treatment of them is merely that required for the wound in the soft parts; no special treatment is demanded by the wounded glands themselves.

### INFLAMMATORY AFFECTIONS.

These may be divided into septic adenitis, acute and chronic; the various forms of venereal adenitis; and tuberculous disease of glands.

**ACUTE ADENITIS**, with or without suppuration, is a very common affection, infective material being frequently transported by the lymphatic vessels to the glands from all sorts of injuries, and diseases of the skin. When this infective material contains pyogenic organisms, acute suppuration of the gland is very apt to follow. In these cases the gland, which is at first enlarged, reddish and firm, becomes soft and friable, and generally contains a number of foci of suppuration. Peri-adenitis rapidly occurs, the pus escapes through the capsule of the gland into the tissues around, and then, as in other acute abscesses, gradually spreads towards a free surface. When the abscess is opened, portions of the gland are usually found at the bottom of the wound, and if these be examined, independent foci of suppuration can often be seen in them.

**Symptoms.**—The symptoms of acute adenitis are those of acute inflammation in general, with the addition of the local symptoms due to the affection of the glands; a single gland is usually affected at first, but later on others in the neighbourhood become enlarged, hard and painful, and, after a time, matted to the surrounding parts as a result of the peri-adenitis. If no suppuration occur, the pain generally subsides in the course of a few days, and the swelling gradually goes down, though it may be some weeks before it entirely disappears. Should suppuration occur, the glands become fixed, the skin reddened over them, and fluctuation is evident. As a rule, suppuration does not take place till the sixth or the seventh day; it usually results in a circumscribed abscess, but sometimes, especially in the neck, a diffuse cellulitis may be set up.

**Treatment.**—The treatment, in the early stage before suppuration has commenced, is that of acute inflammation (see Part I., Chap. I.), and in addition to this, any primary focus which is giving rise to irritation of the glands should be treated. Inflamed ulcers should be disinfected, boils should be freely opened, and so on. Warm fomentations (see Part I., p. 12) should be applied over the gland, the parts kept at rest, if necessary on a splint, and the general treatment carefully attended to.

When an **abscess** forms in connection with the gland it should be opened like any other acute abscess (see Part I., p. 26). Besides simply incising the abscess, however, it is well to scrape away the remains of the gland, because there may originally have been several foci of suppuration in it, and although the main one is opened, the others may subsequently enlarge and keep up the suppuration. Hence an incision large enough to admit the finger should be made, and if any portions of the gland be felt at the bottom of the wound, they can easily be enucleated either by the finger alone or by the aid of a sharp spoon; it is not necessary to make an elaborate dissection for the purpose. Having thoroughly opened the abscess and removed the remains of the gland, the cavity should be drained in the usual manner and the ordinary dressings applied. As a rule, healing will occur in the course of a few days. This does not apply to the acute form of adenitis due to venereal causes, which will be described presently.

**CHRONIC ADENITIS** may follow on the acute form, and it is not uncommonly associated with uncleanliness, lice, eczema, ulcers, etc. If the enlargement persist for some time, or increase in size, it will frequently be found, on excising the affected gland, that the condition is a tuberculous one; secondary tuberculous infection is very prone to occur in these chronic cases.

**Treatment.**—If a primary source of irritation can be found, it should at once be removed. For example, if there be an eczema, steps should be taken to cure it; if there be an open ulcer, it should be treated by appropriate methods; should the condition arise from lice or uncleanliness, the removal of the cause is all that is called for. If the glandular enlargement be simple it will then subside without anything special in the way of local treatment; at most some *placebo*, such as belladonna ointment, may be applied, the part of course being meanwhile placed at rest. The use of iodine should be avoided. Where, however, the enlargement of the glands continues or increases after the removal of all primary sources of irritation, there will be strong grounds for suspicion that the condition is tuberculous, and special treatment (see p. 185) must be adopted accordingly.

**VENEREAL ADENITIS.**—Under this term are included simple bubo, arising in connection with want of cleanliness, and also gonorrhœal, chancrous, and syphilitic buboes.

**Simple Bubo.**—This consists of enlargement of the lymphatic glands in the groin, and may occur as the result of some irritation, such as a slight abrasion, balanitis, or uncleanliness. The enlargement of the glands is not accompanied by any great pain or tenderness, and it does not usually end in suppuration. It very quickly subsides if the patient be kept at rest in bed, with fomentations applied to the enlarged glands, and appropriate treatment to the primary source of irritation.

**Gonorrhœal Bubo.**—Enlargement of the lymphatic glands in the groin occasionally occurs in cases of gonorrhœa. It does not, however, usually end in suppuration unless septic organisms have gained access. When suppuration does occur, the probability is that in addition to the gonococcus there is also infection by the pyogenic organisms. In these cases it is generally possible to detect an intra-urethral sore by means of the urethroscope.

**Treatment.**—The treatment of gonorrhœal bubo is practically the same as that of the simple variety. The patient should be kept in bed so as to ensure complete rest to the part, and the ordinary treatment suitable for inflammatory conditions generally, viz., fomentations, a purge, etc. (see Part. I., Chap. I.), should be carried out, and attention should be paid to the treatment of the primary condition. If irritating injections have been employed, these should for a time be discontinued, but the urethra may be washed out two or three times daily with tepid water, or very dilute Condy's fluid. Large quantities of diluents should be given by the mouth, and copaiba or sandalwood oil should be administered; in other words, the ordinary treatment for gonorrhœa must be adopted. When suppuration occurs the treatment is the same as that for acute adenitis with abscess (*vide supra*).

**Chancrous Bubo** is very common, a large number of cases of soft chancre being complicated by adenitis. Generally one or two glands at the inner end of the horizontal inguinal group are affected, and the trouble begins about 14 days after the appearance of the sore.

The **symptoms** of a chancrous bubo are usually sub-acute. They may, however, be acute and, if the case be complicated by the entry of pyogenic organisms, suppuration ensues early. Indeed, in most cases, even though no pyogenic organisms be present, the chancrous virus is active enough to ensure the formation of an abscess. The suppuration begins in the substance of the gland, giving rise to an oval swelling parallel to Poupart's ligament; this swelling gradually softens and points. The pus, when evacuated, is somewhat thin and dark, and contains flakes or clots; it is quite unlike the ordinary yellow pus of an acute abscess. If the abscess be freely opened, it often happens that a chancrous ulcer forms in the groin, which may extend deeply and prove extremely obstinate in healing.

**Treatment.**—This is somewhat difficult, and has already been referred to (see Part I., p. 240). **In the early stages** when the inflammation is not very acute, *compression* is the best means to employ. A large pad of cotton wool is laid over the inflamed glands, and kept in place by a firm spica bandage, outside which a piece of elastic webbing is applied so as to exercise gentle pressure. The patient should of course be kept in bed or in the recumbent position on a couch, and the primary sore should be treated on the lines laid down in Part I., Chapter XIII. In some cases the condition will subside entirely under this treatment.

**When the affection is progressive**, however, the question as to what further procedure is the best is somewhat hard to answer. Bearing in mind the obstinacy of the ulcer which follows free incision of these abscesses, and also the fact that fresh glands are apt to enlarge, and thus lead to the formation of ulcerating cavities in the groin, it is advisable, as soon as it is evident that softening of the glands is about to occur, to *excise the affected gland*, and, with it, any others in its vicinity that may be enlarged. If, in excising the mass, great care be taken not to come too near to the infected gland, and more especially to avoid puncturing it, it is not uncommon for the wound to heal by first intention, and thus the patient is saved a prolonged and tedious illness. When the glands are not adherent to the skin, a semi-lunar flap, consisting of skin and fascia, may be raised, but if the skin be at all thinned, or even reddened, the affected portion should be included in an oval incision and removed, care being taken to keep wide of the glands. The incision should be carried through the fat in the groin above and below the affected area, and the whole mass of fat and glands is removed without the latter being exposed. It is generally well to insert a drainage tube for two or three days. Injections of carbolic acid, or similar antiseptic substances, into the glands at an early stage are not to be recommended.

On the other hand, **if there be a large abscess** when the case is first seen, excision of the glands is not advisable; firstly, because the affection is wide-spread, and a very extensive dissection would be required; and, secondly, because there is a great probability of the abscess bursting during the operation, and thus infecting the whole of the large wound. It is best, under these circumstances, to *open up the bubo*, and this should be done by as small an incision as possible. Experiments on the organism that causes soft chancre show that it is essentially aërobic: clinically also, so long as the skin is unbroken over one of the glandular abscesses, the condition progresses comparatively slowly; but as soon as the interior is freely exposed to the air, there is very rapid formation of a large chancroid ulcer. Hence, in dealing with these abscesses, the access of the air to the interior should be hindered as far as possible. Two methods may be employed, the first being more to be recommended in the early stages. In both, the operation must be carried out with strict antiseptic precautions, the area of operation, the hands, instruments, etc., being rigidly sterilized.

(1) A small incision should be made into the abscess, sufficient to admit

a small flushing spoon (Barker's). The pus is allowed to escape, and the spoon (see Fig. 69) is introduced attached to an irrigator containing a 1-4000 sublimate solution. The interior of the abscess is then thoroughly flushed out, and the remains of the gland scraped away. After the cavity

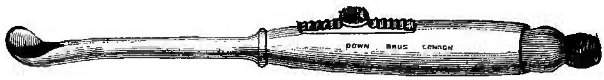


FIG. 69.—BARKER'S FLUSHING SPOON. This is a hollow sharp spoon which is connected with a reservoir of fluid by means of india-rubber tubing attached to the handle (the attachment is shown at the right-hand end of the figure). The passage of the fluid is regulated by the sliding valve seen on the upper surface.

has been thoroughly cleansed, it should be emptied, and then filled with a 10% emulsion of iodoform and glycerine[1] (some use a 10% emulsion of iodoform and vaseline, liquified by heat); an antiseptic dressing is afterwards applied, no stitches at all being inserted. In some cases the wound heals without any further trouble.

(2) A small incision is made, the pus evacuated, the interior scraped and washed out as before, and then sponged with undiluted carbolic acid. A small drainage tube is inserted, and antiseptic dressings are applied. The subsequent treatment, as regards dressings and drainage tube, is the same as in acute abscess.

If the wound tend to enlarge and become chancrous, it must be laid freely open, all sinuses or diverticula slit up, the surface thoroughly scraped, nitric acid applied and its action neutralized after about five minutes by carbonate of soda solution (see Part I., p. 239), the cavity being stuffed afterwards with cyanide gauze impregnated with iodoform. At first the superficial dressings must be renewed daily, but the packing need not be taken out for some days if it adhere firmly to the wound; later on the dressings will need changing at less frequent intervals and, finally, weak boracic ointment may be substituted when the cavity has become completely filled up with granulation tissue.

**Syphilitic Adenitis.**—Syphilitic affections of the glands may occur in any stage of the disease. In the *primary* stage the adenitis generally begins from the fourth to the tenth day after the appearance of the sore; it is usually bilateral, and several glands are affected, the one nearest the chancre being usually the largest. There is no tendency in these cases to suppuration. The *secondary* form of adenitis affects the glands elsewhere, the most common seat being the glandulæ concatenatæ, which become enlarged and firm. Small sclerosed glands are also sometimes found in the *tertiary* stage; a gummatous condition has been described, but is very rare.

The **treatment** of these conditions is the general treatment of syphilis (see Part I., Chap. XII.), no local treatment being called for.

[1] Made by adding 1 part of sterilized iodoform to 9 parts of a 1-1000 solution of corrosive sublimate in glycerine. The iodoform is sterilized by keeping it submerged for some days in a 1-20 watery solution of carbolic acid.

**TUBERCULOUS ADENITIS.**—Tuberculosis is a very frequent and important form of glandular disease. It most commonly occurs before twenty years of age, but is not uncommon at other ages, and is even met with at an advanced period of life. The glands most commonly affected are the cervical, the bronchial and mesenteric glands, but glandular tuberculosis frequently occurs in connection with disease of joints; for instance the supra-condyloid glands are often affected in cases of tuberculous disease of the wrist, those in the groin in disease of the knee, etc. The glands are also frequently affected secondarily to tuberculous ulcers on the skin. In the case of the cervical, bronchial, and mesenteric glands, however, there may be no lesion at the point of entrance of the bacillus, the virus passing straight on through the mucous membranes to the glands.

**Pathology.**—In tuberculous gland disease in the earlier stages there are found small discrete tubercles which subsequently run together, undergo softening, and then lead to chronic abscess; they may, however, become caseous and gradually diminish in size, being finally impregnated with calcareous salts. Although only one or two glands may appear from external examination to be enlarged, as a rule a large number are affected; this is an extremely important fact to bear in mind as regards operation.

**Symptoms.**—The glands form ovoid, firm, indolent masses, which are often quite painless, and at first freely mobile. At a later stage peri-adenitis may occur, and then the glands become matted together and gradually form a large lobulated or nodular mass. This is perhaps the most usual condition, at any rate it is common where suppuration is about to occur. In a third stage the glands undergo softening, the capsule being broken through and the disease spreading in the cellular tissue and towards the skin in the manner described in speaking of chronic abscess (see Part I., p. 247). When these abscesses burst they leave tuberculous ulcers with sinuses leading down to cheesy glands. They are slow in healing, and very unsightly scars are left when this finally takes place.

**Treatment.**—The simplest plan is to consider the treatment appropriate to each of the clinical stages mentioned, namely, (1) when the glands are isolated and there is no peri-adenitis; (2) when they have become matted together; (3) when abscess is present; (4) when abscesses have burst, and have left sinuses and ulcers.

(1) **When peri-adenitis is absent.**—When the glands are isolated, mobile and small, and there is no peri-adenitis or any tendency to softening, no surgical interference is at first necessary. The **general treatment** of tuberculosis (see Part I., p. 245) should be attended to, residence at the sea-side, or in a part of the country which suits the patient, the use of cod-liver oil, sea-water baths, and plenty of fresh air being of the utmost importance. Arsenic is also of considerable value in some cases; the ordinary dose of liquor arsenicalis (which will vary according to the age of the patient) should be given to begin with, and this should be increased gradually until the patient is taking a dose just short of that necessary to produce toxic

symptoms. **Local applications** are on the whole best avoided. Iodine paint is very commonly employed, but it is doubtful whether it ever does any good at all, whilst certainly, when peri-adenitis is present, it seems to precipitate the suppuration. The various ointments commonly employed can only be regarded as *placebos*, and cannot be recommended. When the glands are situated in parts of the body subject to movement, as in the groin, rest must be enjoined, and, if necessary, the part may be fixed with splints and bandages.

In some cases where the glands are large, and cause deformity, and are increasing in size and number, it is advisable to excise them, even though they are not actually breaking down.

(2) **When peri-adenitis is present.**—When the glands are becoming matted together into a large nodular mass, suppuration is very apt to occur in some portion of it; therefore, if after a comparatively short period devoted to a trial of change of air and general treatment, the condition persists or increases, much subsequent trouble and considerable unsightly scarring will be avoided, by proceeding without further delay to *excise the glands*. It is true that, under good hygienic conditions, a certain proportion of these cases recover perfectly without operative interference; but, in the large majority, suppuration will occur, and then the operation becomes very difficult. If, however, it be performed before an abscess of noticeable size is present, no skin need be taken away, and a delicate linear cicatrix is left which in process of time will become practically unnoticeable. The operation must be done very thoroughly; not only should all the enlarged glands be removed, but with them should also be taken all the smaller ones in the neighbourhood, even though they may not be visibly tuberculous. In order to get the most successful result, the whole of the fat and glands in the vicinity should be removed, as far as possible, in one mass. For example, in the case of the anterior triangle of the neck, all the fat and glands under the sterno-mastoid muscle and along the course of the jugular vein should be most carefully dissected out. Moreover, if the mass be adherent to the vein, it is best to ligature the latter above and below, and remove the adherent portion. The precise steps of the operation in these cases (especially for tuberculous glands in the neck) will be described when we come to deal with the regions in which they occur.

(3) **When there is an unopened abscess.**—Provided that the abscess be of moderate size, and do not involve any extensive area of the skin, the best plan is still *excision*. Any skin that is thin or adherent to the glandular mass should be enclosed in an elliptical incision and removed, and the greatest care should be taken to avoid puncture of the abscess during the dissection. Free removal of the whole lymphatic area must also be practised as in the previous case. Partial excision, that is to say removal of those glands only which are visibly diseased, is very apt indeed to end in disappointment; there is almost always enlargement of other glands subsequently, and this is especially likely to be the case if

asepsis be not rigidly enforced. Where it is neglected, irritation and rapid enlargement of the smaller glands already infected take place. The surgeon should never be content with merely shelling tuberculous glands out of their capsules.

When the glandular abscess is very large, or when, as sometimes happens, there is a mixed infection with pyogenic organisms, an excision, practised when the case first comes under notice, would mean the removal of a large portion of the skin and would entail a very difficult dissection. In these cases it is probably best first of all to open the abscess antiseptically, to introduce a drainage tube, and to wait for the subsidence of the swelling and inflammation. It will then be found after a week or two that the greater part of the swelling has gone down and a sinus is left leading to the mass of tuberculous glands. At this stage excision of the glands may be practised with advantage, care of course being taken that the sinus is carefully dissected out at the same time (*vide infra*).

There is not much to be said in favour of such partial operations for tuberculous glands, as scraping with a sharp spoon. In this plan, a small incision is made over the gland, whether it be suppurating or not, and a sharp spoon is bored into it, and the cheesy material or the pus evacuated. The result is generally unsatisfactory; a certain number of cases do extremely well, and recover with a very small scar, but in the greater proportion a sinus is left, fresh glands enlarge, abscesses form in connection with them, and ultimately the surgeon is compelled to excise the whole of the affected area. In scraping out these tubercular glands, there is also a risk that acute tuberculosis may occur after the operation. If it be decided to employ scraping, it is well to leave the glands unopened as long as possible, so that they may become completely broken down. The surgeon may then possibly succeed in scraping away all the disease, and is not so likely to leave behind tissue that may infect the wound. In fact, most of the cases in which a good result is obtained by scraping are those in which the glands have become completely broken down by the chronic suppurative process, before operative measures are resorted to. After the glands have been scraped out, the cavity is generally filled with the glycerine and iodoform emulsion, and the wound stitched up without a drainage tube. Strict asepsis must be employed, and if the wound gives way, antiseptic dressings will have to be continued until healing is complete.

(4) **When a sinus is present.**—A fourth condition is when the patient comes under notice with sinuses leading down to diseased glands. In this case also *excision* of the mass is the best treatment. The operation is of course rather a difficult one, but still if proper lines be followed, such as will be laid down for dealing with cases of glands in the neck, the operation can usually be completed with comparatively little trouble. It is necessary, however, to remember that there is already a septic sinus present, and, therefore, the outer end of the latter should first be thoroughly

scraped, and then a small fragment of sponge or wool dipped in undiluted carbolic acid introduced into it, and left in as a plug. The skin is next thoroughly purified, the sinus enclosed in an elliptical incision, and care is taken not to button-hole it in excising the mass. As even then it is impossible to be quite sure that perfect asepsis has been secured, a drainage tube should be introduced into the wound, as otherwise suppuration might occur and lead to the failure of healing by first intention.

**After-treatment.**—Of course in all cases the patient should be placed under the best hygienic conditions, and after the wound has healed should be sent to the country for some weeks so as to thoroughly re-establish the general health.

## TUMOURS.

The neoplasms occurring in lymphatic glands may be either primary or secondary. The **primary** tumours of lymphatic glands are rare, the chief being **lymphadenoma**, a condition already fully described in Part I., p. 262. The **secondary** tumours of lymphatic glands are either **sarcomata** or **carcinomata**, and as they have been referred to under tumours (see Part I., Chap. XV.), and will be referred to again in speaking of these diseases as they affect various organs and parts of the body, we need not enlarge upon them here.

**Treatment.**—In all cases of cancerous disease the glandular tumours should be removed, if possible, and great care should be taken, as in the case of tuberculosis, not only to remove the visibly enlarged glands, but also the whole glandular area, which can only be done by making a complete dissection, embracing all the glands and fat, and removing them in one mass. This is most important, and is most easily carried out in the axilla and the neck, where glandular infection after disease of the breast or mouth is very likely to occur. Further, in cases of degenerating malignant glands, the greatest care must be taken not to rupture them, as otherwise the whole wound may become a diffuse malignant sore.

# CHAPTER XIII.

## THE SURGICAL AFFECTIONS OF FASCIÆ.

### TRAUMATIC AFFECTIONS.

**RUPTURE.**—This is the most important of the injuries of fasciæ; for example, in the case of the foot, an overstretching or a sudden descent from a height on to the sole may lead to rupture of portions of the plantar fascia. The injury is accompanied by great pain at the time, and sometimes imperfect union of the ruptured fascia may lead to a condition in which the foot is extremely tender whenever the patient bears his weight upon it.

**Treatment.**—The main object of the treatment of this accident must be to ensure complete rest, so as to allow the ruptured fibres to unite. When the plantar fascia is ruptured the foot should be put up in plaster of Paris with the instep fully arched by bending the toes downwards as much as possible, so as to relax the fascia to the utmost extent. This casing should be kept on for about a fortnight; if it be kept on too long the fascia is apt to contract, and there may afterwards be difficulty in obtaining free extension of the foot. After the plaster is removed, care must be taken for some time to prevent any sudden strain or great weight being thrown upon the arch of the instep, so as to allow of perfect consolidation taking place. The patient must therefore be cautioned against bearing too much weight upon it at first, and all heavy jars or strains must be avoided.

### CONTRACTIONS.

Of diseases of fasciæ the chief is the occurrence of various contractions. These may be the result of disease, such as gout; or may be due to repeated, long-continued, and severe pressure; or to prolonged immobilization of the limb in a faulty position. Of contractions of the fasciæ due to disease the most marked example is that known as **Dupuytren's Contraction** of the palmar fascia, which is frequently associated with gout or rheumatism, and which has been already fully described (see p. 27).

Contraction of the fascia from pressure is also seen in the hand, as the result of the use of instruments which constantly exert pressure on a particular part of the palm. Probably a certain amount of inflammation is set up in this way, and this leads subsequently to contraction of the fascia. A similar condition produced by immobilization is sometimes met with after fractures or joint disease; while the effects of prolonged faulty position are well marked in cases of infantile paralysis, where, for example, the front part of the foot drops as a result of paralysis of the anterior muscles of the leg, and a secondary contraction of the plantar fascia subsequently occurs and interferes with proper extension of the foot. In the case of fractures and joint disease, inflammation probably plays some part in the production of the contraction of the fascia, while, in the case of infantile paralysis, it may be largely a question of imperfect development.

**TREATMENT.**—This will consist mainly in the employment of subcutaneous division. A tenotome which should have a sharp point and a cutting edge of not more than a quarter of an inch in length, is introduced flatwise between the fascia and the skin while the parts are lax. The cutting edge is turned towards the fascia, this is put upon the stretch, and the part beneath the edge of the knife is divided by nicking it with the point. When one band is cut, fresh resisting bands are found to start into prominence, and so the knife is pushed on in various directions until all tight bands are divided. Sometimes the division can be completed through one puncture; generally a number of separate ones will be required. The contracted fascia usually consists of a number of tight bands, and not of an even continuous layer; it is therefore of importance to use a tenotome with a small cutting blade, and to do most of the division by nicking the contracted bands with the point, for fear of damaging important underlying structures. When as much as possible has been done by the knife, the part is thoroughly stretched, so as to tear any portions which may have escaped division, and the limb is then put up in the stretched position in a suitable apparatus, or a plaster of Paris case is applied; this is kept on for some weeks or months, until, in fact, contraction in connection with the healing process has ceased. The detailed treatment for the principal cases in which the fascia is contracted, *e.g.* club-foot and Dupuytren's contraction of the palmar fascia, has already been given.

**RHEUMATIC NODULES** are not uncommon in connection with the fasciæ. They are hard rounded masses, of variable size, which are generally scattered over the body, and which often develop rapidly in connection with chronic rheumatism. They generally yield to anti-rheumatic remedies such as the salicylates.

**NEW GROWTHS** are not uncommonly met with in connection with fasciæ. The most frequent of these are **fibromata**, which frequently begin in the dense fibrous tissues. **Sarcomata**, more especially of the spindle-celled variety, also occur. The treatment of these has been referred to under the treatment of tumours (see Part I., Chap. XV.).

# CHAPTER XIV

## THE SURGICAL AFFECTIONS OF BURSÆ.

### WOUNDS.

It must be remembered that the bursal cavities are in close relation with the lymphatic vessels, and therefore any septic infection of them is particularly dangerous, and may lead to very violent inflammation. For example, when the bursa over the olecranon has been punctured, enormous swelling of the arm with great redness and œdema not at all uncommonly results. The bursa and the parts around become acutely inflamed, and the redness of the skin often closely resembles erysipelas. So great is the swelling in proportion to the damage done to the bursa, that, in cases in which the puncture is not easily visible, it might be difficult to make out the main seat of the inflammation if these facts were not clearly borne in mind.

**TREATMENT.**—When, therefore, a bursa is wounded, great care must be taken to disinfect the wound, and for this purpose the entire bursal cavity should be swabbed out with undiluted carbolic acid, the opening, if necessary, being enlarged for the purpose, whilst the skin around is disinfected in the ordinary manner. A drainage tube is then inserted into the cavity and antiseptic dressings are applied. The **after-treatment** must be conducted on the lines already laid down for the treatment of accidental wounds (see Part I., Chap. IX.).

If a considerable interval has elapsed before the case is seen, and inflammation has already set in, the cavity must be laid freely open, sponged with undiluted carbolic acid, and packed with strips of gauze impregnated with iodoform ; if the inflammation be very great, warm boracic fomentations (see Part I., p. 48) may be applied outside.

### BURSITIS.

**ACUTE BURSITIS.**—Inflammation of a bursa may be acute or chronic. Acute bursitis occurs either as a serous or a purulent inflammation. It may follow contusions, especially if there has already been some chronic inflammation, or it may be secondary to some inflammation in its vicinity, *e.g.* erysipelas of the skin or inflammation of a neighbouring joint. In some cases it is due to a direct wound. Acute bursitis also occurs in rheumatism, and a gouty form of the affection is described.

**Treatment.**—In cases of **acute suppurative bursitis,** the bursa must be laid freely open, a drainage tube or tubes inserted at the most dependent points, and the parts kept aseptic. It is often necessary for efficient drainage in a large bursa like the pre-patellar, to make two, or even more, counter-openings at its lowest points. In the pre-patellar bursa this is best done by a small median incision, through which the finger explores the cavity and directs a probe or pair of sinus forceps, which are made to project beneath the skin at the most dependent points, and are cut down upon for counter-openings. The neighbouring joint should be fixed with splints until the inflammation has subsided.

**When suppuration has not occurred**, the ordinary treatment of inflammation (see Part I., Chap. I.) should be employed; this will be rest and cold in the early stages, hot fomentations, leeches, etc., later on. If there be any rheumatic tendency, salicin or salicylate of soda (20 grains three times daily) should be given. The majority of cases of acute bursitis, however, go on to suppuration, and, provided that the wound can be kept aseptic, time is saved and a better result obtained by early incision and drainage, even though no pus has formed. When there is no pus, a fine drainage tube (No. 5) inserted between the edges of the wound will suffice; its use can generally be dispensed with after the third day, and the wound allowed to close. Here there is no need for counter-openings; drainage through a median vertical incision, carried out as above, will suffice. If the pre-patellar bursa be affected, the patient may be allowed to walk about with the knee fixed in a suitable casing.

**CHRONIC BURSITIS.**—Chronic inflammation of a bursa may follow upon the acute form, or it may be chronic from the commencement; it is usually the result of slight contusions or injuries to the part. The most common seat of chronic bursitis is the pre-patellar bursa, and here it usually results from prolonged kneeling. Sometimes at an early stage of the disease there is considerable pain and some redness of the skin—a *subacute* inflammation in fact—but there is not the acute œdema and the violent symptoms characteristic of an acute suppurative inflammation. The pain soon subsides and leaves the wall of the bursa dilated and thickened; the subacute inflammation is, however, very liable to recur on the slightest provocation. In other cases again, adventitious bursæ may develop over parts subjected to pressure, and these may subsequently inflame; common examples of these are the bursæ which develop over the side of the metatarsal bone of the great toe, as a result of pressure in cases of hallux valgus, and which are known as bunions.

**Pathology.**—As the result of the chronic inflammation, various changes take place in the wall of the bursa. In the early stages the cavity is merely distended with fluid, and the inner surface of its wall becomes covered with a layer of lymph; this leads to thickening of the wall of the bursa, and, very often, to the formation of adhesions between its opposite surfaces. In this way are produced bands crossing the bursa, or tags hanging into it, and the latter may become detached, and form loose bodies in the interior. In fact the chief cause of the constant recurrence of chronic bursitis, after it has subsided under treatment by rest and counter-irritation, is the presence in the bursa of these loose bodies or tags. As time goes on, the wall becomes more and more thickened and fibrous, until, ultimately, it may practically become converted into a fibrous tumour with a very small cavity containing a little fluid. Often, as the result of a little extra irritation, the cavity fills up with blood-stained fluid.

**Treatment.**—(a) **Radical.**—The treatment of chronic bursitis should be radical wherever it is possible. Undoubtedly the best of all methods of treating the affection is to *excise* the sac entirely, and thus in the long run a great deal of time is saved. This method of treatment moreover is absolutely essential when the bursal wall is much thickened, or when there are bands or loose bodies present in the interior. In any case, however, when once a chronic bursitis is established, it is best to excise the bursa completely.

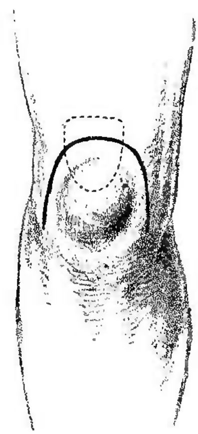


FIG. 70.—INCISION FOR REMOVAL OF THE PRE-PATELLAR BURSA. The sketch is designed to show the relative positions of the incision, the enlarged bursa and the patella (the shape of which is somewhat incorrectly represented by the dotted line). The flap should be made as shown above, and not with its convexity downwards, as is sometimes done, as then the scar would be directly exposed to pressure on kneeling.

In dealing thus, for instance, with a **pre-patellar bursa,** the skin about the front of the knee should be purified with scrupulous care. The pre-patellar region is one of the spots where, owing to the thickness of the skin, and its frequent exposure to pressure, septic material is apt to accumulate, and where it is only got rid of with difficulty. A curved incision should be made around the swelling with the convexity upwards, its upper border coming just above the upper limit of the bursa, and its ends terminating a little to each side, well below the centre of the tumour (see Fig. 70). The flap thus marked out, consisting of skin and subcutaneous tissue, is turned down until the anterior surface of the enlarged bursa is fully exposed, and it is then quite easy to see the limits of its wall, and with a few strokes of the knife to detach the connective tissue around, and peel the whole thing off unopened from the front of the bone and the ligamentum patellæ. There is no danger of wounding the joint if ordinary care be taken to keep close to the sac. After the bursa has been removed the wound is stitched up, an antiseptic dressing is applied, and the limb put upon a splint. If preferred, a splint need not be employed; a thick mass of dressing is sufficient to check the movements of the joint sufficiently to permit rapid healing. The wound will heal in a few days, the stitches may be taken out in a week, a collodion dressing applied, and the patient allowed to walk about on the eighth or the tenth day. By making a curved incision in this manner the scar does not lie over the lower part of the bone, so that there is no danger of pressure upon the scar and a recurrence of pain on kneeling. The skin over the patella very soon becomes loose and supple, and the patient experiences no inconvenience from the absence of the bursa.

(b) **Palliative.**—This should only be employed when the patient declines radical treatment; it consists in *rest* and *counter-irritation*. The limb is placed upon a back splint, the patient being kept in bed or only allowed to walk about with the splint on, and iodine or blisters are applied over the bursa. A certain amount of time may be saved by drawing off the fluid with an aspirating needle before beginning the treatment, and then applying the counter-irritation. If the patient continue to walk about, only a slight diminution of the swelling as a rule results; if, however, she be confined to bed from the first, the swelling may disappear almost entirely, the fluid being all absorbed, and only a somewhat thickened wall left. In many cases it is then possible to feel cords or loose bodies moving under the finger in the interior of the bursa. As a rule, when the patient begins to kneel or resume her work, the effusion recurs, so that really nothing is gained by this palliative method of treatment.

Other methods intermediate between complete excision and rest have been employed. For example, it is common to *puncture* the bursa and *inject* it with tincture of iodine or undiluted carbolic acid, as is done in the case of a hydrocele; at least as much time, however, is taken up by this method of treatment as if excision were practised, and the result is not at all certain. A more certain method is drainage of the bursa, and this is distinctly preferable to the palliative treatment just mentioned. *Incision and drainage* will often lead to a permanent cure of the trouble, even if loose bodies or tags be present in the bursal cavity, as they can be removed at the same time. But this plan does not seem to possess any particular advantage over excision. In the first place, it takes longer (as a rule, it is not possibe to leave out the tube in less than ten days, and then the wound has still to heal), and it is more dangerous on account of the risk of sepsis. If sepsis were to occur in the wound made for removal of the bursa (provided no communication had been made with the joint), the probability is that it would be a purely local accident; whereas, if sepsis occur in an open bursa, a most violent suppurative inflammation is set up, which not only causes local trouble, and leads to a long illness, but may cause very serious general septic infection. Cases are also known where recurrence of the original bursitis has taken place even after incision and drainage. The only conceivable advantage of these methods over excision is that in them the bursa is left, and that, therefore, the skin might be presumed to move more freely over the subjacent bone. As a matter of fact, however, this is a purely fallacious reason, since the point aimed at in incision and drainage is to obtain complete obliteration of the bursal cavity, so that the bursa is removed as effectually as if it were excised; in the latter case (*i.e.* complete excision) it is found by experience that patients never complain of any adhesion of the skin due to loss of the bursa.

Hence we recommend in these cases—(1) the performance of *excision* of the enlarged bursa; (2) should the patient refuse excision *drainage* may be employed; and (3) only where this is refused, or the surgeon is not sufficiently sure of his asepsis, should *injection*, etc. be practised.

## TUBERCULOSIS.

This is not very uncommon, and the disease runs the ordinary course of tuberculosis elsewhere. The wall of the bursa becomes thickened, and effusion occurs into its cavity. The fluid very often contains *rice bodies*, and subsequently pus is developed, which gradually finds its way to the surface. These bursæ may or may not be connected with and secondary to disease of the joint; those most commonly affected are the bursæ over the great trochanter, and that beneath the deltoid muscle.

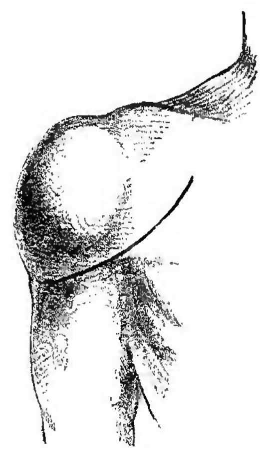


FIG. 71.—INCISION FOR REMOVAL OF A DELTOID BURSA. This should correspond mainly to the anterior edge of the deltoid muscle, and should curve round well on to the outer aspect of the arm at its lower end.

**TREATMENT.**—The treatment is essentially that of chronic abscess (see Part I., p. 247). If possible, the affected bursa and its contents should be dissected out, and where this cannot be done the wall should be clipped away as far as possible, after the cavity has been laid freely open, and then, if any portion has to be left behind, its surface should be thoroughly scraped and sponged over with undiluted carbolic acid.

Where the entire bursal wall is not easily accessible, for example in the **psoas bursa**, the pus should be evacuated, the walls scraped, the cavity injected with a 10% emulsion of iodoform and glycerine (see p. 184), and the wound stitched up without a drainage tube. In the case of the **bursa over the great trochanter** of the femur, an incision should be made with the convexity forwards, and a flap turned back so as to completely expose the swelling. The bursal wall is then exposed and peeled off carefully from the surrounding tissues, and the whole structure removed, the surface of the bone being carefully examined for evidence of tuberculous infection; if any deposit of tubercle be found in it, it must be cleanly gouged out. The wound is then stitched up and an antiseptic dressing and pressure applied. In the case of the **bursa under the deltoid**, it is impossible to remove it entirely without a very extensive dissection. It is possible, however, by means of an incision made along the anterior edge of the deltoid muscle, curving backwards at the lower part (see Fig. 71), to dissect away the greater part of the bursa as it lies beneath the muscle. The remainder must then be thoroughly scraped out, the rice bodies, if present, all removed, iodoform and glycerine emulsion injected, and the wound stitched up without a drainage tube. Tuberculosis of this bursa is generally secondary to tuberculous disease of the shoulder joint, and in that case, if the disease be extensive, it may be advisable to excise the joint. In such a case it is best to begin by dissecting away the bursa as completely as possible before proceeding to deal with the synovial membrane and the joint surfaces. This point will be dealt with more fully in speaking of diseases of joints.

## SYPHILIS.

Syphilitic bursitis occurs in the *secondary* stage as an acute affection; in the *tertiary* stage it occurs as a gummatous deposit, but these lesions are rare, and the treatment does not require any special mention.

## TUMOURS.

New growths in the walls of bursæ are also rare. *Sarcomata* and *myxomata* are met with occasionally, and at first they are very difficult to distinguish from bursæ, the walls of which are merely thickened by inflammatory deposit.

The **treatment** of course is essentially the same as that of new growths elsewhere, and consists in the complete removal of the tumour.

# CHAPTER XV

## THE SURGICAL AFFECTIONS OF MUSCLES.

### ATROPHY.

ATROPHY of muscles arises from a variety of causes, and is usually due to defective innervation, such as occurs after division of a motor nerve, central paralysis or peripheral neuritis. Atrophy is also a common sequel to disuse of muscles, and this condition may result from direct injuries, such as blows, when the atrophy is due to hæmorrhage into the substance of the muscle, or to damage to the nerve supplying it. It also occurs in the muscles in the neighbourhood of joints which are the seat of either tuberculous or rheumatic disease, and in these cases it proceeds more rapidly and completely than can be accounted for by mere disuse of the articulation. After atrophy has gone on for some time, the muscle tends to shrink, and thus the tendons become tight, and may require division before proper restoration of movement can be obtained.

**TREATMENT.**—This will of course depend upon the cause of the atrophy. When it is due to some central nervous derangement very little can be done, except to promote the nutrition of the muscles; when it results from division of the nerves supplying the muscles, nerve suture must be practised. When it occurs in connection with joint disease, the atrophy will persist until the condition of the joint so far improves that its movements can be freely carried out. If it occur after an injury causing hæmorrhage into the muscles, the sooner the effused blood is got rid of the better will the functions of the muscle be restored.

**Massage.**—Although the first point in the treatment of this condition is to find out the cause of the atrophy, and, if possible, to remedy it, a good deal may often be done in the way of preventing it, or at any rate of checking its spread and hindering the shrinking of the muscle whilst the cause is being treated; the most useful methods for this purpose are manipulations, massage, and electricity. The principles of massage have already been mentioned (see Part I., p. 22); the object of the massage here is not to remove effused materials, but to improve the circulation in the muscle, and to stimulate the muscle-fibres themselves, so that by contracting they may regain a certain amount of power. Attempts to improve the circulation are best made by rubbing and kneading the muscle, especially in the upward direction, and spontaneous contractions of the muscular fibres are induced by repeated tappings and vibrations applied to the muscle itself, not so severe, however, as to paralyze it.

**Electricity.**—In employing electricity, the Faradic current should be used, except where there is some joint lesion, and where, therefore, the contractions of the muscles which its action produces might aggravate the mischief. A large electrode, about three inches square, covered with chamois leather or thick flannel and well soaked with warm water or salt solution is applied to the spine, while another electrode, not less than two inches square, is applied to the skin over the affected muscle and moved slowly all over it, keeping in close contact with the skin. A current of about five milliampères or less is generally sufficient; the patient's sensations are, however, the best guide to this point; the current should never be strong enough to cause pain. If preferred, the two electrodes may be placed side by side on the skin and moved about. Each sitting should last from ten to twenty minutes, and should be repeated every other day or oftener for a considerable period.

**Manipulations.**—At the same time that massage and electricity are employed frequent manipulations should be practised, except in cases of joint disease, with the view of stretching the muscles and preventing the occurrence of contractures.

## TRAUMATIC AFFECTIONS.

Injuries of muscles may vary in degree from a simple blow or contusion to complete rupture of the muscular fibres.

**CONTUSION** of muscles sometimes gives rise to very considerable mischief. In the first place it leads to infiltration of blood among the muscular fibres, and this interferes with their action; in the second place it very often causes a temporary paralysis. As the result of a blow the muscle contracts, and this is followed by fibrillary twitchings, after which the muscle relaxes and may not recover its power for two or three days. When permanent paralysis of a muscle occurs after a blow it is usually due to damage to its nerve supply rather than to injury of the muscular fibres themselves.

**Hæmorrhage** into a muscle may be followed by a variety of troubles; it may lead to adhesion of the muscular fibres to each other, or to fibrosis and consequent impairment of function. In some cases calcareous salts are deposited in the muscle and calcification occurs; in others a true ossification may take place. Occasionally the effused blood is neither absorbed nor organized, but becomes encysted and forms a blood cyst in the substance of the muscle.

**Treatment.**—Efforts should always be made to get rid of the blood as quickly as possible, and this is best done in the first place by placing the part completely at *rest* and afterwards by the employment of suitable massage. *Massage* should be begun on the second or third day after the injury, and should at first consist of gentle rubbing in the upward direction twice a day, continued for about twenty minutes at a time. In a few days the other methods for breaking up the exudation (see Part I., p. 22) may also be employed. The duration of each sitting should be gradually increased up to half or three-quarters of an hour at a time, and the massage should be persisted in for at least two or three weeks.

When the effusion is large and does not readily become absorbed, the best plan is to make a curved *incision* towards one side of the swelling, expose the muscle, turn out the clots and put in a drainage tube for two or three days. Such an operation must of course be done strictly antiseptically on account of the danger of septic infection. As soon as the wound has healed, massage and manipulations should be employed.

**WOUNDS OF MUSCLES.—Incised** wounds of muscles are of no particular moment unless the incision runs transversely to the direction of the muscular fibres. Before the antiseptic era, however, wounds of muscles were specially dreaded, as being apt to lead to general septic infection. **Punctured** wounds over muscles very often do not injure the muscle at all, as it contracts, and slides out of the way, but, in some cases, the muscle is punctured and some of its fibres may be divided. Should this occur, the divided fibres retract, and may leave a large irregular gap in the muscle (see Punctured Wounds, Part I., Chap. IX.). When the incision is of considerable size and, particularly, when it is transverse to the direction of the muscular fibres, very considerable retraction takes place, and, unless means be taken to restore the continuity of the muscle, very serious functional disability may result.

**Treatment.**—In the case of an incised wound involving a muscle and dividing it transversely, an attempt must be made, after thoroughly disinfecting the wound, to bring the divided ends of the muscle together, and this is especially necessary when the wound involves the greater part of the width of the muscle. The approximation is effected by means of sutures, but this is a somewhat difficult task. If the sutures be inserted in the manner employed for interrupted stitches in the skin, it will be found that as soon as the thread is tightened, it simply separates the muscular fibres and cuts its way out. In order to avoid this, the stitch must be passed transversely across the muscle at some distance from the divided edge, and the two ends tied together in front so as to surround a mass of the muscular fibre. The suture should not be tied so tightly as to unduly constrict the included portion of muscle, but sufficiently so to prevent the portion included in the ligature from slipping through the loop. A similar stitch is then put in the other divided end, and tied in a like manner. The ends of these two stitches are then tied together firmly, and by this means the divided ends of the muscle may be approximated (see Fig. 72). Before the stitches are tied the muscle should be fully relaxed by placing the limb in a position of flexion or extension according to the muscle affected; more than one suture may be required, the number being regulated by the breadth of the particular muscle. When these fixation stitches have been tied, the approximated muscular edges may be united by means of a continuous catgut suture, the button-hole stitch (see Part I., p. 158) being the best. For suturing muscles catgut is on the

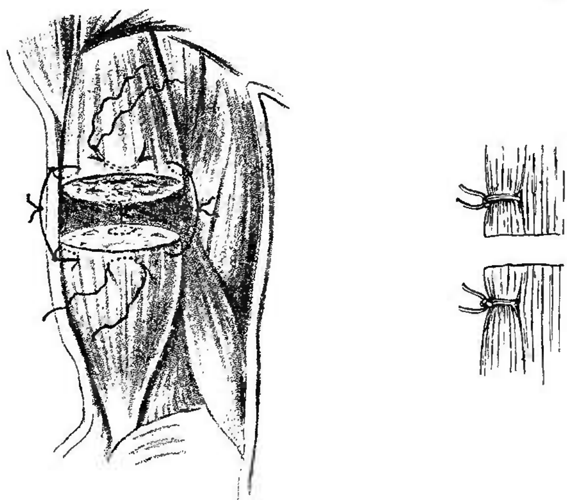


FIG. 72.—METHOD OF SUTURING A DIVIDED MUSCLE. The method of introducing and tying the sutures is shown diagrammatically. The smaller figure shows the detail of the individual sutures. In the larger one four such stitches have been inserted and are ready for tying. When they have been tied and the cut edges of the muscle thus approximated, a continuous buttonhole suture is put in along the line of junction.

whole the best material; silk may be used, but in accidental wounds of muscles it is impossible to be certain of securing asepsis, and should the wound be septic, the silk will almost certainly work its way out, and a sinus will remain for a considerable time. After the muscle has been sutured, a drainage tube should be inserted and the skin wound stitched up. The limb should be placed upon a splint in the position that ensures the greatest relaxation of the muscle.

**After-treatment.**—The further treatment of the wound will follow the lines already laid down for accidental incised wounds (see Part I., p. 184). The position of full muscular relaxation should be kept up for about a couple of days, and then, day by day, the limb may be slightly extended or flexed as the case may be, until, in the course of two to three weeks, the muscle is put fully upon the stretch. It is important not to keep the muscle too long in the fully relaxed position because a certain amount of adhesion is likely to form between the line of suture and the tissues around, and this should, as far as possible, be made to occur in the position in which the muscle is fully extended; the muscular contractions will then pull upon the adhesions, and gradually stretch them. In the course of about four weeks the patient should be encouraged to move the muscle voluntarily, but up till then only passive movement should be resorted to. If any firm adhesions should form between the line of union in the muscle and the soft parts, massage and faradism are of the greatest use in breaking them up; if necessary, they may be divided transversely by a tenotomy knife.

The uniting material in these cases is composed of fibrous tissue; but if the parts have been well approximated by stitches, and care taken in the course of the treatment not to allow separation to take place afterwards, the line of union is quite narrow and firm, and the muscle is as good as ever.

**Rupture of muscles** may occur independently of an external wound, and results from violent, irregular, or inco-ordinated contraction, though an actual rupture of muscle is much less common than is rupture of a tendon; it generally occurs in men, and is usually only partial, but certain muscles may be torn completely across. The muscle which ruptures may previously have been the seat of disease, or it may be quite healthy; for instance, it occurs more commonly in old than in young men, the muscles in the old taking part in the general atrophy of the body. In other cases, the muscle is found to have been the seat of waxy or fatty degeneration, such as occurs, for example, after typhoid or any other acute infective fever. The muscles most frequently ruptured after infective diseases are the rectus abdominis, below the umbilicus, and the psoas; in both cases rupture generally occurs when the patient sits up in bed too suddenly. Rupture of healthy muscles generally results from violent exertion, especially some sudden and unexpected movement, such as recovering the balance. The muscles which most commonly rupture in this way are the plantaris in playing tennis, the rectus femoris in recovering the balance, the pectoral or the deltoid in throwing, the biceps in pulling, or the sacro-lumbalis in twisting the body rapidly. The long muscles are most exposed to this injury, and it generally occurs at or near the point of junction of the muscular fibres with the tendon; the rupture may be either complete or partial. Effusion of blood occurs between the divided ends, and the ultimate result, if the case be left alone, is the formation of a fibrous cicatrix between the torn ends with possibly some slight regeneration of muscular fibres; as time goes on, this cicatrix, which is at first broad and resisting, tends to stretch considerably, and under these circumstances the patient never regains the full use of the muscle. Great care must therefore be exercised in the treatment of a ruptured muscle.

The **symptoms** which lead one to suspect this accident are sudden pain in the part, accompanied by a sensation of tearing, followed by loss of power in the affected muscle. There is a characteristic depression over the seat of rupture, and a swelling immediately above it, due to the retraction of the upper part of the divided muscle; the gap and the swelling above it become more pronounced when the muscle is voluntarily thrown into contraction.

**Treatment.**—(1) **Recent Cases.**—In these cases we may either operate with the object of stitching the torn fibres together, or else attempt to get healing without an operation. The decision depends upon whether the rupture is complete or incomplete, whether the muscle is healthy or diseased, and also whether the ruptured muscle is an important one. When a large portion or the whole of an important and healthy muscle is torn through, and there is no contra-indication, the best treatment is immediate operation. It must, however, be borne in mind that this should only be done by those who are quite sure of the asepsis of their wounds. If an operation of this kind be performed, and the wound become septic, very disastrous suppuration may occur; this may lead, not only to a permanent impairment of the usefulness of the limb from adhesions between neighbouring muscles of far greater severity than would have been the case had it been treated without operation, but even to actual loss of life. If, however, the surgeon has confidence in his asepsis, he is doing the best thing for his patient by suturing the muscle at once, and he will get a far better result by this means than by attempting to treat the case by position and relaxation of the muscle.

(*a*) *Operative.*—The operation should be performed as follows. After the skin has been thoroughly shaved and disinfected, a curved incision, with its convexity upwards, is made across the limb at the seat of rupture, and the flap thus marked out containing skin and fascia is turned down. The convexity of the incision should run well above the actual seat of rupture; its upper limit should be on the proximal end of the divided muscle, while the lower limits of the incision will be on either side of the distal end. By this means the torn ends are completely exposed. This curved incision is much better than a vertical or transverse one, not only because it gives a better access to the parts, but also because the line of union in the muscle nowhere corresponds to the scar in the skin, and therefore adhesions between the scar and the rent in the muscle cannot occur. As soon as the deep fascia is divided, the mass of blood lying between the divided ends of the muscle comes into view. This should be thoroughly cleared out, all adherent clots carefully sponged away, and then the ends of the muscle are united together by means of the stitch just described (see Fig. 72), as many stitches being inserted as are rendered necessary by the size of the muscle. In these cases silk is better than catgut for the deep sutures, for here, of course, the wound is through unbroken skin, and is not expected to become septic; the silk will retain its hold better and longer than catgut, and thus the patient may be allowed to move the limb rather sooner than if catgut were used. The union is completed by a fine continuous catgut suture.

*After-treatment.*—The limb should be put on a splint, with the muscle completely relaxed. In the course of two or three days the latter is gradually put upon the stretch until, after a week or ten days, it is fully extended. After a fortnight the splint should be left off, and the patient allowed to move the limb to a limited extent. The movement at this time may be safely left to the patient himself as he is sure not to do too much. This movement, however slight, is of advantage in preventing any firm adhesions between the divided ends of the muscles and the surrounding tissues. In about five weeks the limb may be used actively, and by that time massage and passive movements may also be employed. The above description applies more particularly to a rupture of the quadriceps femoris muscle, but it is equally applicable to a rupture of any other muscle. In cases of rupture of a muscle of the upper extremity, such as the biceps, it is of course unnecessary to confine the patient to bed for any length of time.

(*b*) *Non-operative*.—This will be the line of treatment to follow when the patient himself objects to operation, when the muscle is only partially ruptured, or is small and unimportant, when the rupture is only one of several serious injuries, or when the surgeon does not deem it advisable to operate, either because he is afraid of suppuration or because he thinks the patient too old or too feeble. With regard to the last point, however, the operation is not as a rule accompanied by shock, and it is seldom that this would form in itself a sufficient reason for refusing operative treatment. In rupture of degenerated muscles, as after typhoid and other infective diseases, operation is not expedient, because the patient is not in a condition for operation, and also because the degenerated muscles would not unite satisfactorily.

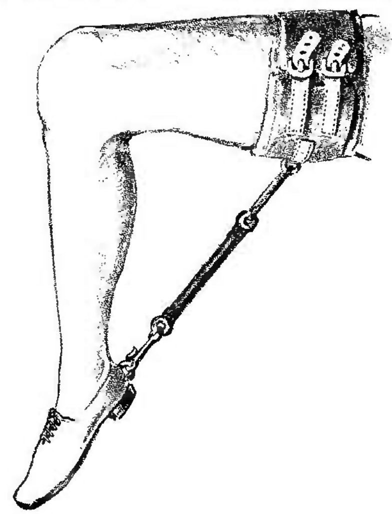


FIG. 73.—APPARATUS FOR USE AFTER RUPTURE OF THE PLANTARIS.—This is sufficiently clear from tbe figure. Should the thigh-band tend to slip, as it often will from wasting of the muscles, it may be kept in position by fastening it to a band round the waist.

The non-operative treatment consists in putting the part at rest, and fixing the joint in such a position that the muscles are relaxed as completely as possible, so as to allow the torn muscular fibres to come close together. For example, in the case of a rupture of the *plantaris*, the knee is flexed and the heel is drawn up and fastened to the thigh; this is usually done by means of a slipper which has an elastic band attached to the heel and fastened to a band around the middle of the thigh (see Fig. 73). This apparatus must be worn night and day for three or four weeks, in order to allow the union which is taking place to become fairly firm before it is subjected to stretching. Later on massage or electricity may be employed if there be any signs of adhesions.

In the case of rupture of the *quadriceps extensor femoris* the leg is placed on a back splint which is elevated on an inclined plane, so as to relax the muscle as far as possible. The skin of the thigh is first shaved, and then a large piece of adhesive plaster, cut as shown in Fig. 74 with an end left free at each side, is applied over the upper portion of the ruptured

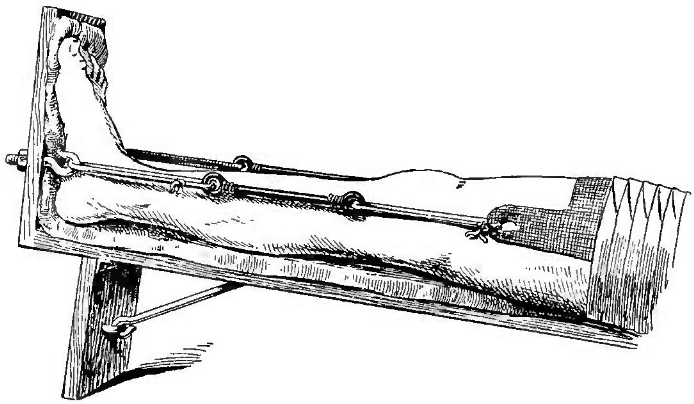


FIG. 74.—TREATMENT OF RUPTURE OF QUADRICEPS EXTENSOR FEMORIS BY POSITION. The details are given in full in the text. For the sake of clearness the bandages securing the limb to the splint have been omitted.

muscle, and firmly bandaged to the limb. To each free end is attached a piece of elastic tubing, which is fastened to an upright on the bottom of the splint; as the elastic is tightened, the upper portion of the muscle is pulled down by the traction upon the skin. This method, however, is very imperfect, as the actual pulling down of the muscle is very small indeed. The splint must be kept in the elevated position for at least three weeks after the accident. It is then gradually lowered until, after four or five weeks, the limb is lying flat on the bed. The patient should not be allowed to use the muscle till eight or ten weeks have elapsed since the injury. Subsequently, careful passive and active movements, massage, and electricity should be employed.

In rupture of the *rectus abdominis* muscle, the divided ends are approximated as much as possible by diminishing the distance between the ensiform cartilage and the symphysis pubis; this is best done by propping the thorax well up by a suitable bed-rest and pillows, and flexing the hip-joint by means of a large firm pillow placed beneath the knees. This pillow should be fastened to the head of the bed by a length of bandage on each side so as to prevent it from slipping, and it is well to have a firm foot-rest fixed to the bed-frame, so that the patient can brace himself against it.

(2) **Long-standing cases.**—Cases may also be met with where rupture of a muscle has occurred some considerable time before the patient is seen, and the result may be great loss of power. Much good may often be done by operating with the object of uniting the separated ends, even though as much as a year or two may have elapsed since the rupture. In

long-standing cases of rupture of the rectus femoris, we have ourselves operated more than once with very great benefit.

The operation is conducted much in the same way as that just described. A curved incision, with the convexity upwards, is carried across the limb, well above the seat of rupture, the flap being turned down, the fascia divided, and the fibrous tissue between the divided ends exposed. This is cut away, and an attempt is made to bring the ends of the muscle together. We have noticed a point of great practical importance in cases of rupture of the rectus femoris, namely, that the divided upper end curls up underneath, and becomes adherent to the back of the belly of the muscle at a little distance from the free end. If, therefore, one were to cut across the muscular fibres at the point where they apparently join the fibrous tissue, with a view of refreshing them, a considerable portion of the length of

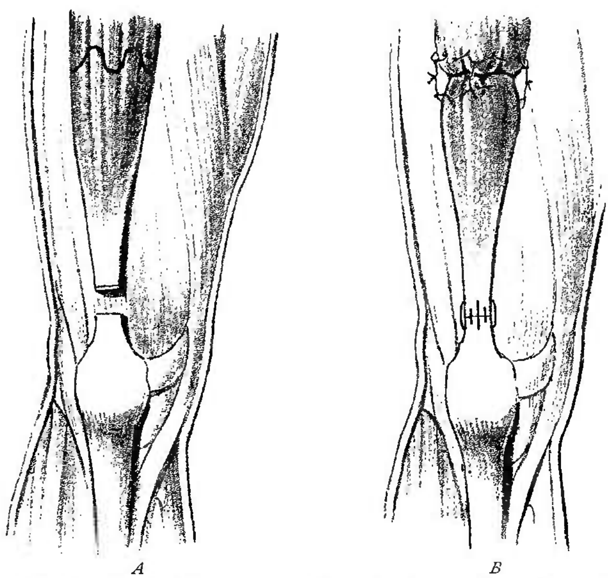



Fig. 75.—Method of Lengthening a Muscle. In *A* is shown the method of dividing the whole widtb of the muscle by means of a zig-zag incision. This gives rise to a series of blunt serrations on either side of the incision when the lower part of the muscle is pulled down. This has been done in *B* which represents diagrammatically how the sides of the gaps left by the incision are first sewn together so as to leave a blunt conical end to the muscle above and below the gap left by pulling down the lower portion, and how these blunt conical ends are then sutured to each other by the stitch shown in Fig. 72. This allows the edges of the original defect in the muscle below (which has been shown in error in the tendon) to be approximated and sutured.

the muscle would be lost. Hence, after dividing and removing the fibrous tissue, which connects the separated ends, the belly of the muscle should be turned up, and the spot where the latter has actually been divided should be looked for. The cicatrix at that part is then dissected out, and the muscular fibres unfolded. After the ends of the muscle have been prepared in this way, the stitches are passed in the manner already described (see p. 199); as they are tightened, the muscle is relaxed to its fullest extent, and the suture completed.

If, in spite of full relaxation of the limb, it should be found quite impossible to bring the ends of the muscle into apposition, it may be necessary to divide the muscle higher up, in a zig-zag manner, so as to lengthen it. Beginning at one side of the proximal portion of the muscle, and three or four inches above the rupture, an incision is carried obliquely upwards for about two inches, then obliquely downwards again to the original level, then upwards, and so on to the other side, until a zig-zag incision giving rise to a series of serrations or V's has been carried across the muscle. The portion below this incision is then pulled down until only the apices of the serrations or V's remain in contact; the adjacent sides of the serrations are then stitched together, so that the muscular fibres terminate in blunt cones, one above and one below the original zig-zag incision. The apices of these cones are then stitched together (see Fig. 75).

*After-treatment.*—During the subsequent treatment, the gradual stretching of the muscle must be carried out more slowly and carefully than after a recent rupture, but usually after about six or eight weeks the limb can be extended to its fullest extent, and the splint can then be left off; the patient may be allowed to commence walking in about ten weeks after the operation. In all these cases it is particularly important to divide all adhesions between the muscle and the surrounding tissues at the time of the operation, as otherwise proper movement will not be obtained afterwards; if it be done at the time of the operation, the gradual stretching of the muscle and the subsequent movement will prevent these firm adhesions from re-forming.

**Union of muscles with fractures.**—An accident which sometimes happens in connection with fractures, is that the torn muscular fibres become united to the fractured ends of the bone; or, in other cases, the bones are displaced, and, although the muscular fibres are not markedly damaged, the muscle becomes adherent to the displaced bones.

**Treatment.**—In the early stages of this condition, namely, within a few weeks after the injury, a good deal may be done in the way of getting rid of these adhesions by *massage*; this is especially the case where the muscles have not been ruptured. When a muscle has been ruptured, or when a considerable time has elapsed before the patient comes under observation, it is usually necessary to have recourse to operative interference.

*Operation.*—The usual curved incision (see p. 202) is made, the fracture exposed, and the muscle carefully detached from the bone. It may also be necessary, if the ends of the bones be much displaced, to chisel away projecting portions, or, if there be considerable deformity, to divide the union and bring the bones into proper position. Where there has been no rupture of the muscular fibres the wound is then closed, and, as soon as healing is complete, massage is begun and full movements encouraged. Where, however, the muscle has been ruptured, and the ruptured ends have become adherent to the broken bones, the former must be carefully detached and all fibrous tissue cut away from between the divided ends, which are then united in the manner already described (see p. 199). Should this condition be recognized in recent fractures, there is the further advantage in early operation that the bones can be placed in good position, and fixed by pegs or screws. This question will be dealt with more fully under the treatment of Fractures (Part III.).

**Hernia of muscles.**—This is a rare accident; in it the fascia surrounding the muscle is torn, and the belly of the muscle protrudes through the opening, and becomes adherent to its edges. The affection is recognized by the presence, in the course of the muscle, of a localized lump of a soft character which moves when the muscle contracts; the hole in the fascia can also be felt. The condition sometimes gives rise to pain and a certain difficulty in the action of the muscle; in some cases the disability is so great that the patient is compelled to seek surgical advice.

**Treatment.**—Under these circumstances the clear indication is to cut down upon and reduce the hernia of the muscle by separating the adhesions between it and the hole in the fascia, and to attempt to bring the torn portion of the fascia together again. If the slit be vertical the result is very satisfactory; when it is a transverse tear, however, union is not so easily effected. The usual curved incision should be made over the herniated portion and a flap turned aside. The muscular fibres and the fascia are defined, and the latter separated from the muscle. The herniated portion is then pushed back, and if the fascia be sufficiently loose, an attempt should be made to close the opening with stitches. In any case it should be sewn together as closely as possible with a continuous catgut suture, and, if the edges do not come quite closely together, the bands of catgut crossing the space will probably be sufficient to retain the belly of the muscle in position till new connective tissue has formed (see Fig. 76).

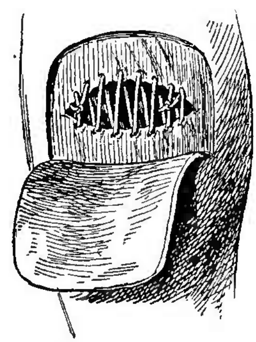


Fig. 76.—Method of treating a Herniated Muscle. The figure shows diagrammatically the manner in which, when the torn edges of the fascia cannot be accurately sutured together, the gap can be closed by bridging it with catgut after the hernia of the muscle has been reduced.

Active movements should be practised as soon as possible, and if necessary the faradic current should be used in order to cause contraction of the muscle, and thus prevent it from adhering to the edge of the opening in the fascia.

## INFLAMMATORY AFFECTIONS.

Myositis or inflammation of muscle may be either acute or chronic; the acute form may be circumscribed or diffuse, suppurative or non-suppurative.

**ACUTE CIRCUMSCRIBED MYOSITIS** may be primary or secondary. As a primary affection it is usually met with in young people, chiefly in males, and is attributed principally to over-work of the muscles or to cold; most probably, however, it is either of traumatic or infective origin. When it occurs secondarily it may be an extension from a wound, or may follow inflammation in the vicinity. Acute myositis may be either hyperplastic or suppurative.

(a) **The acute hyperplastic form.**—In the hyperplastic form, which is much the more common, the muscle becomes hard and friable, the fibres gradually disappearing and fibrous tissue taking their place; the final result of the condition is sclerosis of the muscle. The affection occurs very often in thc neighbourhood of suppurative inflammations, for example near glandular abscesses; it may also be the result of rheumatism.

**Treatment.**—The treatment of the hyperplastic form is first of all to remove the cause if possible. If it occur secondarily to abscesses or inflammations in the vicinity, the abscesses should be opened and treated appropriately, and the necessary measures taken for the treatment of the adjacent inflammatory condition. In cases where there is primary non-suppurative inflammation of the muscle itself, a rheumatic tendency may generally be suspected, and salicylate of soda in 10-grain doses every four or six hours may be administered; given in milk it is quite a palatable drug. At the same time hot fomentations or india-rubber hot-water bottles should be applied over the part, and this will usually very soon relieve the pain; more rarely, the pain may be acute enough to call for the administration of morphine. As soon as the acuter symptoms have passed off, and the patient can bear it, massage should be employed to get rid of the exuded material as quickly as possible, and so to avoid a permanent sclerosis of the muscle.

(b) **The acute suppurative form.**—The suppurative form very rarely occurs as a primary condition; it is usually due to the extension of suppuration from the neighbourhood. When multiple abscesses occur in muscles we have generally to do with pyæmia or glanders, and the suppuration is due to the deposit of micro-organisms. If it be a diffuse myositis,—a condition corresponding to diffuse cellulitis,—it generally arises in connection with a septic wound.

Apart from pyæmia the affection is said to occur idiopathically in certain muscles, the most common of which is the psoas. This condition is very rare, and its pathology, that is to say, the reason why the inflammation should locate itself in the psoas muscle, is obscure; but, quite apart from suppuration in glands, or from disease of the vertebræ and so forth, acute suppuration is sometimes met with in connection with the psoas in which no extraneous origin can be traced, and which may be spoken of as **acute psoitis.**

**Treatment.**—The treatment of acute suppurative myositis consists in free incision into the abscess, and thorough drainage of the cavity in the manner already described for the treatment of acute abscess (see Part I., Chap. I.).

**CHRONIC MYOSITIS** is a very serious condition, because it leads to great impairment of the function of the muscle, and also because it is very difficult to arrest. It occurs in two forms—the sclerosing and the ossifying myositis.

**(a) Sclerosing myositis.** In sclerosing myositis the muscles gradually become converted into fibrous tissue, which contracts and leads to permanent shortening; in some cases the entire muscle may not be affected, but still, if fibrous bands form in its course, movement must necessarily be materially interfered with. The condition may follow upon an acute suppurative or non-suppurative myositis; it also occurs in muscles around inflammatory foci of long standing, such as suppurating joints, or where hydatid cysts, gummata, foreign bodies, etc., are present in the muscle. It is also supposed to occur as the result of rheumatism. It leads to shortening and to imperfect action of the muscles and to various deformities.

**Treatment.**—In treating this affection it is necessary first of all to ascertain and remove if possible the cause of the disease, and secondly to attempt to arrest the inflammatory process and to prevent subsequent contraction. The **general** treatment is usually very difficult and ineffectual; when no definite local cause is found it should be directed against any rheumatic or gouty tendency that may possibly be present. The administration of mercury is sometimes of service. The important point in the **local** treatment is to fix the part in such a position that the muscle is put as much upon the stretch as the patient can bear; counter-irritants should then be applied over the affected area. All possible steps should be taken, by means of splints, extension apparatus, etc., to prevent contraction of the muscle during the progress of the case. This is a very difficult matter to accomplish, for, as the case goes on, the contraction leads to such pressure on the apparatus that it must occasionally be altered and thus the contraction is very apt to increase. After the inflammation has subsided, however, matters may be improved a good deal either by dividing the tense bands in the muscle itself, or by tenotomy. In order to divide the fibrous bands which run in the muscle, it is best to make a free incision down on to the latter in order to see the exact condition of affairs; if a large muscle be affected it is well to turn down a flap of suitable size. With a fine tenotomy knife everything is cut through that appears to be infiltrated or fibrous, and the healthy muscular bundles are left intact. The various incisions should be made at different levels. In many cases, however, it is better to divide the tendon instead of the muscle, because satisfactory union is more likely to take place in tendon than in the muscle. After the muscle or tendon has been divided, suitable appararatus is applied to retain the position and to guard against subsequent contraction.

**(b) Ossifying myositis.**—The ossifying form of chronic myositis occurs either as an affection limited to one muscle or group of muscles, or as an ossification of the entire muscular system.

**The localized form** may be seen in the neighbourhood of fractures, where spicules of bone radiate from the fracture into the muscles which are attached in its neighbourhood; the ossification usually commences in the tendons and extends thence into the muscle. A similar condition also occurs around joints which are the seat of rheumatoid arthritis. Apart from these conditions, however, ossification is sometimes met with in the bellies of muscles. The most common seat is in the adductors of the thigh, more especially the adductor longus, and the name given to this condition is "rider's bone." Here ossification occurs in the substance of the muscle, and may extend through it from end to end, rendering it entirely rigid, and, of course, interfering very considerably with the movement of the limb. Among other muscles which may be affected are the deltoid or the biceps cubiti in soldiers as a result of musketry drill.

The *pathology* of the condition is not clear. Some look on it as due at first to a hæmatoma in the muscle, followed by partial absorption of the blood, and a deposit of calcareous salts in the remainder, but in many cases true bone is actually formed.

*Treatment.*—When the condition is limited to a single muscle, the treatment clearly is to excise the new bone formed in it. There is no other possible method of getting rid of the trouble or of arresting its progress, and the loss of the rigid muscle does not make the patient any worse off; on the contrary, its removal allows the others to act freely once more. When the entire muscle is not involved, it is only necessary to remove the ossified portion; if sufficient healthy muscle be left the divided ends may be reunited.

**The generalized form** of ossifying myositis is fortunately not very common; it usually begins in children, especially in males. It is probably a form of neurosis resembling pseudo-hypertrophic muscular paralysis, and it probably affects the connective tissue of the muscle. It generally begins in the muscles about the spine. Whether or not the affection is a true inflammation is a matter of great doubt. For the present, however, it is more convenient to refer to it here.

*Treatment.*—Unfortunately there is nothing known that will arrest the condition. Iodide of potassium is given in 5–10-grain doses three times a day, but it is practically useless; the condition progresses in spite of treatment, affecting whole groups of muscles, and ultimately, it may be, the entire muscular system, so that the patient finally dies from exhaustion or from difficulty in breathing, repeated bronchitis, and broncho-pneumonia.

## TUBERCULOSIS.

Tuberculosis of muscles is usually secondary to tuberculosis in the vicinity: for example, tuberculous ulcers on the tongue may lead to tuberculous disease in its muscles; tuberculous abscesses in the neck very often perforate the sterno-mastoid and set up tuberculosis there. In psoas abscess, which is a tuberculous abscess extending down the sheath or in the substance of the psoas muscle, the psoas may be more or less completely destroyed by the tuberculous growth.

The **treatment** of tuberculosis of muscles is the same as that of local tuberculosis in other tissues; namely, excision if possible, or, if not, scraping and general treatment.

## SYPHILIS.

Syphilis of muscle may be met with both in the secondary and tertiary stage. In **secondary** syphilis, generalized muscular pains are not uncommon, as, for example, syphilitic lumbago, or syphilitic inflammation of the occipito-frontalis, giving rise to severe headache. In these cases the pain is more or less nocturnal, is increased on pressure, and is intermittent. These conditions yield readily to the treatment appropriate for secondary syphilis (see Part I., Chap. XII.).

**Tertiary** lesions are rarer, and consist essentially of gummata in the muscles, which may be followed by sclerosis. The **treatment** called for here is identical with that necessary for gummata in other situations, and has been dealt with in Part I., Chap. XII. If much sclerosis subsequently occur, it must be dealt with on the lines laid down for the treatment of the similar condition resulting from chronic myositis (see p. 209).

In **congenital** syphilis a painful mass is found in the sterno-mastoid muscle during the first few months of life, and this is generally looked upon as a gummatous condition. Sometimes, no doubt, these are simple hæmatomata occurring during birth, but sometimes, undoubtedly, they are tertiary lesions, and yield very readily to mercurial inunction, which is best done over the sterno-mastoid itself. At the same time internal treatment with mercury and iodide of potassium is of benefit.

## CYSTS.

**HYDATID CYSTS** are not at all uncommon; something like 2% of all cases occur in the muscles. Those most frequently affected are the adductors of the thigh, the trunk muscles (more especially those of the lumbar region), and the pectorals. The cyst is usually embedded in the substance of the muscle, and around it the muscular substance becomes thinned, degenerated, and fibrous.

The **treatment** of hydatid cysts occurring in muscles should consist in opening and shelling out the whole cyst wall. It is not necessary to take away the fibrous wall surrounding the true cyst wall, but the latter, which lies within the fibrous capsule, should be thoroughly peeled off. If this be impossible, the cyst must be freely opened and drained, and it is well also to scrape the wall.

## NEW GROWTHS.

**PRIMARY TUMOURS** of muscle are rare. The most common are the **cavernous angiomata** which occur about the masseter, the muscles of the cheek, etc. They are characterized by the presence of an enlargement of the muscle of a soft character, which increases on coughing or crying, and which disappears almost entirely when pressure is made upon it; it re-appears immediately the pressure is left off. The **treatment** for tumours of this character is electrolysis (see Part I., p. 266).

Of other primary neoplasms, **lipomata** occur within the muscular sheaths, **myxomata** are met with, and sometimes also **sarcoma.**

**SECONDARY TUMOURS** of muscle. Usually, however, tumours of muscles are secondary. They attack the muscles by direct extension, as in cases of epithelioma of the lip or tongue, cancer of the breast, stomach, etc., or they may result from metastasis.

The **treatment** of cases of this kind consists of excision, the amount to be removed depending on the nature of the tumour. For example, a lipoma may be shelled out of its sheath, while a sarcoma must be removed along with a considerable portion of the muscle around. In the case of carcinoma the whole muscle should be taken away.

# CHAPTER XVI.

## THE SURGICAL AFFECTIONS OF TENDON SHEATHS.

### INFLAMMATORY AFFECTIONS.

**ACUTE TENO-SYNOVITIS.**—The most important diseases of the tendon sheaths are the various inflammatory conditions commonly grouped together under the name of teno-synovitis. As in the analogous case of the pleura, a suppurative and an acute non-suppurative teno-synovitis are met with. The acute non-suppurative form may be further subdivided into the dry and the serous forms. Some authors again divide the dry form into two groups, namely, the dry crepitating teno-synovitis, and the plastic teno-synovitis. Thus we shall describe: (1) dry crepitating teno-synovitis; (2) plastic teno-synovitis; (3) acute serous teno-synovitis; and (4) suppurative teno-synovitis.

**(1) Dry crepitating teno-synovitis** manifests itself chiefly by crepitation on manipulation. Pain on movement is complained of, but it is not usually very acute; there may also be a certain amount of pain on pressure, and some diminution in the freedom of the muscular movements. Sometimes there is slight swelling along the course of the tendon; often there is none. Whenever the muscles contract, a characteristic soft rubbing sensation is felt, which is very similar to that experienced when two pieces of silk are rubbed one over the other; this crepitation commences on the second or third day of the affection. The condition may be symmetrical, which is more commonly the case when it affects the tendons on the back of the wrist. The disease usually runs a favourable course, disappearing spontaneously in from ten to fifteen days, but it is an affection which is very prone to recur. Adhesion of the tendon to its sheath and consequent more or less imperfect movement may occur if suitable treatment be not adopted early.

**Causes.**—The condition may result from extensive and repeated play of the tendon in its sheath, as, for example, in certain occupations. It is perhaps most common in washerwomen, in whom it occurs about the back of the wrist, the tendon sheaths chiefly affected being those of the thumb and the radial extensor tendons. It also occurs in the sheaths of the extensor tendons in pianists. It is sometimes met with also in the lower extremity after prolonged swimming or bicycling, when it usually affects the tibials, the long extensors of the toes, or sometimes the peronei. It may occur in connection with the tendo Achillis in soldiers as a result of over-marching. Rheumatism is supposed to be a predisposing cause, and, in the case of washerwomen, many attribute the occurrence more to the hands being repeatedly alternately plunged into warm water and then exposed to cold air, than to excessive use.

**Treatment.**—*Rest* to the affected limb for a week or two is usually advisable; it must not be continued longer than this, lest adhesions form and interfere with movement. In the case of the hand, the forearm and hand should be placed on an anterior splint, reaching almost as low as the knuckles, and should be carried in a sling; the thumb should be allowed to hang down by the edge of the splint, and the metacarpus should be thrown well back. *Blisters* are often of considerable value; an elongated blister (see Part I., p. 18) should be applied over the region of crepitation, and this may be repeated in three or four days; generally two applications are sufficient. When the blister has risen, it should be punctured, the fluid allowed to escape, and boracic ointment applied, while outside this *light compression* may be applied by means of a mass of wool bandaged on moderately firmly until the blister has quite healed. When this has occurred, benefit may be obtained from the use of *mercurial ointment* rubbed into the part night and morning for two or three days. As soon as the splint is left off, the patient is encouraged to move the fingers and wrist, and if there be any tendency to stiffness, *passive movement* should also be employed. These are the three essential points in the treatment during the active stage—rest, blistering, and light compression followed by early active and passive movement. If there be a rheumatic tendency, salicylate of soda should be administered in doses of five to ten grains three times a day.

(2) **Plastic teno-synovitis.**—This form of the affection is much more serious than the one just described; the effusion is greater and the tendency to the formation of adhesions is much more marked. In it a considerable quantity of fibrinous material is thrown out on the surface of the sheath, and this afterwards tends to organize and give rise to firm adhesions between the tendon and its sheath, whereby movement is seriously impeded. The origin of this condition is generally traumatic; it follows contusions, fractures about the joints, sprains, or dislocations, or it occurs after wounds and suppurations in the vicinity of the tendon sheaths. It may also, however, occur without any previous injury, in which case it is supposed to be of rheumatic or gouty origin. The plastic form is the one so common after diffuse cellulitis of the hand, whitlow, and similar affections, and here the inflammation of the tendon sheaths is secondary to the other conditions, and is not necessarily due to infective organisms.

**Symptoms.**—Pain, especially on movement or pressure, is very acute, but crepitation is not marked. From a very early stage there is consider able interference with the free movements of the tendons in their sheaths; even when the disease has lasted only two or three days it may be found that, on attempting to move the fingers, numerous soft adhesions give way, even though very slight force be employed. Later on these become organized, and increased force is required to break them down, while the power of spontaneous movement is lost.

**Treatment.**—The treatment requires great patience and endurance both on the part of the patient and the surgeon, while the ultimate result is not always as satisfactory as could be wished. From the earliest stage care must be taken to prevent the formation of adhesions, and to put the limb in such a position that if adhesions do form they can be readily broken down. For example, when the flexor tendons of the hand are affected, the hand must be in a condition of semi-flexion, because if the fingers be kept extended on a splint, passive flexion of the fingers would not help to break down the adhesions. In dealing with the hand, the best plan is to keep it in a sling, or, if the patient be confined to bed, to lay it on a pillow with the metacarpus well thrown back, and to leave the position of the fingers, at first at any rate, to nature; they will be found to assume a position of semi-flexion. At the same time, during the acute stage of the inflammation, warm *fomentations* should be applied. Important as rest is in acute inflammatory conditions, it must not be persevered with too long in these cases. At the end of a week at latest, *passive movement* of the fingers should be practised at least once a day, so as to break up the adhesions which are in process of formation; the patient should also be encouraged to move the fingers for himself. Unfortunately both active and passive motion cause intense pain, but despite this they must be vigorously persevered with.

As soon as the acuteness of the inflammation has passed off (as evidenced by the disappearance of tenderness on pressure) *massage* should be employed to promote absorption of the plastic material, while the passive and active motions should be continued. At this stage the patient can do a great deal for himself by moving the affected fingers to their fullest extent with the unaffected hand, and by trying to carry out active movement. The surgeon himself should also move the fingers completely in all directions once a day, and in this way the formation of adhesions can generally be kept under.

Where the patient is seen at a later period, and firm adhesions have formed, they should be broken down under an anæsthetic (nitrous oxide is generally sufficient) once, or even twice a week if the procedure does not produce very strong reaction; in the interval, massage, passive movement, and faradism to the muscle should be employed every day. In this way, a fairly satisfactory result may be obtained in some cases if the adhesions are not numerous. In the majority, however, whilst a certain amount of improvement will result, it is, unfortunately, by no means complete.

**(3) Acute serous teno-synovitis** may follow the dry form, or may be synovitis with effusion from the first. It is, perhaps, most commonly met with in gonorrhœal arthritis, and also in cases of ordinary rheumatism, and it more epecially affects the extensor tendons of the fingers, the long flexor of the thumb, the peronei, and the tibial tendons.

**Symptoms.**—The disease is characterized, as a rule, by pain, by interference with movement, and (especially in the gonorrhœal form) by redness and œdema of the skin. It usually gets well, but, as the fluid becomes absorbed, there is a tendency to the formation of adhesions, although not to the same extent as in the plastic form.

**Treatment.**—The treatment consists of *rest* and *fomentations*, followed by the employment of massage and movement. If the extensor tendons of the fingers be affected, the hand should be placed on a splint, with a pad in the hollow of the palm, and the fingers not quite fully extended. In the first place, the splint may extend as far as the tips of the fingers, but, as soon as the effusion begins to disappear, the splint should be shortened down to the transverse crease of the palm, so as to allow a certain amount of play to the fingers. During the acute stages, warm fomentations should be employed with a little laudanum sprinkled over them if there be much pain (see Part I., p. 12). As the fluid becomes absorbed and the acute stage passes off, compression by means of a mass of cotton wool (see Part I., p. 21) should be used. As soon as the effusion has disappeared, active and passive *movement* of the fingers must be employed and *massage* carefully carried out. Even with massage it is necessary to be careful, because if it be too vigorous, it may lead to a recurrence of the trouble; it should at any rate be tried, and may do a great deal of good.

**(4) Suppurative teno-synovitis.**—This condition is usually traumatic, and follows upon wounds involving tendon sheaths, or tenotomies that have become septic. It may also occur in scarlet fever, in pyæmia, etc., but it is most often secondary to inflammation of the surrounding parts, as in the case of a whitlow, especially one affecting the thumb or the little finger, where there is direct extension of the septic material along the sheath of the tendon. In these cases the inflammation is usually very violent, and suppuration occurs early. When the condition is very acute the tendon generally sloughs, while in less acute cases the tendon sheath and the tendon itself become covered with granulations, which subsequently lead to the formation of firm adhesions. After a time the sheath gives way, an abscess forms outside it, and the inflammation may spread to neighbouring bones or joints.

**Treatment.**—In a case of suppurative teno-synovitis the sooner the sheath is laid freely open the better; in fact, in the very acute form *early incision* presents the only chance of preserving the vitality of the tendon. If the opening of the abscess be delayed, the tendon will certainly slough, and irretrievable damage will result; as soon, therefore, as the condition is recognized, free incisions should be made into the tendon sheath, the pus washed out with a 1-4000 sublimate solution, and a drainage tube introduced. The free exit of the pus is so important that the surgeon should not hesitate to lay the sheath very freely open.

When the tendon sloughs, the part is irretrievably damaged, and the separation of the dead tendon is often extremely slow; when death of the whole tendon right up to the muscle occurs, the separation is more rapidly effected, but when only a portion sloughs it may be months before the dead part is got rid off, and, as there can be no hope of the tendon being of use subsequently, matters may be materially shortened by cutting it away as soon as the surgeon is sure that it has necrosed—as will be indicated by its ragged and greyish appearance; if a little too much be taken away, no particular harm is done. When the tendon of a finger is affected it may save time if amputation be performed at the same time.

When sloughing does not occur, *active and passive movement* should be begun as soon as the wound begins to heal, and should be persevered with daily; it is not necessary to wait until the wound has quite healed before commencing it. It should be remembered that in these cases the tendency to adhesion is even greater and the resulting adhesions firmer than in the plastic form, and very great patience and self-denial must be exercised by the patient, if anything like a satisfactory result is to be obtained. The result of abandoning passive movement prematurely will certainly be that permanent and irremediable uselessness of the part will ensue.

During the acute stage the patient suffers from severe inflammatory fever, and the appropriate treatment for this condition (see Part I., Chap. I.) must be employed. Stimulants should be given if necessary, and the patient put on liquid diet, and then, as the temperature falls, nourishing food and fresh air are the chief requisites. When the upper extremity is affected the patient need not be confined to bed after the acute inflammatory symptoms subside.

**CHRONIC TENO-SYNOVITIS.**—This affection is generally serous, and may follow on the acute form, or it may occur as the result of rheumatism or of excessive use, as, for example, in various trades. Chronic serous teno-synovitis is most often seen in the hand, where it chiefly affects the common palmar sheath; it also occurs in connection with the popliteus and certain other muscles.

**Symptoms.**—The tendon sheath becomes slowly distended with serous fluid, without any marked pain or interference with movement at first, and the patient may only become conscious of the trouble when the distension has become considerable. In the case of hygroma of the common palmar sheath a swelling forms in the palm, and the fluid extends beneath the annular ligament into the forearm, where it forms a second swelling, and fluctuation between the two can generally be readily obtained. The fluid is limpid and straw-coloured, and the tendon sheath is smooth and not materially thickened.

A second form however occurs, probably in connection with rheumatism, in which the tendon sheath becomes much thickened and covered with villous outgrowths. This condition resembles that sometimes found in rheumatoid joints, where the synovial fringes become hypertrophied, a condition which is known as "lipoma arborescens." In these cases the chances of getting a good result without an extensive operation are comparatively slight. Many cases of chronic teno-synovitis are, however, tuberculous in nature, and in these the fluid is scanty and turbid, and very often contains rice-like bodies, and there is thickening of the wall of the sac. There is then much more pain and stiffness, less marked fluctuation, tendency to the formation of abscesses, and other signs of tuberculosis. We shall describe this affection separately.

**Treatment.**—**(a) Simple chronic teno-synovitis.**—Where there is limpid fluid and the wall of the sheath is not thickened, the best treatment is to *open the sac antiseptically and drain it;* this will usually suffice to effect a cure. An incision is made into the sac above the annular ligament, and a drainage tube is introduced, and pushed beneath the ligament into the palm. In a simple teno-synovitis it is not necessary to make an opening into the palm as well. Of course an operation of this kind must be conducted with careful antiseptic precautions; unless this can be done, drainage should not be adopted, for, as has been said, tendon sheaths are essentially liable to septic inflammation of an exceedingly dangerous character, leading not only to sloughing of the tendon and abscesses along its sheath, but often to general septic poisoning. If, however, the surgeon be sure of his asepsis, drainage is by far the most satisfactory method of treatment.

The question as to the length of time during which drainage should be employed is a little difficult to answer; it is necessary to be guided by the amount of discharge present. In most cases the tube may be removed in from ten to fourteen days, but, if the discharge be considerable, that is to say if there be several drops of fluid in the course of twenty-four hours and the dressing be stained over the area of a two-shilling piece or more, the drainage should be continued. As soon as the stain on the dressing does not exceed the size of the orifice of the drainage tube, and does not extend deeply through the layers of the dressing, it may be considered that the tube has done its work.

While drainage is being carried out, the arm should be supported in a sling; a splint is not usually called for. It is of course necessary to put on a large dressing, which is applied not only around the forearm and wrist, but also made to fill up the whole hollow of the hand, so that by means of the dressing alone the limb is really kept quite at rest; if it then be carried in a sling there will not be enough movement to interfere with healing. The fingers must not, however, be confined for too long, and, whether drainage is being continued or not, they should be left free for active movements after ten days, and should be moved passively at intervals. If there be no adhesions the patient may move them himself, but if adhesions have formed they should be broken down by means of passive movement, which should be employed, if necessary under a general anæsthetic, every two or three days at first and more frequently later on. After the drainage tube has been removed, the small incision will heal in the course of a few days, and in most cases there will be no recurrence of the effusion.

Whenever for any reason this method is deemed inadvisable, or when the patient objects to an incision, the next best method of treatment is to *puncture the sac*, withdraw the fluid, *and inject tincture of iodine*. The aspirating needle or trochar and cannula must be boiled for 15 to 20 minutes, or immersed in a 1-20 carbolic acid solution for a considerable time prior to use, and the syringe must also be thoroughly disinfected by the same solution. The cannula is inserted into the sac above the wrist, the fluid drawn off, and then tincture of iodine is injected, as in the case of hydrocele of the tunica vaginalis. The best preparation of iodine to use is the Edinburgh tincture, which is stronger than that of the British Pharmacopœia, the quantity employed being about half a drachm, which is left in the sac. It is not desirable to set up too much inflammation in the cavity, as otherwise adhesions would be very apt to form. The hand should be placed on a splint and kept at rest for about ten days, fomentations being applied if there be much swelling or pain. Afterwards massage and movement should be employed, as in the other cases.

**(b) Villous teno-synovitis.**—In the other form of chronic teno-synovitis, where there is a villous condition of the sheath resembling "lipoma arborescens," it is seldom that anything short of excision of the tendon sheath will arrest the effusion. As a preliminary measure, removal of the fluid by a cannula and injection of iodine into the cavity may be resorted to; in some cases the villous projections become adherent to the wall, and the surface to a considerable extent loses its roughness, but in most cases, as has been said, *excision* must be employed. In hygroma of the wrist this operation is one of considerable difficulty. In order to perform it a free vertical median incision must be made from the lower third of the forearm, above the swelling, to the middle of the palm of the hand, the annular ligament divided, and the sheath carefully cut down upon. The parts are held aside with retractors, and the tendon sheath is clipped away wherever it shows the villous condition. The annular ligament is then stitched up with catgut and the wound closed, a drainage tube being used for some days. Subsequently massage and movement are commenced and carried out as already described.

**TUBERCULOUS TENO-SYNOVITIS.**—This affection is met with in two forms, one in which the tendon sheath is greatly distended and filled with loose bodies, the so-called "rice bodies," and the other in which the chief change is thickening of the wall of the sac without much effusion into the cavity, a condition corresponding to the thickening of the synovial membrane of joints.

**(a) Teno-synovitis with "rice bodies."**—The first form, viz., that in which the synovial sheath is distended and filled with rice-like bodies, was at one time looked upon as simply a chronic teno-synovitis, but it is now known to be of a tuberculous nature. In addition to the presence of a small quantity of turbid fluid, which is sometimes indeed sero-purulent, and the presence of these rice-like bodies, the sheath itself is thickened and irregular, with fibrinous or cheesy material and "rice bodies" adherent to its surface. The latter vary in size from the head of a pin to a pea, they are smooth and flattened, and are usually somewhat ovoid in shape. The condition may co-exist with disease of a neighbouring joint, but it more often occurs alone. The most usual situation for the affection is in the common flexor sheath in front of the wrist; it may also occur on the front of the fingers or at the back of the wrist, in the sheath of the peronei tendons and the extensors of the foot. Active work seems to predispose to the condition.

**Symptoms.**—The most noticeable signs of this condition are the rubbing of these bodies against each other, the presence of a certain amount of dull pain, increased by pressure, and an indistinct sense of fluctuation. The presence of the rice bodies is very noticeable where there is a constriction in the sac, as for example on the palmar surface of the fingers, where one part of the distended sheath is in front of the phalanx, and the other part is in front of the metacarpal bone. On pressing the contents from one part into the other the crepitant feeling of the rice bodies as they pass through the constricted portion is quite evident; this is also well marked in the case of the hygroma in front of the wrist.

The **prognosis** is very grave. The disease is apt to extend from the sheath to the tendons themselves and destroy them, and, apart from local troubles such as adhesion and suppuration, the disease is likely to become general or to extend to neighbouring bones or joints.

**Treatment.**—The best method of treatment is to make a *free incision* into the tendon sheath, and to evacuate all the rice bodies. The cavity should then be scraped with a sharp spoon and washed out with a 1-4000 sublimate solution, and a small quantity of a 10% emulsion of iodoform and glycerine (see p. 184) injected. The cavity is filled up with the emulsion, and while it is welling out, the incision in the skin is stitched up by a continuous suture; no drainage tube is required. In a good many cases the trouble subsides after this treatment, but if there should be recurrence the operation must be repeated; in fact the treatment is the same as that recommended for tuberculous chronic abscess (see Part I., p. 249).

In the case of hygroma of the wrist extending into the forearm, two incisions should be made, one above and one below the annular ligament. The contents of the sac should then be completely evacuated, the cavity filled up with iodoform and glycerine and the skin wound stitched up. Of course all these operations must be done with strict antiseptic precautions. The hand should be kept on a splint for several weeks, passive movement being carried out once or twice a week.

When this method does not succeed, the sheath must be dissected out as completely as possible in the manner described below for the treatment of the second form of tuberculous teno-synovitis. Formerly various other methods, such as compression or the injection of iodine, were employed, or in some cases of hygroma of the wrist the cavity was drained antiseptically after splitting the annular ligament; but none of them are as satisfactory as the one just mentioned.

**(b) Teno-synovitis without "rice bodies."**—In the second form of tuberculous teno-synovitis the synovial membrane is much thickened and pulpy, and this condition is often secondary to diseases of bones or joints in the neighbourhood, or to chronic abscesses, though sometimes it is a primary affection.

The patients are usually young adults from 18 to 25 years of age, and the tendon sheaths chiefly affected are those about the hand and instep. In the hand the common sheath of the flexors, or those of the fingers or thumb are most often affected; the sheaths of the extensors are also frequently attacked. The disease generally begins in the tendon sheath, and may be confined to it for a considerable time, but the tendon often becomes affected eventually, and may ultimately be completely eaten through by the granulation tissue. Abscesses frequently form, make their way to the skin and burst; in other cases the disease may extend to the joint over which the tendon passes.

The condition may follow upon some previous inflammation, or may come on insidiously, and in the latter case the first thing that the patient usually notices is difficulty in movement and the presence of a diffuse, ill-defined, soft swelling parallel with the tendon; in some situations, as for example at the front of the wrist, this swelling may be hour-glass in shape. The mass is movable laterally along with the tendon, but not longitudinally. It is elastic and semi-fluctuating, but unless there be actual suppuration true fluctuation is absent. The movements of the tendons are impeded, and later on there will be contraction of the fingers, or even solution of continuity of the tendons.

**Treatment.**—**Operative.**—*Excision* of the affected sheath or sheaths is by far the best treatment. This of course must be done strictly antiseptically, and the operation required is usually an extensive one. The treatment must be as thorough as in the case of an arthrectomy for tuberculous joint mischief. The incisions must be so planned that the sheath or sheaths are fully exposed over the whole of the affected area. In the case of the extensor tendons, for instance, a flap with its convexity

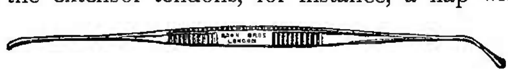


FIG. 77.—GLAND SEPARATOR OR FINE DISSECTOR. One end is a very fine dissector with which delicate work, such as the separation of the tendon sheath from the surrounding parts, can be easily done; the other is bent and is probe pointed and serves to pull aside the structures thus isolated.

to one side is raised from the back of the hand so as to expose the whole swelling. The tendon sheath is then carefully isolated from the surrounding parts, and the whole of the disease is cut away with scissors or the knife.

This is usually comparatively easily done; the chief essential for success is to isolate the whole of the affected area from the healthy tissues before opening and clipping the sheath away. By means of a blunt periosteum detacher or a gland separator (see Fig. 77), the tendon sheath is easily isolated, and the deeper part especially so freed that it can be lifted up from the subjacent tissues. The tendon sheath is then divided by two circular incisions, one well above and the other well below the limits of the disease, and the affected portion is incised vertically from one circular incision to the other; this lays the sheath fully open, and the whole of the diseased portion of the sheath can then be removed in one piece (see Fig. 78). After removal of the sheath the tendon should be examined to see whether it be affected, and if any soft points be found, they should be thoroughly scraped out. The skin flap is then laid down and stitched in place, and, if the operation has been done antiseptically, the wound heals by first intention, and the result is remarkably satisfactory.

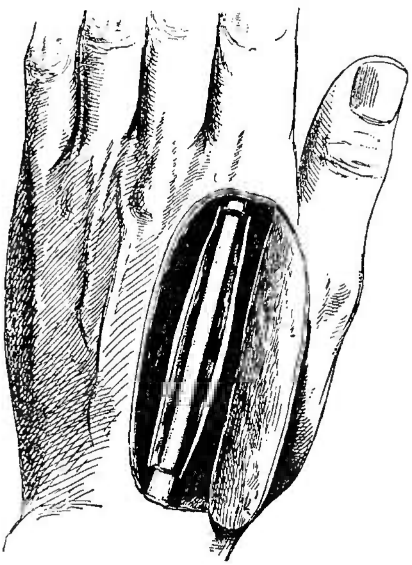


FIG. 78.—METHOD OF EXCISION OF A TENDON SHEATH. To illustrate the description of the operation in the text. A flap is thrown back, and after the sheath has been isolated from the surrounding structures, it is divided circularly well beyond the limits of the disease. A longitudinal incision joining the two circular ones then allows the whole of the affected portion to be removed as a flat ribbon-like mass.

*After-treatment.*—After the operation the hand is placed on a splint with the fingers somewhat flexed and kept at rest until the wound has healed. The first dressings may generally be removed and the stitches taken out in ten days, when a collodion dressing is fixed on, the splint left off, and the patient encouraged to practise active movements; passive motion is employed once or twice a week for several weeks.

We have had the opportunity of treating several cases of this kind, and have been very much surprised at the ease with which movement is regained. There is not nearly the same difficulty in obtaining free movement, nor is there the same tendency to adhesion to surrounding parts as there is in cases where the tendon sheath is intact, and where the surgeon has to do with plastic teno-synovitis; indeed the difference is so great that it has occurred to us that in cases of plastic teno-synovitis limited to a few tendons removal of the sheath might also be the best practice. The tendon moves freely in the cellular tissue, and very soon a sort of sheath is re-formed around it. If recurrence of the tuberculous affection take place, the operation should be repeated; as a rule the recurrence is at the upper or lower end of the incision, where a sufficient amount of the sheath has not been removed at the first operation. When the affection is situated in the palmar bursa, the operation is performed in a similar manner, the annular ligament being split as already described on p. 219, and the tendon sheath dissected out.

Short of this, which is by far the best method of treating these cases, the next best plan is to *scrape* away as much of the tuberculous material as possible, and to inject iodoform and glycerine emulsion. If it be not desirable to give an anæsthetic for the purpose, a hypodermic needle may be introduced into the cavity, any fluid that is present drawn off, and the emulsion then injected without withdrawing the needle.

**The non-operative methods** of treatment which may have to be employed in some cases are very unsatisfactory. They consist in *fixation* of the part on a suitable splint for a very prolonged period. Simultaneously, *firm pressure* should be applied by means of a large mass of cotton wool wrapped around the limb with a bandage stiffened with gum or starch outside it. In the hand, for example, the limb is fixed on a splint with the fingers in a semi-flexed position, the metacarpus extended, and the thumb hanging down over the side of the splint, and not applied closely to the forefinger lest stiffness occur, when the power of opposition of the thumb to the fingers would be lost. The starch and cotton wool bandage is then firmly applied. At the same time the patient should be placed under the best hygienic conditions obtainable; he should, if possible, be sent to the country, and cod-liver oil and a plentiful nourishing diet should be administered. The results, however, are usually very unsatisfactory, and unless some radical treatment be employed, the condition is likely to become complicated with disease of a neighbouring joint.

When a case of this kind is complicated with joint or bone disease, the chances of eradicating the mischief, either by expectant or by operative treatment, are comparatively small. Expectant treatment is almost certain to lead to disappointment, whilst operative treatment will generally require to be too extensive to be feasible. When both the joint and the tendon sheaths lying over it are diseased, it would be necessary not only to dissect away the tendon sheath, as already described, but also to perform arthrectomy of the joint; between the two, the chances of eradicating the disease, on the one hand, and of obtaining a useful limb, on the other, are very remote. An operation of this nature will also of necessity be a very prolonged one, and the patient will be exposed to the danger of severe shock. In most cases, therefore, where well-marked disease of a joint co-exists with that of the tendon sheaths over it, *amputation* is the best practice. It is only when the disease in the joint is in quite an early stage and when the tendons involved are few in number that it is possible to content oneself with dissecting out the tendons sheaths and fixing the joint. But when the disease is extensive, and more especially when abscesses have formed in connection either with the sheaths or the joint, some radical operation such as amputation is necessary. Further, it must be remembered that in these cases of tendon sheath disease, there seems to be a special liability to the occurrence of phthisis, and unless something radical be done, the patient is very apt indeed to develop lung trouble.

**SYPHILITIC TENO-SYNOVITIS.**—Syphilis affects the sheaths of tendons in the same way as it attacks the synovial membrane of joints. In the *secondary period* of the disease the tendon sheaths, especially in the neighbourhood of the joints, are apt to be affected with a form of serous synovitis. The condition is chronic, but it yields very readily to anti-syphilitic treatment (see Part I., Chap. XII.). In the *tertiary stage* gummata may form in connection with the tendon sheaths, but they are very rare. The treatment is, of course, that appropriate for tertiary syphilis.

## NEW GROWTHS.

New growths in connection with the tendons and tendon sheaths are very rare. Myxoma, fibroma, and sarcoma may occur as primary growths, and their treatment is removal according to the circumstances of the case.

## GANGLION.

The only other condition which need be referred to in connection with tendon sheaths is that known as ganglion. By this term is understood a sac, usually comparatively small and containing a glairy fluid, whose wall resembles in structure the tendon sheath to which it is attached. They generally occur in connection with tendons which are over-used. In pianists they are very common on the back of the wrist; in needle-women, about the thumb and the wrist. They form hard tumours which move laterally with the tendon and vertically also when the fingers are moved. Ganglia may also occur in connection with joints; this variety is most often seen about the wrist, where they communicate directly with the synovial cavity. In this form the sac is very often multiple, whilst in those connected with the finger tendons it is usually single.

**TREATMENT.**—The simplest method of treatment is to burst the ganglion by pressure, and so disperse its contents into the cellular tissue, and by subsequent pressure to effect an obliteration of the cavity. This may sometimes be readily done when the wall of the sac is thin, and good pressure can be made against the subjacent bone. Forcible pressure is applied to the swelling by one or both thumbs, which squeeze the ganglion against the bone; if sufficient pressure be exerted, the ganglion is suddenly felt to give way. The compression is maintained, and the part kneaded until the whole of the contents of the sac have been pressed out into the cellular tissue. A pad in the form of a graduated compress is then applied, a piece of lint about the size of the ganglion being first placed over the spot, a somewhat larger piece outside, and then one larger still, until a sufficient amount has been put on to enable the bandage to get firm hold, and thus to apply effectual pressure; outside the last layer of lint may be placed a penny, or a piece of metal or wood of about that size. The object of this is to press the walls of the sac together, in the hope that they will adhere. The bandage is left on for about a week, and then nothing further is necessary. If the ganglion be cured, there will be no further trouble; if not, it will re-fill. This treatment is successful in a considerable number of cases, and it should be tried as a first measure.

If the ganglion re-fill after rupture, or if the sac be too firm to give way on pressure, the best procedure is to take a small tenotomy knife, and, after purifying it and the skin, to puncture the latter at a little distance from the ganglion, make the knife penetrate right across the sac to the wall on the opposite side, and then to cut horizontally to one side so as to divide the ganglion. The tenotomy knife is then withdrawn, and the contents of the sac are squeezed out; a small quantity often oozes through the tenotomy wound whilst the rest is dispersed into the cellular tissue. Of course the anatomical distribution of vessels and nerves in the vicinity must be borne in mind whilst performing this small operation, and in some situations, for this reason, the method cannot be employed. It is important to remember that if the sac wall be merely punctured, the ganglion will re-fill; a wide opening must be made so that the contents are freely evacuated into the cellular tissue around. After the knife is withdrawn, collodion is painted over the skin puncture, and a pad and bandage are firmly applied over the seat of the ganglion in the manner just described, and this is left on for about a week.

In some cases the ganglion persistently re-fills after rupture or tenotomy, or in others it may be so situated that it can neither be ruptured nor safely divided with a tenotome, on account of the relation of the vessels, etc. Apart from these, the case may be one of compound ganglion, in which one compartment has been evacuated, but others remain, and afterwards increase in size. In all these cases it is best to dissect out the sac. A curved incision is made over the swelling, of course with careful antiseptic precautions, a flap turned aside, the ganglion exposed, and its wall isolated with a dissector and cut away. In doing this the sheath of the tendon is naturally opened, and, when the ganglion communicates with a joint, the articular cavity also; but if the operation be done antiseptically, no trouble results. The wound is then stitched up and antiseptic dressings are applied; as a rule it is not necessary to put on a splint. After a few days active and passive motion is begun, but there is very little tendency for the tendon to adhere to its sheath.

*Summary of treatment.*—The treatment, then, of ganglion in the order of severity of the procedures is rupture by simple pressure, division by means of the tenotomy knife, and excision. The choice must depend on the circumstances of the case, more especially on the situation of the ganglion, the firmness of its walls, and the question whether it is compound or not; those connected with joints are usually compound.

# CHAPTER XVII.

## THE SURGICAL AFFECTIONS OF TENDONS.

### TRAUMATIC AFFECTIONS.

THE injuries of tendons which require consideration are division through an open wound, subcutaneous rupture, and dislocation. The treatment of these will vary according as the case comes under notice directly the injury has occurred or as it is seen only after the lapse of considerable time.

**DIVISION OF TENDONS.**—The effects of injuries of the tendon sheaths have been described in the preceding chapter, and we shall only consider here the question of division of tendons. Injuries accompanied by divisions of tendons usually occur about the hand or the forearm, and the tendon may be divided transversely or obliquely.

(a) **Recent injuries.—Symptoms.**—The immediate results of division of a tendon are loss of movement in the parts to which the tendon is attached and separation of the divided ends. This separation is entirely due to the retraction of the upper end caused by the contraction of the muscle from which the tendon takes its origin. The degree of separation depends partly on the anatomical arrangement of the tendon and partly on the length of the muscle; the longer the muscle, the greater will be the retraction. As regards the first point, some tendons have accessory connections with bones, or junctions with other tendons, and cannot therefore be drawn up even though completely divided. For instance, in the tendons of the extensor communis digitorum, there are fibrous bands passing between the three inner tendons which prevent any marked degree of retraction of the divided ends. In the tendo Achillis there are bands running from the tendon to the bone above its main point of insertion, and these serve to keep the tendon more or less in position, if the wound be close to its insertion; on the other hand, if the division occur more than an inch above that point there are no restraining bands of this kind, and there may be very marked separation, a gap of as much as an inch and a half being sometimes left between the divided ends.

When a tendon has been divided, and the ends remain in fairly close apposition, the interval between them becomes filled up with clot, and, provided that there be no suppuration, young fibrous tissue forms between the ends in about a fortnight; in five or six weeks this will be dense and able to bear considerable strain, and ultimately it comes to closely resemble the normal tendon in structure. Apart from asepsis, the probability that a divided tendon will unite without surgical assistance depends to a great extent upon the particular tendon involved. For instance, the tendo Achillis unites much more readily than the flexors of the fingers, when they are divided within their synovial sheaths. In the latter case, if the ends of the tendon be not brought close together, they very quickly contract adhesions to the sheath, and their action is much interfered with, and may be entirely lost.

**Treatment.**—When a tendon has been divided in an open wound, the patient should be placed under an anæsthetic as soon as possible, and steps taken (see Part I., p. 184) to *render the wound aseptic*, because proper union will not take place should suppuration occur, even though the divided ends be brought into apposition. If the soft parts only be injured, it is better not to apply undiluted carbolic acid to the wound, unless the latter be extremely dirty, because necrosis of the ends of the tendons might result, and thus interfere with satisfactory union.

**Primary tendon suture.**—The next point is to stitch the divided ends together; if they be merely approximated, and not directly united, the result is seldom satisfactory. The ends of the tendon will almost certainly unite with the scar tissue, and, even if this do not occur, the lymph thrown out between the ends will not organize properly, and the function of the tendon will be more or less completely destroyed. The first important point is to find the divided ends; it is usually fairly easy to find the distal end, but the proximal one often offers considerable difficulty. The description of the various steps of the operation for tendon suture will be much facilitated if we take as an example a case of transverse division across the front of the wrist. If the lower end of the divided tendon be not lying exposed in the wound, it will readily come into view on flexing the fingers and the wrist. When the cut end appears in the wound, it should be seized with a pair of tenaculum forceps, which are left on, so as to make sure that it does not again escape. The upper end is, however, difficult to find, because at the time of the accident the muscle usually retracts very markedly, and the tendon is often drawn up a long way within its sheath. The simplest way to expose it is to squeeze the belly of the muscle forcibly downwards after flexing the elbow joint fully; in many cases it is thus possible to bring the tendon gradually into reach, so that it can be seized with a pair of catch forceps and pulled well down into the wound.

If this plan be unsuccessful, the tendon may sometimes be brought into view by extending the other fingers; in other cases, it may be necessary to extend the incision upwards, and lay open the sheath until the divided end is reached. Where, however, the slitting-up of the sheath would be likely to involve danger to important structures, an alternative procedure that answers equally well may be employed. A second incision is made over the tendon, well above the wound, and the sheath opened; from this incision the tendon is pushed down until its divided end appears in the original wound. In one or other of these ways it is generally possible to get hold of the two ends, which, in a recent wound, may be brought into apposition without any undue tension by relaxing the parts (in the example before us, by fully flexing the fingers, the wrist, and the elbow).

The next point is to see that the divided ends are clean cut; if they be ragged, a clean section should be made with a sharp knife through each of them. The ends are then stitched together. If an ordinary interrupted suture be passed between the ends, the thread (as in the case of muscles) simply separates the fibres of the tendon as it is tightened and cuts its way out directly. The best plan is to pass the needle across from front to back through the whole thickness of the tendon quite to one edge of it and close to the line of division, and then to tie the thread over the small piece of tendon included in the loop (see Fig. 79. *A*). Although the piece of tendon below the ligature may possibly die, a secure hold is thus obtained, which may be pulled upon firmly without fear of the thread cutting its way out. The same procedure should be adopted also on the opposite side of the tendon, and both the upper and lower ends should be prepared in this way, care being taken that the stitches are inserted at exactly corresponding points in the two ends, so that the tendon is not twisted when they are tied together. The ends of the corresponding threads on either side of the division are then tied together sufficiently closely to bring the two cut surfaces into apposition (see Fig. 79. *B*). It is well in addition to put in one or two stitches in the centre to reinforce the lateral ones; these will prevent the cut surfaces from becoming displaced laterally or curled up, and as they do not bear any strain they may be inserted in the ordinary manner.

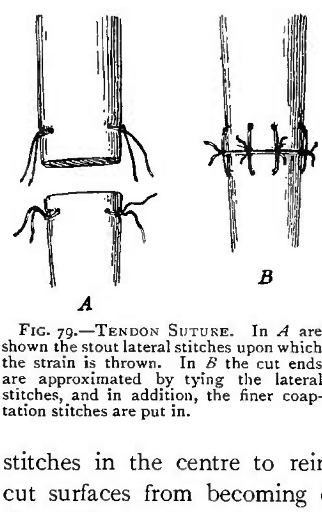



FIG. 79.—TENDON SUTURE. In *A* are shown the stout lateral stitches upon which the strain is thrown. In *B* the cut ends are approximated by tying the lateral stitches, and in addition, the finer coaptation stitches are put in.

The best material for uniting tendons is fine fishing gut. This should not be the ordinary salmon gut, which is used for stitching the skin, but specially fine threads which are prepared by some instrument makers for stitching up wounds in the coats of the intestine. It is better, however, to use the finest chromic catgut for the centre stitches, as it is naturally desirable that they should be absorbed after a time.

When several tendons are divided in the same wound it is necessary to make sure that the two divided ends belong to the same muscle before they are united; if there be any doubt, the muscle in question can be made to contract by applying the Faradic current to it; the tendon thus acted upon is then easily identified.

After the tendon has been united, the wound should be stitched up carefully so as to get union by first intention over the spot at which the division has occurred. If necessary, a catgut drain may be placed in one corner of the wound so as to avoid the possibility of its becoming distended with serum or blood, which would materially interfere with union. When the wound is very dirty when first seen, a drainage tube should, however, be employed. The ordinary antiseptic dressings are applied, and the limb is fixed on a splint in such a position as to keep the tendons fully relaxed. In the case of a wound on the front of the wrist, the upper arm, forearm and hand may be fixed in a trough of poroplastic material or gutta-percha, which is moulded to fit the limb, whilst the elbow, fingers, and wrist are kept fully flexed.

*After-treatment.*—This position of extreme flexion may be gradually relaxed by taking off the splint every two or three days, and increasing its angles slightly each time. In about a fortnight the patient should be encouraged to move the fingers, and gentle passive movement may also be begun. By that time it will be found that, on stretching the fingers, some adhesions have formed, but they are soft, and readily give way. It is of course essential not to use force enough to tear through the union in the tendon, but where the stitching has been done according to the plan recommended above, there is not much fear of such an accident. From this time onward, constant movement of the fingers by the patient himself, and the employment of passive movement once or twice a day, gradually increasing in range and length of time, must be regularly employed. Very considerable movement and sometimes complete restoration of function will result if this treatment be carefully and assiduously carried out.

(b) **Old injuries.**—When a considerable time has elapsed after the receipt of the injury and union has not occurred, it is often extremely difficult to secure a satisfactory result, whether there was in the first instance an open wound or a subcutaneous rupture. The only possible chance of doing so here lies in operation, but even then there is often great difficulty in finding and bringing the divided ends properly into apposition.

**Secondary tendon suture.**—The following is the best method for these cases; for purposes of illustration we shall take division of a tendon in front of the wrist, where no union has resulted, and where the ends of the tendon are not even adherent to the scar. An incision should be made directly in the line of the tendon; if there be no scar tissue, it is well to make it curved, so that the incision in the skin and fascia does not correspond to the point in the tendon at which suture is to be practised (see Fig. 80); there will then be no adhesion between the line of suture and the scar. Very extensive dissection is often required to expose the divided ends. In the example we are considering, the lower portion of the tendon will be behind the annular ligament, possibly in the palm, and the upper one will be some considerable distance up the sheath; both ends will be firmly adherent to the structures in their immediate neighbourhood. Hence it is evident that the ends can only be found by a free dissection. The search for the upper end is greatly facilitated by prolonging the skin incision upwards, so as to expose the lower end of the belly of the muscle; by following this down, the tendon may be found. The sheath is next opened, the tendon freed from any adhesions it may have contracted, and enough of the free end removed to provide a freshly-cut surface. The distal portion of the tendon must next be sought for and treated in a similar manner. In the example before us it is very difficult to find the end behind the annular ligament, but if the end of the tendon cannot be got at, a better plan than dividing the ligament is to cut into the palm and expose the tendon well on the distal side of the division; then, by pushing a probe up the sheath, the point at which adhesion has taken place may be found and an attempt made, by pushing the probe upwards through the adhesions, to make it protrude into the wound and form a guide along which the tissues can be turned aside until the end is got at. When this is secured and the adhesions freed, it is always possible to pull the tendon up into the wound, because the distal end has not undergone shrinking; the interval between the divided ends is due to contraction of the muscular fibres, and therefore the shortening only affects the proximal portion.


FIG. 80.—FLAP FOR OPERATIONS UPON RUPTURED TENDONS. The incision *ab* marks out a flap which, when turned back, exposes the cicatricial tissue between the ends of the tendon (shaded in the diagram) well away from the line of division of the skin.

(*a*) *The flap-method.*—When the free end of the distal portion has been brought into the wound, it must be prepared in a manner similar to that employed for the proximal portion, and the next point is how to bring the two ends properly into apposition. As a rule this cannot be done by the method recommended for recent cases, as the shortening of the muscle does not allow of the ends being brought into apposition without danger of the stitches cutting out. Various plans have been suggested to overcome this difficulty. The simplest is to split the proximal end of the tendon and turn a piece down so as to make it sufficiently long to meet the distal portion without undue tension. This may be done by making a transverse incision at a distance of from one to two inches above the free end of the proximal portion of the divided tendon, according to the amount of shortening present. This incision only goes half way across the tendon, and from this point the latter is split vertically downwards along the middle line as far as can be done without completely detaching the flap; in other words the incision is carried to within a quarter of an inch of the divided end (see Fig. 81. *A*). A flap is thus turned down, but, as it would easily become completely separated if any strain were put upon it, it is well to insert one or two catgut stitches between the sides of the vertical incision at its lower end where the tendon might split, and tie them tightly, thus giving strength to the now elongated structure. If now the tendon be long enough, the flap which has been turned down should be stitched to the distal portion in the manner already described (see p. 228), the various joints of the hand and fingers being fully flexed to obviate tension. In long-standing cases it is often necessary to turn up a similar flap from the distal portion also; if this has been done it is well to make the two flaps longer than necessary so that one overlaps the other. One or two fine catgut stitches between the adjacent sides will then give an extremely satisfactory union (see Fig. 81. *C*).

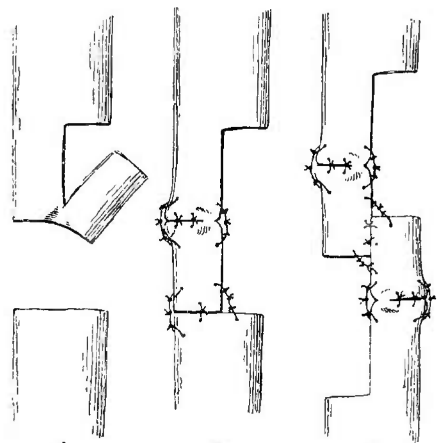



FIG. 81.—METHODS OF APPROXIMATING THE DIVIDED ENDS OF A TENDON. The splitting off of the flap is shown in *A*; in *B* the flap has been turned down into the interval and sutured in position. *C* shows a method that may be used when the gap between the divided ends is too wide to admit of the first method.

*After-treatment.*—This will be much the same as that already described for cases of recent injury. The wound is stitched up and healing by first intention is aimed at. The parts at first are kept fully flexed, and then the joints are gradually extended; at the end of a fortnight active and passive movements are begun with a view of preventing adhesions. Greater care must of course be taken when the tendons have been lengthened, lest the flap of tendon should be torn away altogether; but that danger is to a great extent minimized by putting in lateral stitches below in the manner already described.

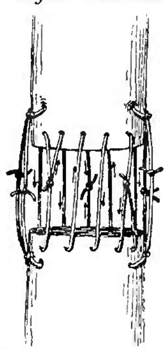


FIG. 82.—METHOD OF BRIDGING A GAP BETWEEN THE ENDS OF A TENDON BY CATGUT. The lateral stitches which draw the ends together as near as possible are seen on either side. The gap between is then bridged in by catgut sutures as shown in the diagram; the arrows show the direction in which the needle is passed.

(*b*) *Bridging with catgut.*—Cases, however, occur in which this method is insufficient, and various others may be adopted. A plan which occasionally yields fairly good results when there is a long tendon enclosed in a sheath, is the following (see Fig. 82). After the ends of the tendon have been freed, they are approximated as much as possible by the lateral stitches already described (see p. 228). A long piece of catgut is then taken and the needle passed backwards and forwards from one end of the tendon to the other several times, so that the gap between the divided ends is bridged by a number of catgut strands; while this is being done, the parts are relaxed and the wound is then closed. The result is that lymph and blood are poured out amongst the catgut threads, the lymph and the catgut itself become organized, and in some cases a fairly satisfactory tendon has resulted.

In these cases, as in the others, it is well to gradually reduce the flexion of the limb, and after two or three weeks active and passive movements may be commenced. There is no likelihood of the stitches cutting through at all quickly. Possibly the small tag of tendon on either side will ultimately die, but the separation of the piece, if it occur at all, is a matter of a very long time, provided that the wound be aseptic.

(*c*) *Transplantation.*—Again, transplantation of tendons has been attempted. A piece is completely split off from a neighbouring tendon and stitched to each end of the one divided; or the tendon of one of the lower animals may be employed in a similar manner. In tendons, however, the blood vessels are too few for the new piece to become quickly vascularized in the same manner as a skin-graft, and thus the plan really acts in very much the same way as the strands of catgut just described. It is hardly likely that the detached portion of tendon will retain its vitality; it probably only serves as a guide for the new tissue and as pabulum for the cells to eat away. Further, on account of its thickness and size, it is less likely to be quickly eaten up and replaced than is catgut, and it is therefore very apt to act as a foreign body. Where transplantation is employed, lateral stitches holding the two ends of the original tendon in position, and also giving support when the period of passive motion arrives, must, of course, be inserted.

(*d*) *Implantation.*—When it is impossible to reconstruct the tendon by one of these methods, a certain amount of restoration of function may sometimes be obtained by attaching the distal end of the divided tendon to a neighbouring sound one. For example, when one of the tendons of the flexor profundus digitorum has been divided and a considerable portion of it has been lost by sloughing or otherwise, the remaining portion of its lower end should be defined and refreshed; the side of the neighbouring uninjured tendon of the same muscle should then be made raw, and the two tendons are united laterally by fine catgut stitches (see Fig. 83). Another way of carrying out the same procedure is to split the healthy tendon, and, after paring the distal end of the divided one, to insert the latter between the two halves of the split tendon and stitch it in place (see Fig. 84); this is a rather more certain method than the preceding one. The fingers must of course be fully flexed so as to relax all tension during union. If successful, the result of the operation is that when the muscle contracts it pulls not only on the uninjured tendons, but also on the newly attached one, and as the function of all four tendons is the same, a uniform flexion of all the fingers is obtained; the power of flexing the affected finger independently of the others is, however, of course lost.

Lastly, in some cases where attempts at union of the divided ends have proved fruitless, both ends of the divided tendon have been attached to the scar, so that when the muscle contracts it pulls upon the scar and,

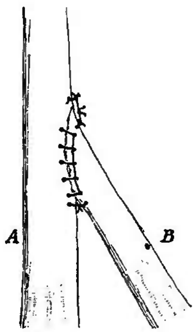



FIG. 83.—TENDON GRAFTING; LATERAL ATTACHMENT. The distal end of the divided tendon *B* is refreshed and attached to a previously prepared raw surface made on the lateral aspect of the sound tendon *A*.

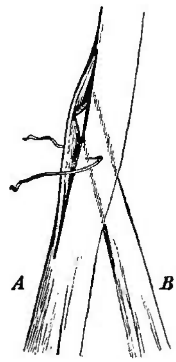



FIG. 84.—TENDON GRAFTING; IMPLANTATION METHOD. Here the distal end of the divided tendon *B* has been made raw on all its surfaces, and is implanted into the sound tendon *A* which has been split to receive it.

through this, upon the distal end of the tendon. This method is of course very inefficient and should only be adopted where nothing else can be done.

In all cases any scar tissue present should be dissected out as completely as possible; as a matter of fact, it is usually found that the uninjured tendons act better after an operation has been performed to unite the divided one, because the former are generally to a certain extent interfered with in their action by adhesions to the scar tissue, and these are of course removed by dissection.

**RUPTURE OF TENDONS.**—Solution of continuity in a tendon without any breach of the skin may occur as a result of irregular and violent muscular contraction. For example, when a person in falling tries to retain his balance, he sometimes ruptures the ligamentum patellæ; indeed, this is more common than rupture of the quadriceps extensor muscle itself. Other tendons which are frequently ruptured are the tendo Achillis, about an inch and a half from its insertion into the os calcis, and the long head of the biceps cubiti.

**Treatment.**—This may be either by means of position, in which the object is to bring the ends into as good apposition as possible, or by operation, in which the ends of the tendon are stitched together. In deciding upon the method to adopt, a good deal will depend upon the tendon ruptured, and the exact point at which the rupture has occurred. For example, rupture of the tendo Achillis is very readily followed by union without any need for operative interference; this is explained by the fact that the tendon runs in loose cellular tissue. On the other hand, rupture of the quadriceps femoris tendon does not usually give nearly such a satisfactory result if treated merely by position. With the latter form of treatment the worst results are those obtained in the case of tendons, such as those of the fingers and thumb, which run in long and rigid tendon sheaths; in these cases union is rare. This fact must also be borne in mind in performing tenotomy; these particular tendons should not be divided opposite the fingers or in parts where the ends are free to retract for a long distance; wherever possible they should be divided in the fore-arm. We shall take as examples of this affection rupture of the tendo Achillis and of the ligamentum patellæ, and shall indicate the treatment appropriate for them.

(*a*) **Rupture of the tendo Achillis.**—In rupture of the tendo Achillis, treatment by position is usually sufficient. A band is secured around the thigh; this may be either a leather strap, furnished with a buckle or ring, or, if this be unobtainable, the thigh may be encircled by a piece of strapping. A length of bandage is inserted beneath the strapping at the centre of the posterior aspect of the limb, and knotted in a loop. A slipper is then put on the foot, and in the heel a hole is made through which another piece of bandage passes, and this is also tied into a loop. Then by means of a piece of elastic bandage or india-rubber tubing passing between these two loops, the heel is drawn up and at the same time the knee is flexed (see Fig. 85), with the result that the divided ends of the tendon remain in fairly good apposition (although they are not absolutely in contact), and union occurs as a rule quite satisfactorily.

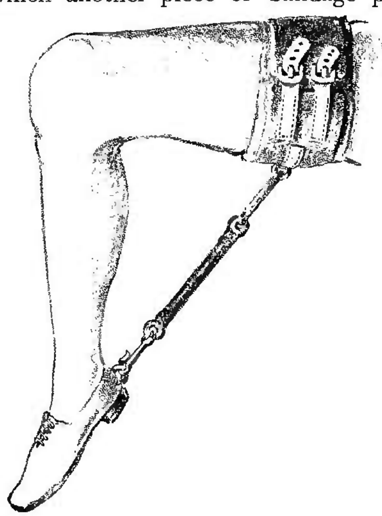


FIG. 85.—TREATMENT OF RUPTURE OF TENDO ACHILLIS BY POSITION.—This is sufficiently clear from the figure. Should the thigh-band tend to slip, as it often will from wasting of the muscles, it may be kept in position by fastening it to a band round the waist.

This apparatus must be kept on continuously for about a fortnight, and then the tension of the elastic should be diminished and the patient encouraged to move the ankle joint. The apparatus may be left off entirely after about three weeks, but the patient should not be allowed to stand on the foot until five weeks have elapsed from the time of the injury. Between the third and the fifth week he should lie in bed and be encouraged to move the foot, and a certain amount of passive movement may be practised with the object of preventing the adhesion of the newly formed tendon to the surrounding parts. After five weeks he may be allowed to walk about, at first with the assistance of a crutch or stick. In many cases he regains complete power without any massage being required.

Sometimes non-union is met with after rupture of the tendo Achillis, either because the case has not been treated, or because for some reason satisfactory union has not occurred. Hence it may be necessary to operate in order to obtain restoration of function. The operation should be done on the lines already laid down for the operations for uniting tendons after division in open wounds (see p. 227). As there is here no scar tissue it is well in operating to use a curved incision so that the skin incision is as far away as possible from the line of union in the tendon. In the case of the tendo Achillis, a curved incision is made with the convexity extending well over towards the outer side of the limb, the centre of the curve being at a point opposite that at which it is hoped to unite the tendon, and the ends being well over the inner border of the tendon. A flap consisting of skin, superficial and deep fascia, is raised and turned inwards, and then the divided ends of the tendon are sought for, the fibrous tissue removed, and the ends united.

(*b*) **Rupture of the ligamentum patellæ.**—In the case of rupture of the ligamentum patellæ, on the other hand, the mere employment of position seldom yields a satisfactory result, and it is therefore well, whenever possible, to employ immediate suture of the tendon. As a rule the tendon is torn off close to or at the patella, and the operation is apt to involve opening the knee joint. The incision made should be a curved one with the convexity downwards, and the lower limit of the incision should run below the tuberosity of the tibia. The flap should be turned up and the torn ligament exposed. Any loose tags of tendon are clipped away, and the latter is united in the manner already described (see p. 228). In the case of a broad tendon like the ligamentum patellæ, it is advisable not merely to have a thread at each side of it, but also to have one or two in the central part; in the intervals between these a continuous catgut suture should be inserted.

After the tendon has been stitched, the wound is closed, an antiseptic dressing applied, and the leg placed on a back splint which is considerably raised on a suitable pillow or rest in order to relax the quadriceps extensor fully. The splint is gradually lowered during the first fortnight until, at the end of that time, it lies flat on the bed. In about three weeks after the operation the splint may be left off, and the patient encouraged to move the limb in bed, but he should not be allowed to get about until six weeks have elapsed from the time of the injury.

This method of treatment is the best in most cases, particularly when the patient is healthy and vigorous, and the asepsis of the wound can be depended upon. But when the surgeon has not sufficient confidence in his asepsis, when the patient objects, or when his health is such that operation is deemed inadvisable, the case should be treated by position, which is carried out in the following manner. The limb is shaved, and a broad piece of strapping, extending about half-way up the limb and reaching down to the tubercle of the tibia, is fixed over the front of the thigh. The portion which lies over the patella is cut away so that the lower end is of a horse-shoe shape, and the sides of the horse-shoe surround the upper and lateral borders of that bone. The strapping is firmly bandaged to the thigh, and on each side of the patella pieces of tape are sewn on to it, and to these the extension apparatus is attached. The limb is then placed on a back splint, with a foot-piece at right angles, and at the sides of the foot-piece, close to the heel, holes are bored or bars are fitted, to which the extension apparatus can be attached. One end of a piece of india-rubber tubing is tied to each of the tapes just mentioned, and the other attached to the foot-piece of the splint or the bars upon it (see Fig. 86). By tightening these, any degree of tension required can be employed, with

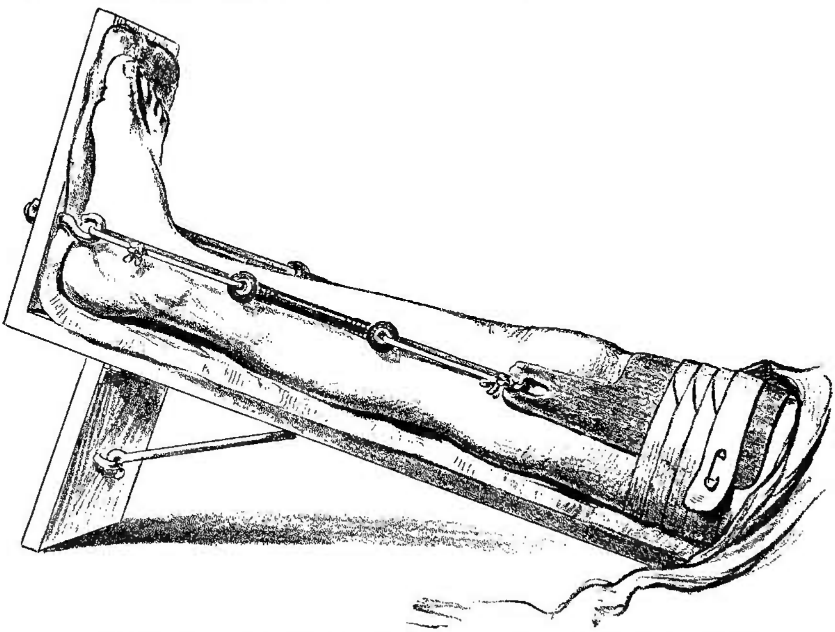


FIG. 86.—RUPTURE OF LIGAMENTUM PATELLÆ TREATED BY POSITION. For the sake of clearness the bandages fastening the limb to the splint have been omitted.

a view of bringing down the patella. The limb is kept considerably elevated, so as to relax the quadriceps extensor femoris. This apparatus should be kept on for about six weeks, the limb being gradually lowered during that time, and great care must be taken afterwards, when the patient begins to walk, to increase the flexion of the joint very slowly, lest the union should again give away.

Cases may be met with in which rupture of the ligamentum patellæ has occurred a considerable time before the patient comes under notice, and no proper union has resulted; they should be operated upon on the lines already laid down. A curved incision is made, the remains of the tendon defined, refreshed, and brought together in the manner just described (see p. 235). In one case on which we operated lately the short upper portion had curled up and become so matted to the tissues around that it was impossible to define it properly, or to get any satisfactory approximation. As the patient was completely disabled, a hole was bored transversely through the tubercle of the tibia and another transversely through the lower end of the patella, and a loop of strong silver wire was passed through these holes, and twisted up as tightly as possible. The remains of the ligamentum patellæ were then united by sutures and the wound closed. Healing took place by first intention, and the patient was allowed to walk about from the third week onwards, reliance being placed on the silver wire to act as a ligamentum patellæ. A year has now elapsed since the operation; the wire is still in position; the patient can bend his knee almost to a right angle, and has complete use of the limb.

(*c*) **Rupture of the long head of the biceps cubiti.**—We may also here refer to rupture of the long head of the biceps cubiti muscle. This is generally torn from its scapular attachment, and no method of treatment by position is completely satisfactory. The plan in general use is to fix the arm across the chest, the shoulder and the elbow being fully flexed, but, as may be readily imagined, union is not satisfactory, because the end of the tendon is pulled away from its attachment to the glenoid cavity. The only way in which a completely satisfactory result can be looked for is by operation. This is, however, very difficult. It involves opening the shoulder joint, and it is very doubtful whether the disability of the limb caused by rupture of this tendon is so great as to make such an elaborate operation worth while.

We, therefore, recommend treatment by position in these cases. In order to fix the arm in the position alluded to above (which is a very irksome one) strapping is used. The axilla, arm and chest are shaved, and a broad strip of strapping is applied to the back of the upper arm, beginning near the shoulder joint; this is brought down over the back of the elbow, the forearm and the hand, and the limb is fixed in a position of full flexion. The elbow must be flexed before the strapping is applied. The strapping is carried over the opposite shoulder and across the back, and is pulled tight enough to produce a sufficient degree of flexion. A second strip is then carried horizontally across the lower part of the arm just above the elbow, and then across the chest, so as to fix the arm to the side, this latter turn being repeated two or three times. A bandage is finally applied over all, and it is well to rub a starch solution into this, so as to form a firm dressing which will not stretch or slip. This apparatus must be kept on for about four weeks.

**DISLOCATION OF TENDONS.**—The tendons most liable to displacement from violence are the peroneus longus at the outer ankle and the long head of the biceps cubiti, which may become dislocated from the bicipital groove.

**Dislocation of the peroneus longus tendon** is the more common accident, and it usually results from the patient trying to regain his balance;

a sudden forcible movement when the foot is everted, such as a fall where the foot suddenly reaches the ground in an everted position, is very apt to dislocate the tendon from its groove. As the accident occurs there is a sensation of tearing, accompanied by sudden pain and a certain amount of loss of power in the foot. Very often, too, there is a good deal of subfascial hæmorrhage and considerable swelling, so that, unless the case be seen very early, the exact injury cannot be diagnosed until two or three weeks have elapsed; it is then found that on the outer side of the malleolus a tendon which ought not to be there rolls about under the finger.

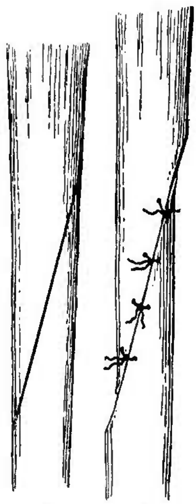
**Treatment.**—The treatment consists in replacing the tendon in its groove and keeping it there by artificial means until the rent in the sheath has united. This may be done either by replacing it by manipulation, and afterwards fixing the foot in the inverted position, or by means of operation. Without operation it is a very difficult matter to get the tendon satisfactorily into place, and more particularly to keep it there afterwards; and, as considerable swelling generally follows the injury, it may readily slip out again and the displacement not be recognized until the swelling subsides some weeks subsequently. Hence *immediate operation* is the better procedure, and we shall, therefore, describe it first.

After the skin has been purified, a curved incision is made with the convexity forwards, and a flap is turned back, so as to expose the groove behind the external malleolus. The tendon is then readily replaced in position after everting and extending the foot; care should be taken, while doing this, to see that the edge of the torn sheath does not roll up between the tendon and the bone. The edges of the sheath are then brought together over the tendon by a continuous stitch of fine catgut. The wound is closed, ordinary dressings are applied, and the foot is brought to a right angle and strongly inverted. This position is maintained by a poro-plastic splint moulded to the outer side of the leg and foot, and padded with salicylic wool. The foot, put up in this manner, is not touched for ten days, when the stitches are removed and active and passive movements are begun. Whilst movement is being practised, the thumb should be firmly pressed over the tendon, and the foot kept well inverted; afterwards, the splint is re-applied. This passive movement should be practised daily, and the patient should at the same time move the foot in various directions himself. It is advisable not to allow walking, or to leave the foot out of the splint permanently, until about six weeks after the operation, so as to give time for the union of the sheath to become quite firm. Adhesion of the tendon to its sheath is avoided by the use of this regular daily active and passive motion carried out while the surgeon keeps the tendon in its groove, and secs that the patient keeps the foot well inverted.

As has already been said, there is often so much swelling about the part that when the surgeon first sees the case it is impossible to diagnose the condition, and some time may elapse before the swelling has sufficiently subsided for the displacement of the tendon to be made out. It is necessary, therefore, to consider what may be done to relieve the patient when the dislocation has remained unreduced for some time. This condition causes considerable disability as there is pain on walking, and the patient is unable to evert the foot properly; in some cases he is completely crippled.

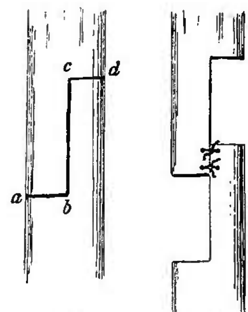
It will be found that, *when the tendon has been dislocated for some weeks*, it is extremely difficult both to return it to the groove, and to keep it in position afterwards. The groove becomes filled up with new tissue, remains of the sheath, etc., and, therefore, even when the tendon is got into position, there is a constant tendency for it to slip out at once, because there is no proper groove for it to lie in. When, therefore, it is possible to get the tendon into position, it will be necessary to deepen the groove in the external malleolus in order to keep it there. This is done as follows. After making the curved incision above mentioned, the soft tissue which fills up the groove is first dissected away, and then, by means of a fine gouge and hammer, a channel may be gradually hollowed out of the bone corresponding in width to the original groove, but of sufficient depth to make it difficult for the tendon to slip out when it has once been replaced. The tendon is then replaced, any soft fascial tissue present stitched over it to form a sheath, the incision closed, and the foot put up flexed and inverted as in the previous case. Passive motion should be begun quite early, as otherwise the tendon is likely to become adherent to the bone; certainly not more than a week should be allowed to elapse before active and passive motions are commenced, and they should be carried out daily for about three or four weeks after the operation, the splint being continued in the intervals. At the end of that time the splint can, as a rule, be left off, and the patient encouraged to move the foot often and to walk about a little, the foot being kept carefully inverted while he does so. Passive motion is required for about eight weeks after the operation, and the case may then be left to nature.

*When a longer period has elapsed* since the injury it may be impossible to replace the tendon in the groove on account of the retraction of the belly of the muscle. In such cases the following procedure has been adopted successfully. The groove in the bone is in the first place thoroughly cleared, and then deepened in the manner just described. The tendon is divided very obliquely, and the two ends are brought over into the groove prepared for them and stitched together. If the incision in the tendon be made sufficiently oblique the two parts do not become actually separated as they lie in the groove but slightly overlap one another. The portions which overlap are then stitched together laterally by fine catgut stitches (see Fig. 87). This lengthening of the tendon may also be carried out in another manner. The tendon is split vertically in the middle line for a distance rather more than half an inch longer than the interval required. At each end of the vertical incision a transverse cut, in opposite directions at the two ends (see Fig. 88), is made dividing half the tendon across. This gives a ‾|_-shaped incision through the tendon, the two ends of which are then separated sufficiently, and the overlapping parts stitched together laterally. The further treatment as regards movement, splint and so forth, is the same as has just been described; the results of these operations are said to be very satisfactory.



*A* *B*

FIG. 87. — OBLIQUE METHOD OF LENGTHENING TENDONS. In *A* is shown the line of incision in the tendon, whilst in *B* one end has been made to slide upon the other until sufficient lengthening has been obtained; the opposing surfaces are then sutured.




*A* *B*

FIG. 88.—⅂ SHAPED INCISION FOR LENGTHENING TENDONS. *A* shows the incision for lengthening the tendon, *B* the manner in which the tendon is united when the lengthening is effected. The incision *bc* should be a good deal longer than the amount of lengthening required.

*When no operation is thought desirable*, or when the patient will not consent to one, the surgeon must content himself with the use of apparatus. The tendon is readily replaced in the early stage by flexing and everting the foot and pressing the tendon into the groove; the foot is then strongly inverted and brought nearly to a right angle. A pad is firmly fixed over the line of the groove so as to prevent the tendon from escaping, and an external poro-plastic splint applied so as to fix the ankle joint. The splint should not be left off for about six weeks, except for passive motion, which is carried out in the same way as after operation, and then the foot and ankle should be bandaged for some time, and the patient cautioned to walk about with the foot inverted.

**Dislocation of the long head of the biceps** gives rise to a very considerable amount of pain and disability, and the tendon cannot satisfactorily be replaced and kept in position except by means of an operation.

**Treatment.**—In order to obtain access to the spot where the tendon has slipped out of its groove (which is usually above the insertion of the latissimus dorsi and the pectoralis major) a long incision should be made from the coracoid process downwards along the anterior border of the deltoid, the deep fascia divided, and the muscle pulled to the outer side; the bicipital groove can then be readily felt, especially if the elbow be pushed backwards. The tendon and its groove are exposed; the former is readily replaced and the rent in the sheath stitched up over it by means of a continuous catgut suture. After the wound has been closed the arm should be put up in the position usually employed for fracture of the clavicle. The hand rests on the opposite shoulder, and the elbow is raised, while the arm is fixed to the chest with a bandage, over which starch solution is applied. As soon as the wound has healed the patient should be encouraged to move the arm, which may be left loose for the greater part of the day. At night, however, it should be firmly bound to the side in the position mentioned, because during sleep the patient might execute some sudden movement, which would lead to the escape of the tendon from its sheath once more.

## TENDON GRAFTING.

An operation which may be referred to here is that of tendon grafting, which is chiefly employed for cases of deformity after infantile paralysis; the principle of the operation is that, when a group of muscles is completely paralyzed and the limb rendered useless, one or more of their tendons should be attached to one belonging to a group which has its nerve supply intact. For example, when the tibialis anticus is paralyzed and the extensor longus digitorum is not, the tendon of the tibialis muscle may be attached to one of the tendons of the extensor, the result being that a certain amount of movement is obtained in a part previously incapable of it. This may be done by exposing the tendons of the sound and the paralyzed muscle at the same level. The tendon of the paralyzed muscle is then divided obliquely, the lateral surface of the sound one is pared, and the distal end of the tendon of the paralyzed muscle is applied to the raw surface thus made and stitched to it by fine catgut sutures (see Fig. 83). Or the tendon of the healthy muscle may be split, and the end of the other pared, inserted into it and stitched in position (see Fig. 84). Both these operations have been already described and illustrated (see p. 232).

After either of these operations the limb should be put up in plaster of Paris, in the proper position, and movement should not be attempted for about three weeks, when the splints may be left off during the day but retained during the night. If either of these operations be done, it should be performed early in the progress of the case; if some years have elapsed after the occurrence of the paralysis the tendon is imperfectly developed and shrunken, and very little good will result.

## OTHER AFFECTIONS.

Inflammatory, syphilitic and tuberculous affections of tendons are secondary to similar affections of their sheaths; as we have already discussed these in the previous chapter, they need no further mention here.

# CHAPTER XVIII.

## THE SURGICAL AFFECTIONS OF NERVES.

### INJURIES OF NERVES.

As far as treatment is concerned, the various traumatic affections of nerves may be considered under three heads—Compression, Contusion, and Division of nerves. Both as regards symptoms and treatment, it will be found that these various groups overlap each other very considerably; nevertheless the subject will be made clearer by treating of each independently.

**COMPRESSION OF NERVES.**—A nerve may be subjected to such a degree of pressure that its functions are materially interfered with for a time at any rate, and under these circumstances a certain amount of pathological change occurs in it. The nerve may be compressed at any portion of its course, but, from the point of view both of symptoms and treatment, it is only necessary to consider the compression as it affects either the trunk of a nerve or its terminal filaments. Again, the compressing force may be severe, and may produce its results rapidly, or it may be milder, and the results may appear more slowly. Lastly, we have to consider the question according as the compression is due to injury or to some pathological process. We shall therefore describe compression of nerves under the following heads: (1) Compression of nerve trunks, which will be divided into Traumatic Compression, both rapid and gradual, and Pathological Compression; (2) Compression of terminal filaments of nerves.

1. **Compression of Nerve Trunks.**—(a) **Rapid Traumatic Compression.**—Here the pressure to which the nerve is subjected is severe and, although lasting for only a short time, may produce profound changes in the injured nerve. It is very probable that we have in reality to do with an actual contusion, the pressure of the nerve against an adjacent bone leading either to rupture and disorganization, or to effusion of blood in and around its fibres; as an example may be mentioned what is popularly spoken of as "drunkard's" or "Saturday night palsy." The

nerve compressed is generally the *musculo-spiral*; the patient falls asleep or becomes insensible with the back of the upper arm resting against or hanging over the edge of a chair or table, and the result is that the sharp edge presses the musculo-spiral nerve against the shaft of the humerus, and produces a more or less temporary paralysis of that nerve. Sometimes under similar circumstances other branches of the *brachial plexus* may be affected, as for example, when the patient sleeps with his hands behind his head, and the head of the humerus presses on the nerves in the axilla. This, however, is much more uncommon than compression of the musculo-spiral. Another example of rapid compression is seen in certain cases of *fracture*, in which a nerve trunk may be suddenly compressed against one of the fragments without being actually torn; this leads to temporary paralysis of the parts supplied by the affected nerve. Again, during *parturition*, temporary paralysis may be met with in the lower extremities of the mother, as the result of the pressure of the fœtal head upon the sacral plexus; in the child there may be paralysis of the facial nerve from pressure of the forceps.

(b) **Gradual Traumatic Compression of Nerve Trunks.**—Perhaps the best example of this form of compression is seen in what is known as *crutch palsy*; this is due to the long-continued use of ill-fitting crutches, and comes on slowly. It occurs chiefly when the arm-pieces of the crutches are insufficiently padded, and particularly when the crutch is too long for the patient. The cause of the affection is probably a slowly developing neuritis, leading to degeneration and atrophy of the nerve filaments.

(c) **Pathological Compression of Nerve Trunks.**—When the compression of nerves is the result of morbid processes, the symptoms come on slowly. Perhaps the commonest example of this is compression of a nerve by the *contraction of fibrous tissue* during the healing of a wound, or by the *callus* surrounding a fracture, which may either stretch the nerve running over it, or may surround and press upon it. Similarly, *tumours* may compress nerves, and malignant tumours may actually destroy them. In pathological compression the result produced is due either to interference with the blood supply of the nerve (as occurs when the latter is stretched over some firm structure), resulting in fatty degeneration and disorganization of the nerve fibres; or it may be due to a neuritis set up by the pressure.

2. **Compression of the Terminal Filaments of Nerves.**—This generally results from some pathological process, and is most commonly due to involvement of the terminations of the nerves in *cicatrices*, or, more rarely, in *malignant tumours* of the skin. The sensory nerves are the ones essentially affected, and, as will be mentioned later, the entanglement of nerves in scars and the pressure thereby produced on them usually ends in the production of a neuritis spreading up to the trunk of the nerve.

**Symptoms.**—However produced, compression of a large trunk nerve gives rise to symptoms which vary according as the nerve is sensory, motor, or mixed; in the latter case the sensory filaments are usually the first affected. In the case of a sensory nerve the patient first complains of neuralgia in the part supplied by the nerve, followed by sensations of heat and cold, numbness, hyperæsthesia, and subsequently complete anæsthesia. In a mixed nerve the sensory disturbance is followed at a somewhat later period by motor paralysis; this is at first slight, but it gradually increases in degree as the compression advances. If the compression and its effects—that is to say, neuritis—still continue, trophic changes, such as the formation of bullæ, ulcerations of the skin, wasting of muscles and so forth, may take place in the parts supplied by the nerve.

When nerve-endings are implicated in cicatrices or malignant growths of the skin, the symptoms are generally great pain, hyperæsthesia, excessive tenderness on pressure, reflex pain in distant parts, convulsive twitching of muscles or even of the whole limb, or in some rare cases epileptiform convulsions.

**Treatment.**—(a) **Prophylaxis.**—The dangers resulting from the compression of nerves must of course always be present to the mind of the surgeon, and must be guarded against wherever possible. In applying compression to a limb the possibility of injury to the nerve must always be remembered; for example, in operations on the forearm by the bloodless method, it must not be forgotten that if a narrow tourniquet or elastic tube be too tightly applied to the upper arm, the nerves are apt to suffer injurious pressure because of their exposed situations. Hence, under those circumstances the tubing should not be used as a tourniquet, but a broad piece of elastic webbing should be employed in its place; this, while exercising sufficiently firm pressure, will not do harm, since, owing to its breadth, such pressure as it exerts is diffused, and is not concentrated on any one point in the nerve. Again, when a patient is compelled to use crutches, the possibility of crutch palsy must be borne in mind, and special care must be taken to see that the crutches are not too long for the patient, and that the arms are sufficiently padded. In cases of fracture also, the possibility of the inclusion of a nerve between the broken ends of the bones, or the possibility of subsequent inclusion of the nerve in the callus must not be lost sight of. Care must be taken in reducing the fracture to see that no soft tissues are left between the bones, and directly symptoms pointing to compression of a nerve make their appearance, steps should be taken to remedy it, even should this involve operative interference.

When the terminations of a nerve may be involved in a cicatrix and lead to a painful scar, every possible means of promoting rapid healing, more especially the avoidance of sepsis, must be had recourse to. Wherever the edges of a wound can be brought together, healing by first intention should be aimed at; where this cannot be done, the employment of immediate skin-grafting, in order to diminish the subsequent contraction, is of the greatest importance.

(b) **Where Compression has already produced its Effect.**—After the compression has been relieved, recovery will almost certainly occur unless the nerve has been very markedly disorganized. In some cases, however, weeks or even months may elapse before recovery is complete. Usually in such accidents as pressure on the musculo-spiral nerve from the edge of a table, etc., recovery begins in about three weeks, and is complete in five or six; but, on the other hand, where the compression has been very severe, months, or even a year or two, may elapse before the nerve regains its normal condition. During the interval preceding recovery it is extremely important to maintain the nutrition both of the nerve itself and of the parts supplied by it. The nutrition of the nerve trunk itself is improved and the restoration of its functions expedited by the use of the *galvanic current*, using in the first place a mild current of not more than five milliampères for about ten minutes, and gradually increasing it in strength up to ten as is found desirable. The current should flow downwards in the course of the nerve: *i.e.* the positive electrode is applied to the spine while the negative is on the affected nerve near its termination. It is also well to have a key in the circuit so that the current can be opened or closed at intervals; this produces muscular action, and thus helps to keep up the tone of the muscles. The nutrition of the muscles supplied by the nerve must also be maintained by suitable massage, and steps must be taken to prevent contracture, which is very apt to occur in consequence of the loss of the nerve supply; unless proper steps be taken to prevent it, this may be permanent even after the nerve has completely recovered its functions.

The use of *massage* to a paralyzed muscle is of the very highest value, as it improves its circulation, gets rid of waste products, and thus promotes its nutrition. The Faradic current, used in a strength sufficient to keep the muscle gently in action, but not strong enough to exhaust it, is also very useful. Should, however, the muscle begin to show signs of "the reaction of degeneration" (*i.e.* loss of contractility to the Faradic current with coincident increase of contractility to the galvanic current), the galvanic current ought to be employed; under these circumstances the circuit should be furnished with a key for opening and closing the current frequently (*vide supra*). At the same time *active and passive movements* of the affected limb should be encouraged, passive motion especially being diligently practised with the view of preventing contractures and adhesions in the neighbouring joints. It is well also to place the limb on a splint, during the night, in such a position as to oppose the tendency to contracture.

Careful treatment on these lines should be persevered in until the functions of the nerve have been restored, however long a time may elapse before the restoration occurs; if not, it may be found that by the time the nerve has regained its functions the parts on which it acts have become irretrievably damaged.

(c) **Where the Compression still continues.**—When, for example, the nerve is involved in callus, steps must be taken to *relieve the compression* as quickly as possible; in the instance before us an incision should be made over the fracture, the nerve exposed above and below the callus, and traced over or through it. In any case, the new bone that is exerting the pressure must be chipped away, but in doing this special care must of course be taken not to divide the nerve as it runs through the callus. Not only should the main trunk be freed from the pressure, but any of its branches which may have become involved should be followed out and similarly set free. After the nerve has been cleared by the removal of the callus it is well to grasp it above and below the seat of compression and stretch it *in situ* so as to rupture any new connective tissue which may surround it.

If the cause of compression be a new growth, the treatment must naturally be directed to the removal of the growth. When a simple tumour presses upon a nerve trunk it must be removed without dividing the nerve. When the nerve is in the interior of the growth, the former must be shelled out in a manner similar to that adopted for nerves involved in callus; when this is done the growth is removed. Should, however, the growth be malignant, the portion of the nerve implicated in it must be cut away, and if the condition of the parts permits, immediate suture of the divided ends by one of the methods to be described immediately (see p. 251) should be practised.

When a cicatrix is causing compression of a main nerve trunk, the latter, together with any branches that may be involved, must be freed in the same manner as when the compression is caused by callus. This should be followed, as in the case of compression by callus, by nerve stretching so as to tear through any bands of fibrous tissue which may have been overlooked. When only the terminal filaments of the nerve are involved in cicatricial tissue, the best plan is to *dissect out the scar* freely; this of course removes the ends of the nerves that are pressed upon. The wound is then closed either by means of a plastic operation or by immediate skin-grafting; by this means union by first intention and a correspondingly small amount of fresh cicatricial tissue are obtained. This must be done early in the case, before the neuritis has become established in the nerve trunk; if not, the operation will be quite useless.

The plan described in some text books of dividing the filaments of the nervc going to the scar, by means of a tenotomy knife introduced beneath it, is very inefficient, because in the first place one very often fails to divide all the involved filaments, and in the second the divided nerves are likely to re-unite, when the patient's troubles will recur.

**(d) Where the Cause cannot be removed.**—When it is impossible to remove the cause of compression, the treatment will depend upon whether a motor or a sensory nerve is involved. If it be a motor nerve alone, no interference is called for, but if a sensory or a mixed nerve be affected, the compression may lead to such severe pain and hyperæsthesia, and is also so prone to set up an ascending neuritis, that something must be done to give the patient relief. If the case be left alone, not only is the pain intolerable, but the neuritis set up by the compression is very apt to spread up the trunk and involve other branches of the nerve, and thus to extend the painful area widely.

Under these circumstances the advisability of dividing the nerve above the area of compression must always be considered, and if this be decided upon, it is found by experience better to cut out a portion of the nerve than to be content with a simple division—in other words, *neurectomy* rather than neurotomy is the better operation. In a mixed nerve this procedure of course abolishes completely the motor as well as the sensory functions, but, when the nerve is badly compressed, paralysis of motion is probably already present, and the abolition of sensation is only what is desired by the patient. Wherever possible, therefore, the nerve should be exposed above the seat of compression, and a portion removed; but in some cases this is not possible. For example, when an inoperable intra-pelvic tumour presses upon the sacral plexus, the latter cannot be exposed above the seat of pressure. Under those circumstances, however, and also in cases where the pain has recurred after a previous neurectomy, it may be quite legitimate, if the patient be suffering intense agony, to open the spinal canal and *divide the posterior nerve roots.* If this be done, it has been found as a matter of experience that it is well not merely to divide the posterior nerve root, but also to remove a portion of it including the ganglion. This operation will be described later (see p. 265).

Lastly, when operative interference is not possible or desirable, the surgeon must be content to relieve the pain by means of *anodynes*, such as injections of morphine or cocaine. When the compression is caused by a malignant tumour, which before long will cause the patient's death, there need be no hesitation in resorting early and freely to the use of these remedies, but when the cause of compression is a simple one and is not likely to destroy life, they should only be employed with great reluctance, on account of the risk of setting up a morphia or cocaine habit; their use is only permissible when it is quite certain that the symptoms cannot be relieved by any form of operation. As a preliminary to the more powerful anodynes, a trial may be made of antipyrine (5 to 20-grain doses), methylene blue (3 grains in pill form), quinine (3 to 5-grain doses), Fowler's solution of arsenic (3 to 12 minim doses), or salicylate of soda (5 to 10-grain doses), either alone or in various combinations.

**CONTUSION OR RUPTURE OF NERVES.**—A nerve may be contused or ruptured by the sudden application of a force which either compresses it violently against a bone or else stretches it so as to lead to partial or complete rupture. Actual rupture of a nerve is extremely difficult to produce, and usually the most that happens is that the nerve is violently stretched, and some of the fibres only are torn.

**Pathological Changes.**—The changes which take place when a nerve is contused or stretched are rupture of some of the fibres, effusion of blood into the sheath (generally in the form of minute hæmorrhages), and rupture of the nutrient vessels, followed by disintegration of the nerve structures at the point of injury. These accidents usually occur as complications of fractures or dislocations; more rarely they result from severe blows on the nerve as it runs over some bony prominence.

**Symptoms.**—In the case of a motor nerve there will, of course, be paralysis of the muscles it supplies. In the case of a sensory nerve there will be complete loss of sensation when the injury is severe; when it is less severe the patient usually complains of tinglings and various perverted sensations. In either case neuritis is apt to supervene after a time.

**Treatment.**—The treatment is practically the same as that already described for compression of nerves (see p. 244) and need not be repeated here. The same careful precautions must be taken, while waiting for recovery, to maintain the nutrition of the damaged nerve itself and the parts it supplies. When a portion of the nerve has been converted into a pulp, and the continuity of nerve transmission completely destroyed, the question of excising the irreparably damaged portion and uniting the two healthy ends may arise. This no doubt is the best treatment should a considerable length of the nerve be completely destroyed, and it should be carried out in the manner to be described immediately for wounds of nerves (see p. 251). It is, however, very difficult to diagnose this condition with certainty, because the complete loss of function might result from a temporary and comparatively trifling injury; where, however, several weeks elapse without any sign of recovery, and where the loss of both sensation and motion is complete, the surgeon is justified in exposing the nerve opposite the seat of injury. Should a portion be found soft and pulpy, sufficient should be removed to allow healthy fibres to be made out above and below; the remaining steps of the operation are those for nerve suture (see p. 251).

Unless, however, the nerve has undergone complete destruction there is no special advantage in excising the injured portion, because the nerve fibrils will spread down from above the seat of damage through the injured portion just as readily as they will across the interval bridged over by catgut or by the other methods employed, while the nerve sheath, being intact, will guide the fibrils in the proper direction. Hence, in these cases, we only advise excision of a portion of the nerve when complete destruction has taken place.

**WOUNDS OF NERVES.**—Wounds of nerves may be either simple punctures, as by a needle; clean-cut divisions; or lacerated wounds, such as are met with in machinery accidents and gun-shot wounds. It is, however, only necessary to discuss here the treatment of a more or less complete division of the nerve, the injury caused by a mere puncture not being usually such as to call for any special treatment.

Before proceeding to deal with the treatment of divided nerves, it will be well to mention the changes that take place in a nerve after division, and the mode in which regeneration occurs.

**Changes that occur in a Nerve after division.**—These differ in the proximal and distal portions. In the **distal end** they are very marked and occur within a short period after receipt of the injury. The ultimate result is that the whole of the distal portion becomes shrunken and thin, and loses its characteristic white shining appearance, while the cut end is usually tapering, although in some cases it may become somewhat bulbous. In the latter case, however, the bulb is usually comparatively small, and does not at all equal in size that which forms in connection with the proximal end.

If the nerve be examined microscopically, it will be found that the earliest changes are the breaking up of the myelin, which, in the course of three or four days, becomes converted into a collection of oil globules; the axis cylinders also split up and undergo rapid degeneration. The result is that before long the sheath of the nerve contains a mass of degenerated products quite incapable of transmitting impulses, and as time goes on these are absorbed, and only the empty shrunken fibrous sheath is left. These changes are quite evident in from four to six days after the injury, and are usually complete throughout the whole of the distal portion of the nerve in from six weeks to two months.

On examining the **proximal end** of a divided nerve some time after the receipt of the injury, it will be found markedly bulbous; the bulb results from the formation of a considerable quantity of new connective tissue, and also of a large number of nerve fibrils of new formation, which represent an attempt at regeneration of the nerve. The degenerative changes which are so marked in the distal end are comparatively slight in the proximal portion, and, while disintegration of the myelin does take place, it seldom extends above the first, or at the very most the second, node of Ranvier. The interval between the divided ends is usually filled up with fibrous tissue.

**Changes that occur when union takes place between the divided ends.**—Restoration of function occurs by growth downwards from the proximal end of new nerve fibrils which gradually extend through the distal portion until they reach the terminal organs. The primitive axis cylinders usually send out small filaments (generally two or three from each cylinder), which enter the nerve sheaths in the distal portion, grow down them, and give rise to fresh nerves. In the sensory branches, the degeneration of the distal portion is not so rapid, and when immediate suture is performed, the restoration of sensation may occur very quickly. Usually, however, a long time elapses before normal sensation is restored, the probability being that a certain amount of conduction goes on, until ultimately the fresh fibres have completely restored the nerve. The restoration of the motor fibres always takes a considerable time, and, as a rule, it is not materially influenced by the period of time which elapses between the injury and the nerve-suture; even when this is performed two or three days after the receipt of the injury, the time that elapses before the restoration of the motor function is practically as long as if several months had intervened. The reason is that degeneration of the filaments in the distal end takes place more or less simultaneously throughout, and restoration of function must occur by growth downwards of new fibres from the proximal end. This is naturally a slow process, and as much as two years has been known to elapse after nerve-suture before complete restoration of the motor functions; the time required will vary according to the length of the distal portion; the longer the latter, the slower the restoration. In any case the process will take some months, and the patient need not abandon hope, nor should the use of electricity and massage to the muscles be given up, until at least two years have elapsed from the time of the operation.

When a nerve has been only partially divided it must be remembered that, as healing occurs, the compression of the cicatricial tissue may lead to complete loss of function of the entire nerve, owing to the fact that the contraction of the new fibrous tissue may cause pressure upon and finally atrophy of the portion undamaged at the time of injury. This is a point of some medico-legal importance in cases where complete loss of function has occurred, but where at the time of the injury the nerve did not appear to be divided. Under these circumstances, of course, the restoration of function may be obtained by the removal of the newly formed cicatricial tissue.

**Treatment.**—In all cases where nerves are divided *strict asepsis* must be aimed at; this is of the highest importance, both with the view of obviating the occurrence of neuritis, and also of reducing to a minimum the amount of cicatricial tissue which must form between the divided ends, and which if large in quantity might lead to severe compression of the nerve trunk. Further, any foreign body present in the wound must, of course, be removed.

(1) **Partial Division.**—When on examination it is found that the nerve is only partially divided, the best plan is to bring the two divided portions into direct contact and secure them by means of one or two fine catgut sutures introduced through the sheath of the nerve. No doubt it is sometimes tempting in these cases to leave the divided portion unsutured, and to hope that union will progress satisfactorily because a portion of the nerve remains intact. Unless, however, the divided portion be brought into accurate contact and secured by sutures, the downward growth of new nerve fibrils, by means of which regeneration of function has to take place, is apt to be very irregular, and, owing to the curling up of the divided portion, the new nerve fibrils may entirely miss the sheath of the distal portion.

(2) **Complete Division.**—Wherever a nerve is completely divided, suture of the two ends is the only possible treatment. The steps of the operation, however, differ according to the period at which the operation is done, and we shall therefore discuss separately the treatment of recent cases and those in which some time has elapsed since division.

**Recent Cases.**—When the nerve has been divided completely, steps should be taken to bring the divided ends together and secure them in position with as little delay as possible. Hence, in any wound where there is loss of nerve function, no time should be lost, after rendering the wound aseptic, in searching for the divided ends of the injured nerve. More than this, care must always be taken, in cases of wounds in the neighbourhood of important nerve trunks, to see whether the functions of those nerves are intact; should one be found to be divided, nerve-suture may be done immediately after the accident, and simultaneously with the treatment of the original wound. The operation is then much easier and much more likely to be successful than if it were delayed until the wound has healed and extensive changes have taken place in the nerve.

*Primary nerve-suture.*—When the divided ends of the nerve have been exposed in the wound they should be carefully examined to see whether the cut surfaces are cleanly cut or are torn; in the latter case it will be necessary to shave off a small portion of the ends on either side with a very sharp knife so as to have them quite smooth and sharply cut where they oppose one another. The best material for the approximation of the divided ends is the finest chromic catgut, and an ordinary round sewing needle should be employed for introducing the sutures instead of the usual triangular surgical needle, the sharp edges of which are very apt to divide the nerve fibrils. If the divided ends cannot be easily brought together, as may be the case when a portion of the nerve has to be removed, the limb should be so bent as to bring the cut surfaces into accurate contact without any tension upon the stitches.

The next step is to insert the sutures, which is done as follows. The needle, threaded with the finest catgut, is passed from before backwards through the whole thickness of the proximal portion of the nerve about its centre, and at least a quarter of an inch from the cut surface; it is then passed through the distal portion from behind forwards in a similar manner. Great care must be taken that this stitch be not tied too tightly, as it may cut its way through the nerve, or may compress its fibres unduly; it should be tied so that, while the cut ends lie in accurate contact, there is no tension at all upon it. When this supporting stitch has been secured, three or four fine interrupted catgut stitches, merely traversing its sheath, are introduced around the periphery of the nerve so as to prevent lateral displacement of the cut ends. The divided ends can thus be kept in close and accurate contact (see Fig. 89).

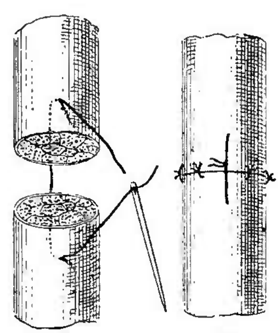



FIG. 89.—NERVE-SUTURE. In *A* is shown the method of inserting the central fixation suture which traverses the entire thickness of the nerve. In *B* the ends of the nerve are brought together by tying this suture, and, in addition, the finer coaptation sutures, which only pass through the nerve sheath, are inserted.

*After-treatment.*—The wound is then closed, and, if necessary, a drainage tube may be inserted, while the limb is fixed in a position that ensures the least possible tension upon the stitches. For instance, when a nerve has been divided on the front of the wrist, the fingers, the wrist, and the elbow should be fully flexed, and kept steady in that position by a suitably moulded posterior splint. This position should be maintained for about ten days, at the end of which time the dressings may be removed, the stitches taken out, and a small collodion dressing applied. In addition to this, active and passive movements of the finger joints should be practised, care being taken not to carry them to such an extent as to pull upon the divided ends of the nerve; the flexion of the fingers and wrists may then be somewhat relaxed. During the following week the fingers may be still further extended, and they may be left out of the splint so that the patient can move them for himself.

In about six weeks' time the splint may be left off altogether, and massage and electricity to the muscles should then be vigorously employed. The patient must be warned that the recovery of function after division of a nerve is often slow, but, as we have already said, there is no need to despair of a successful result even when as long as two years have elapsed after the operation.

**Cases in which Cicatrization of the Wound has taken place.**—Here a considerable time must necessarily have elapsed since the occurrence of the injury, and the treatment appropriate for the condition consists in what is known as "secondary nerve-suture," in contradistinction to the method of "primary nerve-suture" that we have just described.

*Secondary nerve-suture.*—The first part of the operation consists in finding and preparing the divided ends, a task which is not always easy. The dissection is greatly facilitated if the part be rendered completely bloodless, and therefore, whenever the operation is being performed upon one of the nerves of the extremities, an Esmarch's bandage should be employed (see Part I., p. 129). After the bandage has been applied, an incision is made directly over the line of the nerve. Should the scar of the old wound lie in the position of this incision, the cicatricial tissue must be divided as the incision is deepened; should it, however, lie well to one side of the line of the nerve, it is a good plan to make a curved incision with the convexity to one side, and thus to raise a flap, as this gives better access than does a simple straight incision immediately over the nerve trunk. The most satisfactory method for exposing the divided ends is in the first place to identify the sound nerve above the proximal end. This, of course, can be cut down upon and found by means of the ordinary anatomical guides, and when the nerve trunk is thus identified it is easily traced down until the bulbous divided end is reached. The identification of the distal portion is, however, a more difficult matter. An attempt should in the first place be made to expose the nerve below the point of section by using the ordinary anatomical guides, and this may often be facilitated by pulling upon the proximal portion, which by the medium of the intervening fibrous tissuê pulls more or less directly upon the distal portion and so leads to its identification. It is, however, a difficult matter to find the nerve (*e.g.* the median in front of the wrist) when it has been divided just before it splits up into a number of terminal branches.

After the nerve has been identified above and below the point of division, the next step is to dissect out cleanly and thoroughly all the fibrous connective tissue intervening between the two divided ends. The bulbous end of the proximal portion must then be shaved off until healthy nerve fibres are exposed. This must be done with a very sharp knife, the section being kept strictly at right angles to the long axis of the nerve, and it is well, in order to avoid tearing or other damage to the nerve, to introduce some firm structure, such as a copper spatula, beneath it, and to cut down upon it in making the section. The upper end of the distal portion must next be prepared for suture, and this is best done by cutting off as much of the narrow tapering end as is necessary to get a sufficiently wide surface to suture to the proximal portion. There is no object in cutting off a large portion in order to look for healthy nerve fibres; the degeneration will have progressed a long way down, and resection of the cut end only serves to increase the gap and to make it more difficult to obtain proper approximation. The Esmarch's bandage should only be kept on until the ends of the nerve have been identified and isolated, and should then be removed, so that the oozing which so commonly follows may have time to cease spontaneously before the wound is sewn up.

The method employed for the union of the divided ends will depend largely upon the amount of separation between them. To a great extent the latter may be diminished by gently grasping the proximal end of the nerve, and pulling upon it so as to stretch it. In doing this, care must be taken not to rupture any of the nerve fibres. In the case of a long nerve, a quarter or half an inch, or even more, may be gained in this manner without doing any damage to the nerve itself. If the divided ends now come fairly easily into apposition, they may be united by direct suture in the manner just described (see p. 251), and while this is being done the parts must be relaxed as much as possible by flexing the joints, so as to prevent any undue tension upon the stitches. The limb is put up in the flexed position upon a suitably moulded splint.

*Plastic operations upon nerves.*—When, in spite of nerve stretching and attention to the position of the limb, the ends will not come into proper contact, the surgeon has the choice of a number of different procedures, amongst which we may enumerate the following. (1) The interval between the ends may be bridged over with strands of fine catgut, which serve as a guide along which the new fibres can spread from the proximal to the distal portion.

(2) Both ends of the nerve may be included within a tube of decalcified bone of suitable size.

(3) Nerve-grafting may be employed. In this procedure a portion of nerve taken from one of the lower animals, or from the amputated limb of another patient, is introduced between the two ends of the nerve, and fixed there by sutures.

(4) In some cases, when the affection is in the extremities, the interval between the cut ends may be diminished by resecting portions of bones, and thereby shortening the limb and enabling the cut ends of the nerve to come into position.

(5) One or other or both of the divided ends of the nerve may be implanted into another which is intact.

The great desideratum in all these cases is a suitable guide along which the nerve fibres developing from the upper portion of the nerve may find their way downwards to the lower portion, and the object of these plans, with the exception of the two last, is to provide a guide of this sort. In our opinion the best plan for cases in which the interval between the cut ends does not exceed two inches, is a combination of the first two methods above mentioned; that is to say, the ends of the nerves are brought as closely together as possible, the interval between them bridged by means of threads of catgut, and the whole of the defective portion then enclosed in a tube of decalcified bone. This combined procedure has the great advantage that while the decalcified bone tube provides a free and unimpeded channel, down which the new nerve fibres can spread, the threads of catgut ensure that the ends shall not be displaced should the bone tube become absorbed before the regenerated portion has reached the distal end.

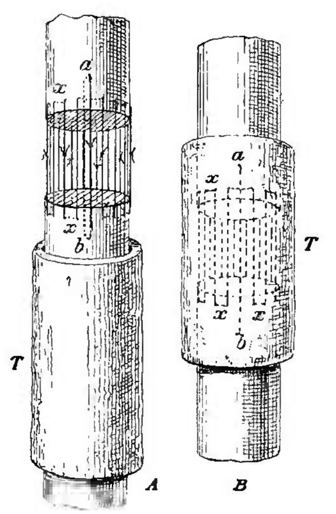



Fig. 90. — The Combined method of Nerve-Suture by bridging with Catgut and enclosure in a decalcified Bone Tube. In *A* is shown the first stage of the procedure. The bone tube *T* has been slipped over one end, well out of the way. A central fixation stitch *ab* has been inserted, and then all around the periphery of the nerve a series of fine catgut stitches *x* have been inserted through the nerve sheath. In *B* the bone tube is shown after it has been slipped up into place over the interval between the divided nerve ends.

*The combined method of bridging with catgut and enclosure in a decalcified bone tube.*—The technique of the operation is as follows. After the ends have been freed and pared and the parts relaxed as much as possible, a decalcified bone tube of suitable size is slipped over one end of the nerve and pushed either upwards or downwards according to circumstances, so as to leave the cut end protruding for some little distance beyond the end of the tube. The divided ends are now sutured with fine catgut much in the manner described for primary nerve-suture (see p. 251). An ordinary round sewing needle is employed, one stitch is passed through the centre of the two portions of the nerve so as to steady them, and then a number of strands of catgut are passed through the sheaths of the two ends and tied. When the interval has been thus more or less completely bridged over, the bone tube is slipped down into position over the catgut and left there (see Fig. 90); the wound is stitched up without a drainage tube, which is unnecessary if the hæmorrhage be properly arrested. The limb is then put in a poroplastic splint moulded so as to relax the parts as much as possible, and after a lapse of ten days the sutures are taken out of the skin wound, which by this time should have healed; the limb may gradually be extended, the splint being finally left off at about the end of six weeks. As in cases of primary nerve-suture, massage, galvanism, and passive motion should then be employed until either the functions of the nerve are restored, or until it is obvious that no good results will accrue. In any case many months will have to elapse before the final result can be ascertained.

*Nerve-grafting.*—The method of grafting a portion of nerve from one of the lower animals into the gap between the divided ends is very uncertain in its results, and in no way better than that just described. As a matter of fact, the graft itself does not live; it merely acts as a connecting medium along which the new nerve fibres from the upper end are enabled to reach the distal portion—a result equally well produced by the method we have just described.

*Excision of bone.*—In some cases when the interval between the cut ends is more than two inches, and when the condition of the part allows of it, a portion of the bone may be excised and the limb shortened so as to bring the divided ends of the nerve together. For instance, when one of the nerves in the upper arm has been divided and there is a large gap between the divided ends, a portion of the humerus can be excised so as to allow the divided ends to come properly together. The union of the nerve is of such great importance to the usefulness of the limb that no hesitation need be felt about undertaking an operation of this kind in suitable cases. The incisions in the bone should be oblique, and the divided ends of the bone are wired or screwed together afterwards.

*Nerve implantation.*—The method of implanting one nerve into another has been tried in several cases, but the results attending it are very disheartening. The operation may be carried out in one of two ways. For example, a case in which the median nerve has been divided and the ulnar nerve is intact may be taken as an illustration. In the first method the upper end of the median is refreshed in the ordinary manner, and is then implanted into the ulnar by making an incision into the sheath of the latter at one side, inserting the end of the median into the opening thus made and attaching the two nerves together by fine catgut sutures passed through the adjacent portions of the sheath. The lower end is then similarly refreshed and attached in like manner lower down upon the ulnar (see Fig. 91). The principle of this method is that new nerve fibres will grow downwards within the sheath of the ulnar nerve, and reach and enter the lower end of the median again; or, failing this, that impulses will be conducted through the intervening portion of the ulnar, and will pass downwards along the distal portion of the divided median.

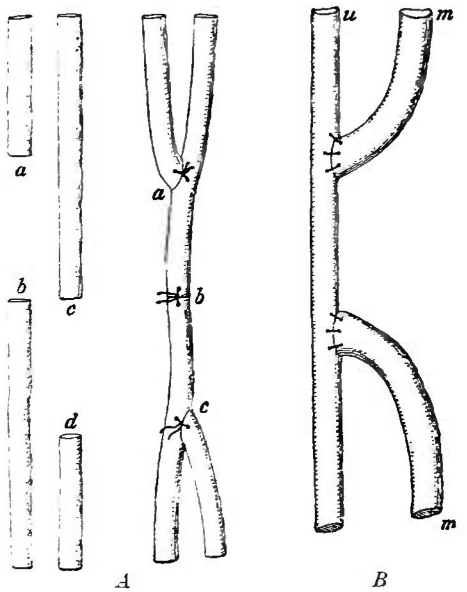



FIG. 91.—NERVE-GRAFTING BY DOUBLE LATERAL IMPLANTATION. In *B* is shown the method described in the text. The divided ends of the median nerve *m* are refreshed and sutured to two raw surfaces made ready to receive them on the lateral surface of the ulnar nerve *u*. *A* is a similar method designed for use when both of two parallel nerves are divided. The proximal end of one nerve is united end-to-end with the distal end of the other, and the two remaining free ends, *a* and *d*, are implanted laterally on to the single trunk thus formed.

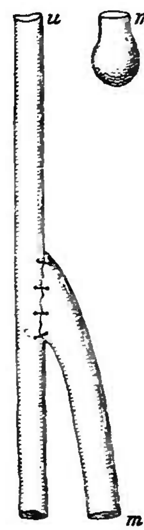



FIG. 92.—NERVE-GRAFTING BY SINGLE LATERAL IMPLANTATION. This is the second method described in the text. The distal end of the median nerve *m* is implanted laterally upon the ulnar *u* while the proximal bulbous end of the median *m* is left untouched.

The second method is to attach only the distal end of the divided nerve to the sound one (see Fig. 92), by a lateral implantation similar to that just described, in the hope that new nerve fibrils will grow outwards from the ulnar nerve into the lower end of the divided median, and thus provide a fresh nerve supply for the muscles supplied by that portion of the median. This, however, is a method that cannot be at all recommended, as practically it invariably fails.

*Results.*—The success likely to attend cases of nerve-suture depends upon three main factors; firstly, the accurate approximation of the divided ends; secondly, the length of nerve which has to be regenerated; and thirdly, the condition of the muscles at the time regeneration occurs. The length of time which elapses between the division of the nerve and the performance of nerve-suture does not seem to matter, at any rate to the same extent. A certain amount of restoration of sensation, although to a very imperfect degree, is often evident in the course of a day or two after the operation, whilst the restoration of the motor functions is generally delayed for a very considerable time, twelve months or even two years often elapsing before the first appearance of signs of recovery. Since the success of nerve-suture depends largely upon the condition of the muscles at the time when regeneration occurs, it is obvious that it is of great importance that the nutrition of the muscles should be kept up as much as possible by massage and electricity, as otherwise, when union of the nerve has taken place the muscles may be so atrophied as to be incapable of work.

## NEURITIS.

Neuritis or inflammation of nerve trunks may be either acute or chronic. The acute form generally occurs in connection with a septic wound, or more rarely from some constitutional cause: in most cases neuritis is a chronic affection.

**VARIETIES.**—Two forms of the disease are met with; one in which it is limited to a single nerve or branch of a nerve, a condition termed local or *peripheral neuritis*, and the other in which many nerves are simultaneously affected, a condition known as *multiple neuritis*. The surgeon has only to deal with the local form, which may be due to either a local or a general cause.

**CAUSES** (*a*) **Local.**—Neuritis may occur in connection with *a wound*, more particularly should this be septic. When it follows upon *an injury* it is most frequently due to incomplete division, or to laceration or contusion of a nerve, rather than to a complete division by a clean cut. The presence of *a foreign body*, such as a piece of glass, in a wound may also frequently set up neuritis, or may aggravate the condition should it have already occurred as a result of sepsis in the wound. The disease may also be caused by the *extension of inflammation* to a nerve from some focus in the neighbourhood. For example, in tuberculous spinal disease the inflammatory process may extend to the nerves as they emerge from the inter-vertebral foramina. Similarly it may follow such an affection as a carious tooth, in which case the inflammation spreads up the nerve and reaches several of its branches. One of the most common local causes of neuritis is *pressure*, as is seen in a marked degree when an aneurysm presses upon some of the large nerve trunks. The pressure of new growths acts in a similar manner. *Exposure to cold* is a common cause of neuritis, as has already been mentioned in speaking of frost-bite (see Vol. I., p. 201): the indolence of the ulcers that often follow upon a mild degree of frost-bite has been attributed by some to neuritis set up by the action of the cold.

(*b*) **General.**—Among these may be mentioned alcoholism, syphilis, gout, rheumatism, and anæmia. When neuritis is due to a constitutional cause it is very apt to be of the multiple variety.

**PATHOLOGICAL CHANGES.**—In acute neuritis the nerve becomes distended, swollen, and softer than usual. Its vessels are much enlarged and full of blood, and extravasation takes place into the nerve; later on, marked degeneration of the nerve fibres occurs. In the more chronic cases the changes in the nerve consist mainly of those characteristic of chronic inflammation. The nerve becomes enlarged and harder than usual; under the microscope the appearances of interstitial inflammation are seen, *i.e.* proliferation of the nerve sheath, and the formation of new fibrous tissue along the course of the nerve, which, as it contracts, presses upon the fibres, causing them to atrophy and degenerate.

**SYMPTOMS.**—The nerve functions soon become impaired; in severe cases the parts supplied may permanently lose both sensation and motion, but such cases are exceptionally rare. In sensory or mixed nerves the earliest effect of the inflammation is neuralgic pain, which is more or less intense in character, and is accompanied by hyperæsthesia of the skin supplied by the nerve; in some rare cases epileptiform convulsions may occur as an early symptom. The neuralgic pains are at first more or less limited to the affected nerve and its branches, but in the later stages of the affection they may spread to nerves other than that primarily affected. For example, in cases of neuralgia in one division of the trigeminal nerve the pain is very apt to spread to the other divisions, and may even cross over to the opposite side and affect the corresponding nerves there.

Accompanying the hyperæsthesia are usually perversions of sensation, such as tinglings; these are generally worse at night. It is also very common for trophic changes to be met with in the part supplied by the affected nerve. The temperature of the limb may at first be considerably raised, whilst the cutaneous circulation is increased, and the limb looks flushed and hot. Various eruptions, such as bullæ on the skin and subsequently indolent ulcers, may also occur. The nails become rough and corrugated, whilst bullæ are common about the tips of the fingers and toes. After a time sensation becomes less and less acute, and the anæsthesia may gradually increase until complete loss of sensation is established. The muscles supplied by the motor fibres waste, but complete paralysis rarely or never occurs. It generally only affects two or three of the muscles supplied by the nerve, and is seldom present except where the inflammatory process has been very acute, or has lasted so long as to completely disorganize the affected nerve.

When neuritis has once become established, there is a great tendency for the disease to extend along the nerve in both directions; that is to say, it may ascend from the branches to the trunk or *vice versâ*. Under these circumstances a condition that was at first one of local or peripheral neuritis, readily develops into the more diffuse or multiple variety.

In bad cases the affection may ascend as far as the spinal cord, where in the severer forms a myelitis may actually be set up.

**Diagnosis of Neuritis from Neuralgia.**—Before proceeding to describe the treatment of this affection, a few words must be said with regard to the differential diagnosis of neuritis from neuralgia. These two affections are very apt to be confounded—a matter of primary importance since the treatment differs considerably in the two cases. The pain in neuralgia is, as a rule, intermittent, whilst in neuritis it is continuous; in neuralgia there is not the same tenderness along the course of the nerve as is almost invariably found when the nerve is actually inflamed. In neuralgia there is no local elevation of temperature, no spasm of the muscles supplied by the nerve, no paralysis, and none of the sensations peculiar to neuritis; and lastly the trophic lesions above described do not occur, at any rate to the same extent.

**TREATMENT.**—In certain cases **prophylactic treatment** is of great importance. This is especially so with wounds in the neighbourhood of large nerve trunks, and particularly when the latter have either been divided or lacerated. Under these circumstances the risk of neuritis must always be borne in mind, and particular care must be taken to prevent it.

The first point of importance is to *see that the wound is made aseptic*, and is kept so during the whole process of the healing, because neuritis is much more frequent in septic wounds than in those kept aseptic. Hence, in all cases of accidental wounds involving important nerves, or occurring in their neighbourhood, scrupulous care should be taken in disinfection, which should be done on the lines already laid down in Part I., p. 184. Search should also be made for any *foreign body* which may be lying in contact with the nerve.

When a nerve is divided in a wound, it is important to *see that its ends are not left projecting* upon the surface, or in any position in which they may become involved in the scar. Hence in amputation wounds it is always the rule to pull out the large nerves with forceps, and snip them across, so that they shall be divided at a considerably higher level than the muscles and other structures. When a nerve has been torn across instead of being divided, it is always well to *cut off the lacerated portion*, and whenever it is possible the divided ends of the nerve should then be brought together and sutured.

**When neuritis is established** the most important point is to *search for the cause* and, if possible, remove it. It must be borne in mind that the cause may be either local or general, and also that a neuritis set up by a local cause may sometimes be much aggravated by some general constitutional condition such as those we have already referred to. Any local cause must, therefore, be searched for in the first instance. Should the neuritis be due to some inflammation in the vicinity of the nerve, such as a carious tooth, this should be removed, or, at any rate, the inflammation should be treated upon suitable lines so as to get rid of it as quickly as possible. Should the neuritis occur in connection with a cicatrix, the scar must be excised; should it occur in connection with amputation flaps, a fresh amputation must be performed higher up, or the flaps must be freely opened up, and the ends of the nerves freed from the scar and cut short, so as to avoid the possibility of their implication a second time. In addition, any constitutional causes should be treated; if the patient be alcoholic, the alcohol should be cut off; should there be a distinct rheumatic tendency, treatment by salicylate of soda or salicin should be adopted; while, if the patient be gouty, a course of colchicum and iodide of potassium should be administered and the diet regulated. Similarly in syphilitic cases much good may be done by the administration of large doses of iodide of potassium, either alone or in combination with mercury (see Part I., p. 235). The general health should in any case be attended to. If there be anæmia, the administration of iron and arsenic will often give great relief to the pain, while quinine is also a very valuable drug.

1. **In acute neuritis** a mercurial or saline *purge* should be at once administered, five to ten grains of calomel being the best for the purpose. The patient should be *confined to bed* if the neuritis affect the lower extremity, or to a warm room if it be situated elsewhere. Should there be a *septic wound*, this should be treated energetically, carefully washed out and properly drained (see Part I., p. 185). The local treatment will be one of the methods already recommended for the treatment of acute inflammation (Part I., Chap. I.). *Hot fomentations* along the course of the nerve are often of considerable value, and to them a few drops of tincture of belladonna may be added with advantage; their action may be still further enhanced by applying an india-rubber hot-water bottle of suitable size outside them. The frequent use of *baths* as hot as they can be borne, or douching the part with hot water, will generally ameliorate the symptoms, and the employment of a Turkish bath may in some cases be followed by considerable relief. If, however, a Turkish bath be employed it must be one of the small portable baths which can be used in the patient's own room. It is of course impossible to allow anyone suffering from acute neuritis to go out of doors for the purpose of taking a bath, because there would be a very considerable risk of catching cold afterwards, and, therefore, the affection might be considerably aggravated. The superheated air apparatus (Tallerman's) often gives good results, particularly when the neuritis affects the upper extremity.

*Local blood-letting*, especially in the form of the application of leeches along the course of the nerve, is very useful, and should be used when the fomentations do not give sufficiently prompt relief. After the leeches have detached themselves, the hot fomentations should be continued. When the pain is very acute it will also be necessary to have resort to general anodynes, and those on which the chief reliance is to be placed are morphine and cocaine or eucaine. Of these, *cocaine* in doses of about a sixth of a grain injected hypodermically in the form of a 2 per cent. solution as near the seat of pain as possible, or higher up along the course of the nerve, is most likely to be uniformly successful. The drug should not all be injected at one spot, but should be distributed, a drop or two at a time, over the tissues around the nerve. The cocaine acts locally upon the nerve affected, and thus often produces immediate, though temporary relief; *eucaine* may also be used in somewhat larger doses ($\frac{1}{4}$-$\frac{1}{3}$rd grains). When the pain is very severe, and the affection comparatively widespread, it may be necessary to have recourse to subcutaneous injections of *morphine*, and these are likely to be more certain and more lasting in their effect than cocaine. Great care, however, must always be taken in employing a remedy of this kind to avoid the possibility of setting up a morphine habit; nothing is worse than to allow a patient to practise the injection for himself, or to have the drug injected whenever he feels the inclination for it.

*Phenacetin* and *antipyrin*, in doses of from five to ten grains every four or six hours, are also of use in some cases. *Exalgine*, in 2-3 grain doses, is especially useful in neuritis affecting the face or head. Apart from this necessity for relieving the acute pain, the treatment is precisely the same as that for other forms of acute inflammation (see Part I., Chap. I.).

2. **In chronic neuritis,** which either follows an acute attack or has been chronic from the first, the treatment consists partly in the employment of *constitutional remedies*, according to the diathesis of the patient—a point already dwelt upon on page 260—and partly in the employment of *local measures* which principally take the form of counter-irritation, followed, as the case improves, by massage, friction, and particularly galvanism. The best form of *counter-irritation* is either a blister or, still better, the actual cautery (Corrigan's) applied over the course of the nerve. If a blister be employed it should be long and narrow, and should be applied with its long axis corresponding to that of the nervc. It should be repeated once a week if necessary, and it is well to prolong the effect by the application of savin or resin ointment to the blistered surface. The method of applying blisters or the actual cautery has been fully described in Part I., p. 18. *Galvanism* is also of considerable value in the more chronic cases. It is best to employ an ascending current, that is to say, the negative pole of the battery is applied to the spine or some indifferent point, whilst the positive electrode is placed over the nerve; no interruptions should be made in the circuit. The current should at first be very weak, and should only be increased very gradually; if it aggravate the pain it should be at once discontinued. When benefit seems to be accruing from its employment, the current may be applied daily for from twenty minutes to half an hour at a time, its strength being gradually increased.

After the pain has disappeared, *massage* should be employed, and this may also with advantage be carried out in the direction of the affected nerve trunk. A good way of combining these various procedures is to order the patient to take frequently a bath as hot as he can bear it, and on emerging from it to have the limb vigorously massaged until the skin is thoroughly glowing. The limb is then wrapped up in flannel or cotton wool, and the patient rests either in bed or upon the sofa for some time. Various anodyne linaments may be useful when the pain is severe, and their use should always be resorted to in preference to the employment of morphine or cocaine as long as they are of any value in arresting the pain. The best of these are linimentum belladonna, linimentum terebinth. aceticum, or the following liniment:

| | | |
|---|---|---|
| ℞ | Menthol, | one drachm. |
| | Liniment. camph. co., | half an ounce. |
| | Liniment. belladonnæ, | half an ounce. |

The employments of these liniments after a hot bath at night is valuable, as the pain is apt to increase when the patient goes to bed.

*The constitutional treatment* must be on the lines already mentioned, namely, the administration of tonics, of which quinine and strychnine, iron and arsenic are of the greatest value, whilst at the same time the patient must have plenty of fresh air, and be under good hygienic conditions; any constitutional condition which may have any bearing upon the affection should also receive appropriate medical treatment.

Should these palliative measures fail to relieve the patient, and to arrest the neuritis, the question of *operative interference* will arise. Palliative measures should not be persisted in too long, and should be abandoned at once in favour of operative procedures, should the symptoms indicate that the neuritis is spreading in spite of careful treatment; in any event bad cases should be operated upon if no improvement takes place in six weeks or two months. The operative measures suitable for neuritis are—(1) nerve-stretching; (2) neurotomy; and (3) neurectomy.

**Nerve-stretching.**—Nerve-stretching was first used by Nussbaum, about 25 years ago, and has since been much employed in cases of obstinate neuritis, more particularly in the form affecting the sciatic nerve (sciatica). The results of the operation vary very considerably, but in some cases the benefit is most marked. The precise manner in which the effect is produced, however, is by no means clear, but in part the explanation may be that the new fibrous tissue which is forming in the nerve in consequence of the inflammation, and which exerts injurious pressure upon the nerve fibrils, is torn through by the stretching, and thus the pressure upon the nervous elements is relieved. Nerve-stretching also produces some alteration in the transmission of the nerve currents, and thus leads to temporary diminution in the transmission of sensory impulses and considerable relief of the pain that is a constant accompaniment of the affection. In the majority of cases of bad neuritis the immediate effect of nerve-stretching properly performed is very marked indeed; the pain may disappear entirely, and is almost invariably much improved, while for a time at least the patient may be apparently well. In some cases this improvement is permanent and a cure results; in the majority, unfortunately, there is apt to be a recurrence after a time, which is probably due to extension of the inflammation and the formation of fresh adhesions in and around the nerve.

In this operation the nerve is exposed by a free incision of suitable length immediately over its course, freed from the surrounding parts and stretched. In a large nerve this is generally performed by the fingers; in

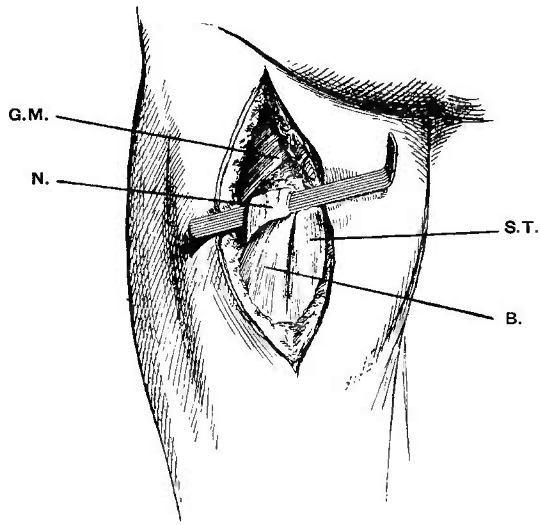



FIG. 93.—OPERATION FOR EXPOSURE OF THE GREAT SCIATIC NERVE.—
G.M. Gluteus maximus muscle.
B. Biceps muscle.
S.T. Semi-tendinosus muscle.
N. Great sciatic nerve, with spatula passed beneath it.

a smaller one it is done by introducing beneath it a blunt hook or similar instrument, upon which the nerve is lifted and traction is thus exerted. In order to describe the method more minutely, we may take as an example the operation upon the sciatic nerve, which is the one most frequently performed. The nerve is exposed by an incision five or six inches long made directly over its course; the centre of the incision corresponds to the lower edge of the gluteus maximus muscle. When the fibres of the latter are exposed, they are hooked well up out of the way by large retractors, the deep fascia of the thigh divided, and the nerve found by following the outer edge of the biceps muscle, beneath and to the outer side of which it lies (see Fig. 93). The nerve is freed from the surrounding parts by one or two strokes of the knife or a suitable dissector, one or two fingers are hooked around it, and by their means it is gradually pulled well up out of the wound, and traction exerted upon it. It should always be pulled sufficiently far out of the wound to allow the whole hand to pass between it and the back of the thigh (see Fig. 94).

The exact amount of force that it is advisable to employ so as to stretch a nerve effectually without damaging it, will vary of course with the particular nerve operated upon. In the case of the sciatic, great force is required to produce rupture; roughly speaking the limb may be raised from

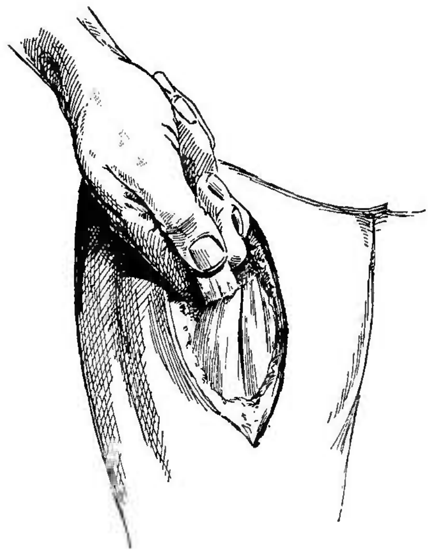


FIG. 94.—METHOD OF STRETCHING THE GREAT SCIATIC NERVE.—The sketch shows the nerve being lifted well up by the fingers passed beneath it and firmly pulled upon.

the table by pulling upon the nerve without fear of doing any damage. This corresponds to a pull of from thirty to sixty pounds, which is well within the limit of safety. The traction should be steady, and should be made in both directions, the peripheral end of the nerve being first pulled upon and afterwards the central; rather less force should be employed in the latter direction. It is common to feel bands of fibrous tissue giving way as the stretching is carried out, and at the end of the operation the nerve will often be found a good deal increased in length, so that it lies loose and flaccid in the wound.

After the nerve has been stretched, it is replaced in the wound, all hæmorrhage stopped, and the wound sewn up without the employment of a drainage tube. Special care must be taken to avoid any possibility of septic infection, as this would aggravate the neuritis already present. The usual effect of the operation is to produce a temporary paralysis of the part supplied by the nerve, which is generally partial but which may be complete. This is often accompanied by perversion of sensation, which gradually passes off as the function of the nerve becomes restored. After the wound has healed, friction, massage, and counter-irritation should be employed.

**Neurotomy.**—When nerve-stretching has been employed in vain for neuritis of a sensory nerve from which the patient is suffering great agony, some further operative interference becomes necessary; this generally takes the form either of neurotomy or neurectomy. It is essential for the success of either of these operations that the portion of nerve divided or excised should be well above the seat of the inflammation, as otherwise the affection spreads upwards in spite of it. The nerve should be exposed as near its central origin as possible before it is divided. Of the two operations neurectomy is much more likely to be efficient than simple neurotomy; when the latter is employed for neuritis of sensory nerves the transmission of impulses is often very rapidly restored, and the relief given by the operation is but temporary.

**Neurectomy.**—We are therefore forced to the conclusion that the best practice is to perform neurectomy when it is possible, and to excise a large portion of the nerve—two inches or more—so as to completely prevent the transmission of impulses along it. Moreover, after the nerve has been divided it is well to turn the divided ends to opposite sides of the wound, so that they do not lie in a straight line; there is thus a further obstacle to the possibility of subsequent union. The operation should, of course, be confined to purely sensory nerves, except in cases of inoperable malignant tumours, where loss of motion is of no consequence.

When a sensory nerve cannot be exposed above the inflammatory area, the question of the removal of the posterior nerve roots of the affected trunk and the ganglion upon them must be entertained. The mere division of the nerve root, without the destruction of the ganglion upon it, does not seem to be nearly so effectual as complete excision of this structure, together with that part of the posterior nerve root upon which it lies. If this procedure is to be adopted at all, it should not be too long delayed, as otherwise the neuritis will have extended so far upwards as to have actually reached the spinal cord, and the patient will then be only very imperfectly relieved by operation.

*Excision of the posterior nerve roots.*—In order to remove portions of the posterior nerve roots the spinal canal must be opened, and the spinal dura mater divided; the particular nerve roots can then be cut off close to their origin from the cord, and as much removed as can be reached. At the same time, the ganglion on each root thus excised should be taken away as completely as possible, either by cutting or tearing it away. Great care must be taken to avoid injuring the anterior roots, so as to obviate the motor paralysis that would otherwise ensue. The operation is done as follows. The patient is turned over upon the face, and, as the operation usually involves a very considerable amount of shock, all the measures recommended for its prevention (see Part I., p. 138) should be carried out. The spinous processes of the vertebræ are carefully counted, and those which require removal are noted. In order to avoid mistake in the latter part of the operation, these processes may be marked out by driving a needle or some similar instrument into one of them, so as to act as a guide for identification later on. The early stages of the operation are exactly the same as those for laminectomy for any other object. A median vertical incision is made over the spinous processes right down to the bone; this should be at least four or five inches in length, and corresponds of course to the vertebræ opposite which the affected nerve roots are given off from the spinal cord. The soft parts in the vertebral groove on each side are then rapidly stripped off the spinous processes and laminæ by a suitable periosteum detacher well back to the transverse processes. This is much facilitated by a long incision; if the patient be very muscular or fat, a small transverse incision may be made at each end of the vertical one. At this stage of the operation there will generally be very free bleeding, but it is not advisable to waste time in attempting to pick up the bleeding vessels, as the hæmorrhage is merely in the nature of very free oozing. The dissection should be carried out rapidly, and then a sponge as hot as the hand can bear should be firmly packed into the wound on the one side while the opposite vertebral groove is being cleared; when both sides have been cleared, any bleeding point that still continues to spout may be clamped. After retracting the soft parts thoroughly, the spinous processes should be identified so as to avoid the possibility of dividing the wrong nerves, and the spines should then be clipped off with a pair of cutting pliers bent at a suitable angle (see Fig. 95). The number of spinous processes removed should correspond to the number of laminæ that will require division.

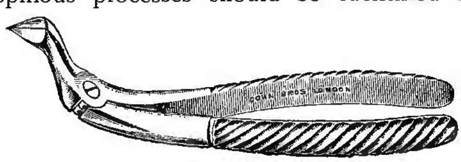


FIG. 95.—LAMINECTOMY PLIERS.

The next step in the operation is to open the spinal canal by dividing the laminæ; there are two methods of doing this. On the one hand, the laminæ may be removed entirely; on the other, they may be simply divided, turned back, and subsequently replaced in position. Of the two operations the latter is of course undoubtedly the better, because after the operation the bony covering to the cord is restored, and all chance of adhesion between the cicatrix and the dura mater is avoided. On the other hand it considerably prolongs the operation, adds to the shock, and is not always easy to perform. We shall describe both methods, it being of course understood that the laminæ should be retained whenever the condition of the patient renders it feasible.

When it is decided to remove the laminæ entirely, the lamina of one vertebra—it is immaterial which, but generally the one at the upper or lower limit of the incision is selected—is carefully cut through first on one side and then on the other, as far out as possible, either by a suitable bone forceps or by careful strokes with a hammer and chisel. This removal of the first neural arch is the most difficult part of the operation. Great care has to be taken to prevent the point of the instrument penetrating through the dura mater and doing damage to the cord or to the nerve roots. When the section of the bone is completed, the lamina is removed by dividing the ligaments connecting it with the vertebræ immediately above and below it, and then it is quite easy to detach the remaining laminæ by means of cutting pliers bent at a suitable angle, and thus to open the vertebral canal fully.

Should it he decided to retain the laminæ, they may be turned back in one piece, after the removal of the spinous processes, by first of all carefully dividing the requisite number of laminæ on each side by a chisel, Hey's saw, or cutting pliers, and then dividing the ligaments connecting the lowest lamina of the block with the one below it, and turning up the laminæ in one mass on a hinge which is formed by the ligaments connecting the uppermost lamina divided with the one immediately above it. In order to facilitate the turning back of the laminæ, it is well to cut away the spinous process of the vertebra immediately above the uppermost of the detached laminæ.

After the vertebral canal has been opened, a quantity of fat containing a large plexus of veins is found lying immediately over the dura mater. This should be carefully divided in the middle line with as little damage to the veins as possible; probably in any case there will be very free oozing, which should be stopped before the operation is further proceeded with. One of the best methods of arresting the oozing is to apply a soft sponge wrung out of lotion as hot as the hand can bear. After the hæmorrhage has been arrested, the dura mater is slit up in the middle line throughout the whole extent of the wound, and the edges carefully held apart either by fine toothed forceps or by one or two fine silk sutures passed through it.

The next point is the identification of the nerve roots that are to be resected. The desired posterior nerve roots are then divided close to the spinal cord, turned outwards, and as much as possible of them removed. The dura mater is then pulled in towards the middle line, and the ganglion upon the posterior nerve root is broken up and dissected out. When the operation is completed, all bleeding is arrested, and the incision in the dura mater is closed by one or two fine catgut sutures. If the laminæ have been merely turned back they are replaced, and the skin wound is sutured. There is no need to fasten the laminæ in place by stitches or other contrivances. It is well as a rule to insert a small drainage tube at the lower end of the wound, because there may be a good deal of oozing from the plexus of veins over the dura mater, which, if it could not escape, might lead to injurious pressure upon the cord.

**Acupuncture.**—At one time the plan of puncturing an inflamed nerve by a long needle was much in vogue; it was especially used in cases of inflammation of the sciatic nerve. The patient is not anæsthetised. The position of the nerve is first marked out partly by anatomical data and partly by the pain experienced on pressure. A long round needle is then thrust rapidly through the skin down into the nerve. The only way of performing this operation successfully is to use a very sharp needle and to plunge it rapidly through the soft parts, as otherwise the point of the needle glances off the nerve and does not penetrate it. After the first needle has been introduced it is left *in situ* so as to fix the nerve, along the course of which some six or eight needles are then introduced at other points. A good guide as to whether the nerve has been punctured or not is the pain experienced by the patient. The pain on puncturing a nerve is sharp and characteristic and is referred to the particular nerve itself, whereas there is no particular pain attached to a puncture rapidly performed through the soft parts; if, therefore, any of the needles fail to elicit this characteristic symptom, they should be removed and re-introduced. The mode in which this procedure acts is very difficult to understand, but it undoubtedly gives relief in not a few cases, and as it is perfectly harmless, it might, in the case of a large nerve like the sciatic, precede the performance of such an operation as nerve-stretching.

**Summary of treatment.**—We may summarize the treatment of neuritis in the order in which it should be employed as follows. *In acute neuritis* the first indication is to remove the cause; besides this, rest, hot fomentations, mustard leaves, and the use of anodyne liniments, antipyrin, etc., or the injection of morphine and cocaine should be resorted to in order to relieve the pain. The patient's diathesis should also be considered, and if there be gout, rheumatism, syphilis, etc., constitutional remedies such as colchicum, salicylate of soda, iodide of potassium, and so forth should be administered.

*In chronic neuritis* rest and counter-irritation (which is best carried out by the use of Corrigan's cautery, blisters and galvanism) are the chief agents. Any constitutional affection that may be present should be treated on the lines just detailed for the acute forms. Anodyne applications, chiefly in the form of liniments, should be employed at night, and, if the pain be severe, occasional injections of morphine may be used. As the neuritis improves, the employment of hot baths and the use of douches and mild massage are very useful. In the more refractory cases operative procedures have to be considered. Where the nerve is a large one, such as the sciatic, it is well perhaps to commence by employing acupuncture. Should this fail, or should the nerve be one of the smaller ones not likely to be hit off by the needle, nerve-stretching is the best procedure; should that fail neurectomy may have to be resorted to in the case of a sensory or mixed nerve. Should the neuritis occur in connection with malignant disease, or any other incurable malady, neurectomy may be at once performed without wasting time by trying nerve-stretching. Under these circumstances, and even in certain cases where the pain is intolerable but the cause is not the pressure of a malignant tumour, the question of the division of posterior nerve roots, in any case in which the nerve cannot be clearly exposed above the limit of the inflammation, must be considered. Thc operation is of course a very much more severe one, and should only be undertaken when the patient suffers such intense agony as to render life unbearable. Under these circumstances, however, it may quite legitimately be performed, and it should not be too long delayed. The ganglion should always be destroyed at the same time that the nerve root is resected.

## NEURALGIA.

Neuralgia is a condition characterised by lancinating pain along the course of a nerve without any co-existing pathological change in the nerve itself. The affection often begins in connection with inflammation or the presence of a foreign body in the neighbourhood of the nerve, or from direct pressure upon some portion of it. The condition differs from neuritis inasmuch as in the latter disease there is an inflammatory change in the structure of the nerve, whilst in neuralgia there are no pathological changes to be found. The affection is very common in anæmic and debilitated subjects, and is frequently met with in those who are neurotic. It is also said to be due to malaria, over-exertion, shock, exposure to cold, etc.

The symptoms consist mainly of paroxysmal attacks of pain of great severity, which start from one point in the distribution of the nerve and extend along its course. In the intervals between the paroxysms there may be entire absence of pain. As a rule there is no pain on pressure over the course of the nerve except when the points pressed upon are those at which the nerve passes through an opening in fascia or bone. The pain often interferes with sleep, and in this way the patient's general nutrition is impaired, but there are no trophic changes occurring in connection with true neuralgia.

**TREATMENT.**—The treatment of neuralgia belongs in the first instance essentially to the physician, but when medical remedies fail the surgeon is not infrequently called in.

**Medical treatment.**—This will consist in the use of various *internal remedies* to improve the patient's general condition, foremost amongst which are those employed for the treatment of anæmia. Of these the most important drugs are arsenic in increasing doses, iron, quinine, strychnine, etc. At the same time careful search must be made for any constitutional tendency which may require rectification; for instance, gout will require treatment with colchicum and other appropriate remedies; rheumatism, with salicin or salicylate of soda; and iodide of potassium will be called for when there is a syphilitic history. For the relief of the pain various *external remedies* will be required, of which the most important are the anodyne liniments, especially belladonna liniment; menthol and aconite are also of considerable use.

Another method of relieving the pain is by the hypodermic administration of such drugs as atropine, cocaine, and morphine. A weak galvanic current may be used daily, and often gives considerable relief. The positive pole should be applied near the seat of the pain, whilst the negative is connected with a large, flat, moist electrode placed over the spine. The current should be passed for 10 to 15 minutes at a time; it should be sufficiently weak not to cause any pain, and it should only be very cautiously increased in strength; no interruptions should be employed in the circuit.

**Operative treatment.**—Of the surgical operations that have already been described in the treatment of neuritis, there are only two applicable to cases of neuralgia: these are *neurotomy* and *neurectomy*, of which the latter operation is far preferable. The portion of nerve excised should be as far away as possible from the seat of the pain. Indeed, in some cases it is advisable to perform the operation in the immediate neighbourhood of the central origin of the nerve, and in some cases one may go back to the spinal or cerebral regions for this purpose, as, for example, in the removal of the Gasserian ganglion for trigeminal neuralgia.

**CONVULSIVE TIC.**—Another nerve affection which must also be shortly referred to, and which will be considered in detail when we deal with the affections of the head and neck, is that in which intermittent muscular spasms occur as a result of some affection of the nerves, more particularly in the facial and cervical regions. This condition is spoken of as convulsive tic, and consists of intermittent and involuntary contraction of various muscles or groups of muscles.

The surgical treatment of this condition will be either *nerve-stretching* (which, however, is only likely to succeed in the milder cases) or *neurectomy*, which may succeed in curing the disease if practised sufficiently early and freely.

## TUMOURS OF NERVES.

**NEUROMATA.**—The ordinary tumours of nerves are spoken of as neuromata, but as a rule they are not strictly neuromata at all, that is to say, they do not consist of true nerve tissue. The ordinary neuroma is usually of the connective tissue type, being in structure either fibromatous or myxomatous; these tumours usually commence in connection with the connective tissue of the nerve sheath, and may be entirely outside the nerve, or may occur between the nerve bundles. They give rise to neuritis and neuralgic pain, which is sometimes quite insupportable. Later on they may cause paralysis both of motion and sensation (if they occur in a mixed nerve) from the pressure they mechanically exert. The tumours may be single, but when myxomatous they are frequently multiple.

**Treatment.**—The treatment of a tumour of this kind should be early and complete removal. If it grow outside the nerve it can generally be dissected off without interfering with the continuity of the nerve trunk. When, however, it grows in the substance of it, it will be necessary to excise a portion of the nerve containing the tumour, and then to perform immediate nerve suture. The method of performing this has already been described (see p. 251).

**MALIGNANT TUMOURS.**—Malignant tumours are also not uncommonly met with in connection with a nerve, but they usually involve it secondarily, either by pressing directly upon it and stretching it as they grow, or by actually invading and destroying it, as is generally the case in a carcinomatous tumour.

**Treatment.**—For tumours that can be removed, this will be early and free removal, with the portion of the nerve implicated, followed if possible by immediate nerve-suture (see p. 251). In cases in which the tumour cannot be removed the treatment can only be directed towards the symptoms, and surgical treatment is only necessary when a sensory nerve is involved and unbearable pain is caused. Should this be the case, a portion of the nerve should be excised well above the tumour so as to prevent the transmission of impulses upwards. In a mixed nerve this operation, of course, entails motor paralysis of the parts supplied by the nerve, but this is of no moment, since the case must eventually end fatally; the important point is to secure a moderate amount of comfort for the patient by the relief of pain. When the tumour is situated in regions where it is difficult to expose the nerve above the seat of pressure, as for example in pelvic tumours, division of the posterior nerve roots may be carried out with advantage, the pain being thereby abolished and the patient much relieved. The operation is performed in the manner already described for the treatment of obstinate neuritis (see p. 265).

## OPERATIONS FOR EXPOSING THE MAIN NERVE TRUNKS IN THE UPPER EXTREMITY.

The operations on the nerves of the head, neck, and trunk, will be referred to when we come to deal with the affections of those regions. In all cases where it is desired to expose a nerve, it is best if possible to make a flap, and turn it upwards, downwards, or to one side, so that the scar shall not lie over the line of the nerve itself; thus there will be no risk of entanglement of the nerve in the scar tissue. This is of course not always possible where there is already a cicatrix present. We may here give shortly the steps of the operations required for the exposure of the different main nerve trunks of the extremities.

**THE MEDIAN NERVE.**—It may be necessary to expose this nerve, either for the purpose of stretching it or suturing it after division. In the upper arm the nerve is readily accessible from its close relation to the brachial artery, being on its outer side in the upper third of the arm, and crossing in front of the artery about the centre to its inner side, along which it runs in the lower third. In the forearm it is rarely necessary to expose the nerve, as it there lies very deep between the superficial and deep flexor muscles, and as a rule escapes injury. The commonest situation in which operations upon this nerve are required is the lower third of the forearm or the front of the wrist, where the nerve lies between the tendons of the flexor carpi radialis and the palmaris longus muscles.

(*a*) **In the Upper Arm.**—In this situation the nerve is most conveniently exposed by an incision in all respects similar to that required for ligature of the brachial artery. The steps of the operation are the same and will be found described in Chap. XXI.

(*b*) **In the Upper Third of the Forearm.**—Here the nerve lies on the inner side of the radial artery, and dips between the two heads of the pronator radii teres muscle. An incision similar to that for ligature of the radial artery in the upper third is made and the pronator radii teres is exposed where it crosses the nerve. If a few fibres of the muscle be then incised internal to the artery or if the muscle be pulled sufficiently forcibly inwards, the nerve is at once rendered accessible.

(*c*) **On the Front of the Wrist.**—The nerve is here quite superficial and is readily exposed by making an incision about an inch and a half in length, parallel to the tendon of the flexor carpi radialis and somewhat to its inner side. The deep fascia is divided and the tendons pulled aside, when the median nerve will at once come into view, lying between the tendons of the flexor sublimis and the flexor profundus digitorum. The former tendons will require to be pulled out of the way.

**THE ULNAR NERVE.**—In the upper third of the arm this nerve passes down between the axillary artery and the vein, after which it leaves the vessel and pierces the internal inter-muscular septum to reach the interval between the internal condyle of the humerus and the olecranon process of the ulna; in this part of its course it is accompanied by the inferior profunda artery. Subsequently it passes between the two heads of the flexor carpi ulnaris, and running down beneath that muscle and upon the flexor profundus digitorum it reaches the wrist. At the junction of the upper with the middle third of the forearm it approaches the inner side of the ulnar artery very closely and runs down with it to the wrist. At the front of the wrist it lies close to the radial border of the pisiform bone, where it divides into two terminal branches.

(*a*) **In the Arm.**—The best place to expose the ulnar nerve in the upper arm is about the centre, where the nerve is just passing through the internal inter-muscular septum. This is easily done by an incision about two inches long situated about half an inch more internally than that employed for the ligature of the brachial artery (see Chap. XXI.). The internal inter-muscular septum is exposed and divided, and the triceps is pulled well backwards whilst the brachial artery and the septum are pulled forward, when the nerve will be found lying upon the inner side of the triceps accompanied by the inferior profunda artery.

(*b*) **At the Elbow.**—Here the ulnar nerve lies immediately behind the internal condyle in the interval between it and the olecranon process, and can be readily felt by the finger and exposed by an incision over it; it is best to make a somewhat curved incision over the olecranon and to turn a flap inwards. This operation is not very frequently required, but it is sometimes called for from the presence of a neuroma upon the nerve or some inflammatory change about the internal condyle giving rise to neuritis, or to dislocation of the nerve forward over the condyle. In the latter case, of course, the nerve after it has been exposed should be replaced in its proper position and the fascia stitched together over it so as to form a sort of sheath to prevent the dislocation recurring.

Should the nerve require stretching, it is best exposed just above the condyle, where it is easily accessible, as the nerve can be felt immediately behind the condyle and traced upwards until it passes towards the front of the arm. Here it may be cut down upon and found behind the internal inter-muscular septum.

(*c*) **On the Front of the Wrist.**—The nerve is here very superficial and can be exposed by a small incision parallel to the tendon of the flexor carpi ulnaris, and on its ulnar side. After the skin and fascia have been divided the nerve is at once seen, with the ulnar artery lying on its outer side.

**THE MUSCULO-SPIRAL NERVE.**—This is the largest branch of the brachial plexus, and is at first situated behind the third part of the axillary artery. Lower down in the arm it is behind the upper part of the brachial artery, but it soon leaves the latter to run, along with the superior profunda artery, in the groove between the inner and outer heads of the triceps; in this groove it runs round the humerus and pierces the external inter-muscular septum, passing downwards between the supinator longus and the brachialis anticus muscles. Just above the bend of the elbow it divides into the radial and the posterior inter-osseous nerves.

The nerve may require exposure either on account of rupture, or from pressure upon it by callus after fractures, or for some neuritis from injury, and it is most commonly exposed about the middle of the upper arm, at which point it lies hehind the humerus in the musculo-spiral groove close to the bone.

(*a*) **In the Middle of the Arm.**—The best guide to the nerve in this situation is that given by Kocher, namely a line drawn along the posterior surface of the upper arm from a point a finger's breadth behind the posterior border of the deltoid, close to the long head of the triceps, down to the tip of the olecranon. The incision should begin immediately below the axillary fold, and the interval between the long and outer heads of the triceps is identified and the two separated down to the bone. The nerve will then be found close to the humerus, between the inner and outer heads of the triceps; in front of it is the superior profunda artery which accompanies it.

(*b*) **In the Lower Third of the Arm.**—Here the nerve is found in the interval between the supinator longus externally and the brachialis anticus internally, and in that situation it is in front of the humerus. An incision is made over this sulcus and the muscles are displaced outwards and inwards, when the nerve will be seen lying on the bone just before it divides into the two terminal branches—the radial and the posterior inter-osseous.

## OPERATIONS FOR EXPOSING THE MAIN NERVE TRUNKS IN THE LOWER EXTREMITY.

**THE GREAT SCIATIC NERVE.**—This is the largest nerve in the body, and it runs vertically down the thigh to a little below its centre, where it divides into the internal and external popliteal trunks. It lies first beneath the gluteus maximus and the biceps muscles, and it is generally exposed below the lower edge of the former. Its course is represented by a line drawn from the centre of the interval between the tuber ischii and the great trochanter to the middle of the ham. It is exposed by a free incision about four or five inches in length, commencing just above the fold of the buttock, the patient being turned almost completely over upon the face, and the thigh fully extended. After the skin and the fascia are divided, the lower border of the gluteus maximus must be defined, and the fibres will be found running obliquely downwards and outwards. The edge of the muscle is firmly retracted by means of a broad retractor, and the finger is introduced into the wound in order to identify the hamstring muscles just below their origin from the tuber ischii. These are drawn inwards by another retractor, when the nerve can readily be exposed and brought into view. Details as to stretching the nerve have already been given (see p. 263).

**THE INTERNAL POPLITEAL NERVE.**—This nerve runs downwards in the centre of the popliteal space considerably behind the artery and the vein, *i.e.* between them and the skin, and may be readily exposed by a vertical incision over the centre of the ham. After the skin and fascia have been divided, the finger is passed in amongst the fat hetween the two heads of the gastrocnemius muscle, and will feel the internal popliteal nerve, which lies to the outer side of the popliteal vein.

**THE EXTERNAL POPLITEAL NERVE.**—This nerve may be exposed by a similar incision to the last, but it is still more readily felt at a point lower down its course, where it passes round behind the head of the fibula to reach the front of the leg. In order to expose it here, an incision is made along the posterior edge of the tendon of the biceps, which will expose the nerve immediately below the fascia, as it lies along the outer edge of the gastrocnemius muscle. Below the head of the fibula the nerve pierces the peroneus longus muscle.

**THE ANTERIOR CRURAL NERVE.**—This nerve sometimes requires to be exposed, and is best reached where it passes into the thigh between the psoas and iliacus muscles. The nerve trunk has only a short course, as it soon breaks up into its terminal branches. The psoas muscle intervenes between it and the artery. It should be exposed by a vertical incision two or more inches in length just external to the line of the artery, and, after the fascia lata has been divided, the hip joint is slightly flexed, when the nerve will at once be exposed on the outer side of the femoral artery.

**THE INTERNAL SAPHENOUS NERVE.**—This nerve rarely requires to be exposed, but should it be necessary to cut down upon it, a very useful and constant guide is found in the internal saphena vein, which lies just in front of it opposite the internal tuberosity of the tibia.

# CHAPTER XIX.

## THE SURGICAL AFFECTIONS OF VEINS.

### WOUNDS.

WOUNDS of veins are of importance both on account of the immediate and the remote effects that they produce. The **immediate troubles** which have to be dealt with when veins are wounded are (*a*) dangerous hæmorrhage and (*b*) entry of air into the vein. The **remote troubles** are chiefly thrombosis, embolism, pyæmia, and œdema of the part corresponding to the distribution of the vein. The immediate troubles are more common in connection with operation wounds; the remote troubles in accidental ones.

**VARIETIES.**—Wounds of veins are usually described as *punctured*, *incised*, and *contused*, but, having regard to the question of treatment, it is better to speak of them as **operation** and **accidental** wounds. As a rule the bleeding from a wounded vein is comparatively slight and readily stops on light pressure, but in the case of the large trunks, such as the internal jugular or the femoral, the hæmorrhage may at first be profuse, and, unless the bleeding point be compressed at once, the loss of blood may be very serious. The blood which flows from a wounded vein is of course dark in colour and escapes in a steady stream, but in a large vein, like the internal jugular at the root of the neck, the jet varies in height with inspiration and expiration. Wounds of veins heal readily, and complete occlusion of the lumen of the vessel by a thrombus does not necessarily occur; should it take place, the thrombus frequently becomes channelled at a later period by the formation of new vessels, and the circulation through the vein is eventually restored.

**TREATMENT—Of Hæmorrhage.**—This has already been referred to in Part I., p. 129. In the smaller veins temporary pressure alone, exerted either by means of a sponge or a pair of pressure forceps, is usually sufficient to arrest the hæmorrhage, and in a short time the wound in the vein becomes closed by adhesion, and no further bleeding occurs. In the large veins some means of permanently closing the wound in the vessel should be adopted; unless this be done, pressure will have to be kept up for at least twenty-four hours, in order to prevent the occurrence of hæmorrhage. When the vein is divided completely or almost completely across, a ligature should be put around it above and below the seat of injury. If only the distal end, from which the blood comes, be tied, it is frequently found that coughing or some sudden movement will force out blood from the proximal end; in the case of the larger veins in the neck, another reason for tying the proximal end of the vein is to prevent the risk of entrance of air into it. This would otherwise be very likely to occur, as there is considerable aspiration during each act of inspiration, and the veins are rigid where they pass through the openings in the deep cervical fascia and do not collapse properly. An additional reason for tying large veins when they are divided, is that the pressure which may be exerted upon the vein between the wound and the heart by the bandage put on to retain the dressings in position may interfere with the return of the blood and lead to serious hæmorrhage from the open distal end; as soon as the bandage is removed this bleeding will cease. This point should be borne in mind in cases of secondary or reactionary hæmorrhage, because it is very seldom nowadays that bleeding of this kind is arterial; as a rule it will be found that when the dressing is removed the bleeding stops, and it is well therefore not to be in too great a hurry to open up a bleeding wound after the dressing has been taken off, unless it be quite certain that active arterial hæmorrhage persists in spite of its removal.

In some cases, when the vein is deeply seated and it is impossible to get a ligature around it, a pair of pressure forceps applied and left *in situ* for from 24 to 36 hours will satisfactorily arrest the bleeding without causing any material disturbance in the healing of the wound. The latter should be stitched up, except immediately around the forceps, and at this spot a stitch is passed through the edges of the wound, but is left untied. The whole wound, including the handles of the forceps, is then enclosed in an antiseptic dressing, and at the end of from 24 to 36 hours, according to the size of the vein, the dressing is removed and the forceps taken off. The removal of the forceps must be effected most carefully; otherwise the vein may be torn open again. The catch of the forceps should be undone without any lateral movement, the blades then gently separated and withdrawn from the wound. The stitch previously passed and left loose should then be tied, and there will not be any further trouble.

When a large vein has only been punctured, or when a branch has been torn off at its junction with the main vessel, it is often a question as to what is the best thing to do. In the case of one of the large veins of the neck, such as the internal jugular, the simplest plan is to tie the vein above and below the puncture and divide the vessel between the ligatures; this causes no embarrassment to the circulation. When, however, the vein is one, such as the femoral, the axillary high up, or the renal vein, which it is not desirable to occlude owing to the great interference with the circulation which would result, some other procedure must be adopted. The favourite method is to pinch up the opening in the vein with a pair of forceps, and then to apply a ligature to the pinched-up part—in other words, a lateral ligature is put on. This may act very well if the operation be completed and the ligature be applied immediately before the closure of the wound, but if it be applied early in the operation it is very apt to slip or be pulled off during the subsequent manipulations, when of course the bleeding will recur and the opening in the vein will probably be larger than before. The simplest plan in these cases is to sew up the opening in the vein. This is done by a fine Hagedorn needle threaded with the finest catgut. The circulation through the vein must be arrested by pressure above and below the point of puncture while the rent in its wall is being closed. By using a fine Hagedorn the puncture made by the needle is closed as the stitch is tightened and this form of vein suture is not followed by thrombosis. This method is especially useful in cases of injury to the renal vein during operations on the kidney.

Hæmorrhage from veins in bones as a rule stops on pressure, but if it be at all persistent or profuse, the use of Horsley's aseptic wax,[1] which has been referred to in Part I., p. 133, will readily arrest it. A small piece of the wax is pinched off and kneaded in the hand until sufficiently soft, and it is then firmly pressed into the hole from which the bleeding is taking place and the wound is closed.

Where there is continuous oozing from a vein as it passes through dense fibrous tissue or lies in the periosteum, so that it cannot be picked up and tied, the best plan is to pass a curved needle threaded with catgut under the bleeding point, and then to tie the ligature, thus including in it both the vein and a portion of the surrounding fibrous tissue. As a rule, however, in venous bleeding there is not much trouble, and, with the exception of the axillary, the femoral or the renal veins, there need be no hesitation in tying and dividing them. Even in the case of the veins of the extremities, the swelling of the limb, resulting from their ligature, is often very much less than one would expect.

**Of entry of air.**—This has been already referred to in Part I.; it is comparatively rare nowadays, but seems most likely to occur in connection with the veins about the root of the neck, and hence in operating in that region every care must be taken to apply pressure immediately at or below any wound or puncture that may be inflicted upon any of the larger veins; while the pressure on the proximal side is kept up, the bleeding point should be clamped as quickly as possible. This dangerous complication can be still further guarded against, partly by always operating upon tumours, etc., of the neck through a sufficiently large incision, so that the mass has not to be pulled up forcibly to get proper access to it (a proceeding which puts the veins on the stretch, and so renders any opening into them unduly patent), partly by taking care to clamp veins, especially

[1] Beeswax 7 parts, almond oil 1 part, and salicylic acid 1 part. It should be kept in a vessel of 1-20 carbolic acid solution.

on the proximal side, before they are divided, and partly by avoiding all muscular movement on the part of the patient. When air is sucked in—an occurrence often indicated by the characteristic hissing sound—pressure should be at once applied to the proximal end of the vein, and the wound flooded with lotion so as to prevent more air entering. The treatment in cases where air has entered will be found in Part I., p. 143.

Among the remote complications of wounds of veins are inflammation or phlebitis, and, associated with this condition, thrombosis, and possibly subsequent embolism. If the thrombosis be septic, the clot may break down, and portions of it may become detached and lead to abscesses in various parts of the body (see Pyæmia, Vol. I., Chap. X.). Secondary hæmorrhage may also occur from a wound in a vein, but this is very rare nowadays, and generally only takes place in septic wounds in which the clot breaks down and the blood escapes from the end of the vein that is thus allowed to re-open.

## INFLAMMATORY AFFECTIONS.

**PHLEBITIS AND THROMBOSIS.**—By phlebitis is meant inflammation of a vein, and by thrombosis, the formation of a coagulum, either white or red, or both, within the lumen of a blood-vessel, most often a vein; thrombosis is a constant result of phlebitis. Inflammation may affect the lining membrane of the vein, when it is termed *endo-phlebitis*; or all the coats of the vein, when it is known as *phlebitis proper*; or the sheath of the vein and the tissues in which it lies, in which case it is called *peri-phlebitis*. The term phlebitis is, however, usually employed in the widest sense, and includes both endo- and peri-phlebitis.

**Causes.**—The condition may arise from a variety of causes. For example, it may follow an injury which causes bruising of the wall of the vein and the subsequent formation of a thrombus in its interior; it may originate in connection with a septic wound; it may be associated with gout or rheumatism, or with general poisons, such as alcohol or lead, circulating in the blood; or it may follow debilitating diseases, such as typhoid fever, when it is probably of an infective character. It most frequently attacks veins which are already unhealthy, notably those that are varicose and those in which the circulation is unduly slow, or in which there are eddies in the blood stream.

**Pathological Changes.**—The changes which occur in the vein are thickening of its wall, proliferation of its endothelial lining, swelling of the internal coat, and early formation of white clot, with ultimate blocking of the lumen of the vessel. The clot thus formed may extend upwards to the nearest branch; or, if a branch only be affected, the clot may reach the main vein itself, and may there project into its lumen. As a result of any sudden movement this projecting portion may become detached and carried on by the blood stream, and give rise to an embolus; when the piece so detached is large enough to block the pulmonary artery, immediate death may result. The later history of the primary thrombus depends upon whether or not sepsis be present; in aseptic cases the clot becomes firmly adherent to the internal coat, remains solid, and subsequently becomes partly absorbed and partly converted into new tissue. In the process of organization, new venous spaces are very often formed, and extend through the clot from one end to the other; the result of the organisation of the thrombus is that the lumen of the vein may either be restored from this channelling of the new tissue, or the vein may be converted into a fibrous cord. Not infrequently earthy salts are deposited in the thrombus in cases of long-standing phlebitis, so that little hard calcareous masses are formed in the interior of the vein, which are adherent to the walls and are usually found in the neighbourhood of the valves; these are often spoken of as *phleboliths*. When the clot is septic, pyæmia is very apt to occur; this has already been described in connection with that disease. (See Part I., Chap. X.)

**Symptoms.**—The disease may run an acute, sub-acute, or chronic course. Acute phlebitis is generally a septic affection. It is accompanied by high temperature, diffuse redness of the skin over the vein, and œdema of the tissues in its vicinity; later on, when the thrombus breaks down, septic emboli are formed and pyæmia develops. Between the acute and the chronic forms there are all sorts of gradations. In a typical case of phlebitis, it is usual to find pain and tenderness in the part, and the formation of a hard cord in the course of the vein, with redness or dusky discoloration of the skin over it; the patient is otherwise well and there may be little or no pyrexia. These are the cases in which the greatest care should be taken in the treatment, because the patient is apt to under-rate the dangers, and there is often much difficulty in persuading him to lie up. The great danger in these sub-acute and chronic cases is the detachment of a portion of clot, and immediate death from pulmonary embolism. Another danger is that constant movement may lead to the gradual spread of the thrombus, and, as a result, to serious interference with the venous return and possibly pulmonary embolism later.

Œdema is also a frequent sequel of phlebitis and thrombosis in the larger veins. How far it is merely a mechanical effect of the interference with the flow of the blood, and how far it is due to an altered and leaky condition of the capillaries, or to increased lymph formation or diminished lymph removal, are points which are still under discussion. In any case it can hardly be a purely mechanical effect.

**Treatment.**—In the treatment of phlebitis and thrombosis it is, in the first instance, important to determine whether the case is one of true septic phlebitis or one in which there is no risk of the clot breaking down. In the first case the danger is pyæmia; in the second, pulmonary embolism or extension of the inflammation to the main veins and subsequent severe œdema of the limb below.

**(a) Acute Septic Phlebitis.**—The treatment of acute septic phlebitis has already been referred to in speaking of the treatment of pyæmia (see Part I., Chap. X.); the vein must be exposed well on the proximal side of the thrombus, as far from the affected spot as is judicious, tied in two places and divided between the ligatures. An incision must then be made over the seat of the inflammation, the pus around the vein evacuated and the part containing the thrombus excised; if that be impossible, the vein should be opened and the clot thoroughly removed by scraping and irrigation. Any branch that is patent should also be cut off by ligature and division. It is very important not to be content with simply tying the main vein, because the septic clot may spread to other veins and may thus get into the circulation again in a somewhat roundabout way. We need not go further into the treatment of septic thrombosis; the reader should refer to the chapter on pyæmia (Part I., Chap. X.).

**(b) Sub-acute and Chronic Phlebitis.**—In sub-acute or chronic phlebitis, occurring, for example, in varicose veins, the first essential is to avoid the risk of the clot becoming detached and being carried into the general circulation. The patient should be *rigidly confined to bed*, and the affected limb put on a suitable splint and somewhat elevated; the dangers of the affection should be clearly explained so as to ensure that the patient shall keep quiet and avoid any muscular exertion which would tell on the inflamed vein.

For the relief of the pain and in order to try to arrest the inflammation, *cold* should be applied in the first instance; this may be in the form either of an ice-bag, or, in old and feeble people, of lead and opium lotion.[1] When the pain is very intense and cold does not relieve it, and particularly if the patient be weakly, *warm fomentations* should be substituted. Of these two applications, warm fomentations used soon after the commencement of the disease are, as a rule, more effectual both in relieving the pain and arresting the inflammation. When the pain is severe, the administration of *opium* may be called for; *digitalis* is also useful in the acute stage when there are no symptoms to contra-indicate it. After the acute pain has subsided, *glycerinum belladonnæ* (B.P.) should be smeared thickly but very gently over the part, and a layer of cotton wool applied outside. Care must be taken in applying this merely to spread it over the surface of the skin without employing friction; otherwise there is a risk of disturbing the clot.

The limb should be kept at rest for three weeks at the very least. It takes about that time for a clot to become organised and adherent to the wall of the vessel in which it lies, and before this time has elapsed there is always a risk that movement may lead to its detachment. In the clinical history of phlebitis, especially when it is associated with gout or with varicose veins, it is not infrequently found that after the lapse of a week or ten days, when the patient is apparently getting better, there is a fresh

[1] Tinct. Opii m.x-xx, Liq. plumb. subacet. dil. ad ℥j.

extension of the disease; therefore the period for which the patient is kept in bed must be reckoned from the appearance of the last extension of this kind and not from the first onset of the disease. Hence, it is not uncommonly necessary in cases of inflamed varicose veins to keep a patient at rest for six weeks or longer.

Apart from the risk of detachment of the clot, it is commonly found that, if the patient be allowed to get up too soon, the result is immediate extension of the phlebitis, and the only effect of attempting to hasten matters is thus to cause very considerable delay. In phlebitis occurring in varicose veins the process may often be cut short by tying the vein well above the thrombosed area and then excising the thrombosed portion; this is the best treatment to adopt under the circumstances.

**Gouty Phlebitis.**—When there is any gouty tendency, the appropriate constitutional treatment for gout must be adopted. A very good local application to inflamed and thrombosed veins is that recommended by Dr. Burney Yeo for inflamed gouty joints, viz. a lotion containing half an ounce of bi-carbonate of soda (in crystals) and two drachms of laudanum to ten ounces of water. A portion of this should be mixed with an equal quantity of hot water, and pieces of lint or soft linen thoroughly wetted with it should be freely applied to the affected part and some of the hot lotion poured over the dressing, which should then be covered with oiled silk overlapping it in all directions, and enveloped in cotton wool.

If the phlebitis be associated with an acute attack of gout, it is a good plan to combine the administration of colchicum with a saline aperient, such as sulphate of magnesia. Dr. Burney Yeo gives the following useful formula :

| | | |
|---|---|---|
| ℞. | Magnesii sulphatis, | 1½ oz. |
| | Magnesiæ levis, | 2 drachms. |
| | Potassii citratis, | 4 ,, |
| | Tinct. sem. colchici, | 2 ,, |
| | Aq. carui, | ad 8 oz. |

M. ft. mist. Two tablespoonfuls, with two of hot water, every three hours until the bowels have been freely relieved.

The sulphate of magnesia may be omitted after the bowels have been well relieved, and when the pain has to a great extent subsided the mixture may be taken thrice daily, but it is well to give each morning a dose of the original mixture to ensure the proper evacuation of the bowels. The same authority gives the following formula for use when there is reason to avoid the use of colchicum and when no aperient action is called for:

| | | |
|---|---|---|
| ℞. | Sodii salicylatis, | 2 drachms. |
| | Lithii salicylatis, | 40 grains. |
| | Potassii citratis, | 4 drachms. |
| | Tinct. zingib., | 20 minims. |
| | Aq. cinnam., | ad 8 oz. |

M. ft. mist. Two tablespoonfuls every two or three hours until the pain is relieved, then every five or six hours.

If the gout be of the chronic form, the following formula given by Whitla is useful:

| | | |
|---|---|---|
| ℞. Potassii iodidi, | | 2 drachms. |
| Potassii bicarbonatis, | | 6 ,, |
| Vini colchici, | | 2 ,, |
| Aq. camphoræ, | ad | 12 oz. |

M. ft. mist. A tablespoonful three times a day in a wineglassful of water after meals.

The *diet* of these patients will require careful attention. Fat, starch, and sugar should be reduced to a minimum, and all meals should be light, simple, and easily digestible. For fuller details upon this complex subject, and also for information regarding the question of alcoholic liquors, we would refer the reader to some special treatise on the subject; he may with advantage consult the section on Gout in Dr. Burney Yeo's *Manual of Medical Treatment*.[1]

**Rheumatic Phlebitis.**—Should the phlebitis occur as a complication or sequela of acute rheumatism, or in a person of a very pronounced rheumatic tendency, the combined administration of salicylate of soda and iodide of potassium, as in the subjoined formula, will be useful:

| | | |
|---|---|---|
| ℞. Potass. iodidi, | | 2 drachms. |
| Sodii salicylatis, | | 1 ,, |
| Syrupi simp., | | 1 oz. |
| Aq. menth. pip., | ad | 6 ,, |

M. ft. mist. A tablespoonful thrice daily.

In the very chronic forms the following prescription recommended by Whitla is useful and pleasant to take:

| | | |
|---|---|---|
| ℞. Sodii iodidi, | | 2 drachms. |
| Sodii bicarb., | | 4 ,, |
| Potassii bicarb., | | 1 oz. |
| Liq. arsenicalis, | | 1½ drachms. |
| Dec. sarsæ comp. | ad | 20 oz. |

M. ft. mist. A small tablespoonful in a claretglassful of effervescing potash water three times a day after meals.

**Post-typhoid Phlebitis, etc.**—In cases occurring after typhoid fever or debilitating illnesses, the administration of tonics, especially iron and arsenic, are advisable; after the acute inflammation has subsided, change of air is beneficial. When the affection is sub-acute, as for instance in gonorrhœal rheumatism, of which phlebitis is a not uncommon complication, salicylate of soda, quinine, and iron are often of great value. The patient, who is generally in a very feeble condition, requires judicious feeding, and the state of the bowels should be attended to, saline purges being given as often as may be necessary, especially at the commencement of the illness. The general condition must of course be carefully watched; should repeated rigors occur, the septic character of the phlebitis becomes apparent, and the treatment appropriate to it should be adopted (*vide supra*).

[1] Cassell & Company, London, 1893.

**Treatment of the resulting œdema.**—As a sequel to phlebitis of the main vein of a limb there will be œdema of the parts below the block, which is often very marked and may take a long time to subside completely. The amount and duration of the œdema depend mainly upon the extent of the thrombosis and upon whether or not vessels able to carry on the circulation open into the main vein above the seat of the disease; they depend also to some degree upon the general condition of the patient, the nutrition of the tissues, the presence of anæmia, etc. Hence the treatment does not by any means necessarily come to an end when the phlebitis passes off.

The œdema of the limb which follows must be treated by the ordinary methods, namely, *pressure* and *massage*. The employment of massage in œdema resulting from phlebitis must be very carefully resorted to. It should not be begun too early or carried out too vigorously, as otherwise fresh phlebitis may be set up. In any case it is well not to commence it for at least a couple of months after an attack. Should no fresh attacks occur during that time, the risk of lighting up fresh inflammation is much less, and the chance of detachment of the clot will be reduced quite to a minimum; even then, however, the massage should be very gently employed in the immediate neighbourhood of the vein. At first it should be done once a day, in the morning, for about twenty minutes, the frequency and length of the sittings being gradually increased; in the intervals, the limb should be firmly bandaged from below upwards, and should be kept elevated on every possible occasion so as to promote the circulation. When the patient is allowed to walk about, an *elastic bandage* should be applied from the foot to above the seat of the œdema, and this should be put on before he leaves his bed and after the employment of the massage. This will be referred to again presently in speaking of the treatment of varicose veins.

The patient's *general health* must also be very carefully attended to. Plenty of nourishing food must be given, whilst amongst *drugs* iron and arsenic are the most useful.

## VARICOSE VEINS.

By varix or varicose veins is meant a condition in which the venous trunks are both dilated and elongated. The lower extremity is the most usual seat of the disease, but varicose veins are also common in the hæmorrhoidal plexus,—where they are known as piles,—and in the pampiniform plexus,—where the affection is termed varicocele. When they occur elsewhere, particularly in the upper arm, they are usually due to some congenital malformation, though they may also be due to pressure on the veins, aneurysmal varix, etc. We shall only deal here with varicose veins in the leg; varix elsewhere will be treated of in connection with the regions in which it occurs.

**CAUSES.**—Varicose veins in the leg may be met with at almost any period of life, but they most frequently commence between the ages of twenty and thirty. They are much more common in men than in women—a fact explained by the more laborious occupations of the male sex; heredity seems to play an important part in the occurrence of the condition; anything which interferes with the circulation, such as pregnancy, may also lead to their production. Occupations involving long-continued standing, especially if associated at the same time with considerable exertion, are very liable to lead to varicosity, and hence it is extremely frequent among shopmen, barmaids, porters, washerwomen, etc. Habitual constipation, the use of tight bands, such as garters around the limb, etc., are also very common accessory causes. Gout is also said to predispose to this condition.

**PATHOLOGICAL CHANGES.**—Obstruction to the circulation alone, however, though it usually predisposes to, or aggravates existing varix, is not necessarily the direct cause of the trouble. Before the actual development of varicosity, the walls of the veins become weakened as the result of some chronic inflammatory condition of the coats of the vessels. The first changes which occur in the veins are swelling and thickening of the walls, which lose their elasticity and become so weak that they cannot resist the pressure of the blood from above; the result is distension of the wall of the vein and incompetence of the valves. The veins also elongate, and after a time stand out as dilated and coiled tubes. The distension is usually irregular, being greater about the valves; when the veins are much convoluted, neighbouring coils may open into one another, and thus large blood sacs may be formed. The most dilated portions may distend the thin skin over them, and, indeed, may sometimes burst through it.

It must be carefully borne in mind that the chief agent in bringing about the dilatation of the veins is the pressure due to the weight of the column of blood from above, which is unsupported by the incompetent valves; the venous pressure from below is trivial. The subcutaneous tissue affords no real support to the veins, and when the valves have become incompetent there is nothing to help them to sustain the weight of the column of blood. In the deeper veins, on the other hand, the contraction of the muscles drives on the blood, and also gives support to the walls of the veins lying beneath and among them; the reason that prolonged standing leads to varicosity is that the muscles are not then in action, and do not give this support at a time when, the patient being erect, the full weight of the blood column tells on the wall of the veins. It is extremely important to remember the importance of this downward pressure, as it bears directly on treatment.

**VARIETIES.**—From the point of view of treatment we may divide varicose veins into two distinct classes. In the first are the cases in which only the larger subcutaneous venous trunks are dilated, and in the second are those in which there is a markedly varicose condition of the small veins in the skin itself, with or without dilatation of the main veins; the skin of the affected part is then mottled with numerous small dilated venous radicals. This latter condition is the one most likely to be associated with ulceration, and the most difficult to relieve.

**COMPLICATIONS.**—When the condition is marked, there is often more or less *œdema* of the extremities, which results in part from the embarrassment of the circulation produced by long standing and by the absence of sufficient muscular movement to force on the blood in the limb, and in part from the general enfeeblement of the tissues as the result of this imperfect nutrition. In the earlier stages the œdema is only noticeable towards the end of a long day's standing and hard work, and is most marked about and just above the instep and ankle; this œdema quickly disappears when the patient lies down.

Again, varicose veins are especially prone to inflammation, and *phlebitis* is therefore a common occurrence. Varicose veins in the legs are also fertile sources of *eczema* and *ulceration* of the skin: this point has been referred to in connection with ulcers (see Part I., Chap. III.). They also cause a good deal of *pain* and aching in the limb, in the early period especially, and this is chiefly noticeable when the patient first gets up in the morning, when it is often accompanied by *cramp*; later on it is chiefly marked in the evening if the patient has been standing much during the day.

**TREATMENT.**—The treatment of varicose veins in the leg may be either palliative or radical. In no case can a cure of the affection be correctly spoken of, although by operative means a very marked improvement in the condition of the patient may be effected—quite sufficient to warrant the operation being done in suitable cases. Even in the case of a small localised mass of veins, where it is possible to eradicate the affected vessels entirely by operation, it is not strictly accurate to speak of this as *curative*, as is so often done. The tendency to varix remains, and there can be no guarantee that other veins will not become affected. The essential object of the treatment, whether palliative or radical, is to support the column of blood and take off the downward pressure from the weakened venous walls.

An *operation* is advisable *as a radical measure* in cases where the varicosity is not very extensive, and more especially where the enlargement is limited to one vein or set of veins. The operation is also necessary in cases of young men entering the public services or going abroad to hot climates, where they are likely to have much standing or exertion. *As a palliative means* it is to be recommended in cases of extensive varix, when it is employed with the view of rendering the patient more comfortable, of diminishing or arresting the spread of the condition, and of enabling him to wear an elastic stocking with comfort even when large venous areas are affected. Whenever the enlargement affects the veins above the knee, operation is indicated, both in order to cut off the blood-column and also to obviate the necessity of wearing a bandage above the knee—a most irksome thing. It is also advisable in cases in which there have been frequent attacks of phlebitis, or in which, even without actual phlebitis, the veins are the cause of much pain or aching. Where there is ulceration of the limb ligature and removal of the veins is often of value after the ulcer has healed, as it tends to prevent recurrence (see Part I., Chap. III.). Excision of the inflamed veins during the acute stage is also indicated in phlebitis associated with varicose veins (see p. 281).

*Non-operative measures* are indicated when the patient objects to an operation, when the varicosity is slight, is not extending, or is easily controlled by supporting bandages, or when the condition is extremely extensive and when the cutaneous veins are essentially the seat of the enlargement.

**Radical Treatment.**—We shall discuss first the operative treatment of varicose veins, in which the object is to shut off the downward blood pressure as far as possible and to obliterate the main vessels affected. When the disease is not limited to the leg, but extends into the thigh and affects the internal saphenous vein up to the groin, radical measures are especially advisable, because in these cases the valves are incompetent, and offer no support at all to the column of blood, and there is a tendency for the varicosity to extend to all the superficial veins of the limb. Under such circumstances the important point is first to block the internal saphena close to its junction with the femoral vein. At first sight this would seem likely to increase the varicosity by interfering with the return of the venous blood, but, as a matter of fact, the blood pressure from below is so slight, and there are so many communications with the deeper veins, that the application of the ligature does not do anything like the harm done by the weight of the column of blood after the valves have become incompetent.

Some surgeons advocate the removal of a portion of the internal saphena high up in all cases of varicose veins of the leg, but that seems hardly necessary when the vein is not dilated in the thigh and the valves are still competent. But when the vein is affected in this situation it should certainly be obliterated as high up as possible. Some surgeons, in Germany especially, are content with the removal of the saphena at the groin, and leave the other enlarged veins untouched; it must, however, be borne in mind that the superficial and deep veins communicate at other points, especially behind and at the inner side of the knee, and in the upper part of the leg, and that therefore the downward pressure upon the veins of the leg is not entirely cut off by the obliteration of the saphena alone. It is a good rule, therefore, not only to excise a portion of the saphena as high up as possible, but also to look for and remove any masses of enlarged veins about the knee or popliteal space, and also any similar groups in the leg, more particularly when they are much dilated and threaten to burst through the skin; any dilatations at the points of junction of a number of veins should also be taken away. Hence, in an ordinary case, besides the removal of the internal saphena, there may be five or six other places in which the veins should be excised.

**Excision of Veins.**—As a preliminary to operation in all cases the veins should be marked out before the patient is placed under the anæsthetic; this is best done by a solution of nitrate of silver. The best plan is to draw a line over the portions of the veins to be removed, with a camel's hair brush dipped in a solution of nitrate of silver (30 to 60 grains to the ounce) the day before the operation, when the patient is in the upright position, and then to leave the part exposed to the light. In this way a sufficient staining of the skin is obtained, which will not be effaced by the most energetic disinfection. If an ordinary flesh pencil or aniline dye be used, the stain is almost sure to be rubbed off, especially by the turpentine, while the skin is being disinfected. On no account should a stronger solution be employed than the one recommended above, or blistering or even deep-seated sloughing of the skin may result. This definition of the veins to be excised is a most important point; much time is saved, and bleeding often avoided by its use.

The operation consists in the removal of a portion of the veins at the various points thus marked out. The larger the portions removed at any one point, and the more branches that can be included in the area of the operation the better. Strict asepsis is imperative, for the slightest amount of suppuration occurring along the stitch tracks may entirely vitiate the success of the operation, either from septic thrombosis or by leading to a septic condition of the wound, which, owing to the varicose condition of the parts, will be very slow in healing.

The limb should first be shaved and most thoroughly disinfected in the manner already described (see Part I., p. 161). After the patient has been anæsthetised, the limb is raised, rotated outwards, the knee flexed and steadied upon a suitable sandbag, and an incision two or three inches in length made over the portion of the vein to be removed. The group of veins highest up the limb should be first removed; for example, the first operation should be the removal of the internal saphena close to the groin, those about the knee and leg being excised after this is done. If it be intended to remove a mass of tortuous and dilated veins completely, the incision may be a semicircular one, but care must be taken not to raise too large a flap, as the skin is usually so extremely thin over the vein that there is danger of its sloughing from want of proper blood supply. When a long straight portion of the vein is to be removed (as in the case of the internal saphena), the incision should lie directly over the long axis of the vein. When only small portions of a vein are to be excised, the incision may either be made directly over the portions to be removed, or it may run somewhat obliquely to the long axis of the vessel. The skin incision must be made cleanly with a very sharp scalpel, and at right angles to the surface of the skin, and care must be taken not to go so deep as to wound the vein. The difficulty of the operation is greatly increased if any accidental puncture of the vein should occur; as long as this is avoided the operation, though somewhat tedious, is fairly simple.

After the skin and fat have been divided, the vein is seen to stand out, usually irregularly, as it is tied down by bands of fibrous tissue running across it from the deep surface of the skin. These bands must be divided, and then by means of a few touches with the point of the knife the skin is raised from the dilated vein. In doing this, care must be taken not to bruise the edges of the delicate skin by holding them tightly with strong forceps; the latter should only be used for just raising the edges of the skin, and as soon as sufficient has been liberated, the skin should be grasped between the finger and thumb, so as to avoid any undue compression of it. When the skin has thus been raised from the veins, the separation of the latter from the cellular tissue in which they lie is readily effected by means of a suitable blunt-pointed, fine dissector, (see Fig. 77). Care must be taken not to include any branches of nerves in the ligature along with the vein, or great pain may result. When the vein and all its branches have been isolated throughout the whole length of the incision, a pair of pressure forceps should be put on the upper end, another on the lower portion, and others on all the branches, the veins being pulled out of their bed, so that as much as possible is removed. The vein is then cut away between the various clamps, each separate branch tied with fine catgut and the forceps removed. A piece of gauze dripping with a 1-2000 sublimate solution is thrown over the wound, and then the next group of veins is dissected out; by proceeding to excise the remaining veins before sewing up the first wound, time is allowed for all bleeding to become permanently arrested—a very important element of success in attaining primary union in these cases.

As a rule no tourniquet is used; the oozing which takes place after its removal more than counterbalances the advantages of the bloodless method by interfering with the proper union of the wound. There are, however, certain cases in which it may usefully be employed, as, for instance, when the operation is undertaken for the relief of varicose ulcer, in which the veins are adherent to the skin, and the latter is much thickened and extremely difficult to dissect off without damaging the veins. When a tourniquet is employed, a portion of the vein, with the skin lying immediately over it, may be freely excised, and the open ends of the vein picked up in the wound and secured by ligatures.

When all the different masses of veins have been thus removed, the various wounds are carefully dried and their edges united with the finest silk threaded on a fine needle. If the operation be carefully done, there will be little or no blood lost, but in all cases it is important to let the wound become quite dry before it is sewn up. Care must be taken to see that the thin skin does not curl inwards during the suturing; the suture used should be the ordinary buttonhole one described in Part I., p. 158; no drainage tube is necessary. The usual cyanide gauze dressings are then applied and the limb put up on a light splint—preferably a Gooch's or Croft's splint—to prevent bending of the knee, and the whole limb should be slightly elevated. The dressing at the groin over the upper part of the saphena vein is apt to become detached by the movements of the patient, and, therefore, after the gauze dressing has been applied, the skin around is dried, and a piece of dry gauze one layer thick is laid over the dressing and the skin around and fixed down by collodion. Outside this some more dressing is applied in the ordinary manner.

*After-treatment.*—The dressings are left unchanged for about ten days. At the end of that time the stitches may be removed, collodion dressings applied, and the limb replaced on the splint, which should be kept on for about three weeks. The patient should not be allowed to get up until about three weeks have elapsed, in case thrombosis should have occurred above the ligatures, when there will be a risk of detachment of clots if he begins to move about too soon.

If both legs be affected, it is exceedingly irksome to the patient to have the two limbs put upon splints at the same time; therefore, if the affection be very marked in both limbs, it is best to operate upon one at a time, the second operation being done about ten days or a fortnight after the first. This has the additional advantage that if many veins have to be excised, the length of time occupied by the operation is materially shortened. The operation is generally tedious, and it is not uncommon for it to last upwards of an hour upon each leg. If, on the other hand, the affection be only slight, and very few veins have to be removed, or if it be severe in one limb and very slight in the other, both may be operated upon at once, and if the affection be very limited no splint need be applied, the limb being merely enveloped in a thick mass of cotton wool, which will hinder the movement of the knee; the limb may be kept steady, if necessary, by being placed between sandbags with a sheet or towel over it. If one limb be affected badly and the other only slightly, a splint may be put upon the bad limb, and the other treated as above.

When the patient gets up it is well to apply a bandage from the foot upwards to support the veins, but this should, in the first instance, be simply an ordinary cotton or flannel bandage, and not an elastic one; it should be put on before getting up in the morning. When the varicosity has not been very marked, and the affected veins have been almost completely extirpated, this bandage may be left off after three or four weeks and no further apparatus is necessary; where, on the other hand, the operation has only been to a certain extent palliative, that is to say, where the varicosity is very extensive and all the veins have not been dealt with, it is advisable to order a light elastic stocking or bandage to be worn in the manner to be described below. After these operations, massage and exercises designed to improve the nutrition of the muscles should be practised, and the patient should be strongly warned against prolonged standing, lifting heavy weights, and so forth; active exercise, walking, bicycling, etc., should not be prohibited, however, provided it be not carried to excess. The bowels should be kept well opened.

Numerous other methods of dealing with varicose veins by operation have been described, such as simple ligature, subcutaneous ligature, or the injection of irritants either into or around the vein, but none of them are in any way preferable as regards results to the methods which we have just described, and they all possess disadvantages which the excision method does not.

**Palliative Treatment.**—The palliative treatment consists primarily in looking for, and, if possible, *removing any local or constitutional cause* which predisposes to the varix; and, secondly, in supporting the dilated veins by suitable apparatus. All constricting bands, such as garters, should be interdicted, the stockings being suspended instead of gartered. If constipation be present it must be remedied by appropriate means, such as the use of cascara, belladonna, strychnine, etc. When the trouble is due to pregnancy, the recumbent position should be assumed as much as possible, so as to diminish the pressure on the large veins. In fact, anything that is found to be causing pressure on the veins should be relieved or removed.

In addition to the removal of pressure, steps must be taken to *relieve the congestion of the extremity*, and to facilitate the flow of blood through the affected veins. While the patient is at rest the limb should be kept elevated so as to aid the return of blood, and to diminish any œdema present. It is unnecessary, except in very severe cases, to confine the patient to bed or even to the couch for this purpose, but whenever there is an opportunity of sitting down, the limb should be placed on a suitable rest at a higher level than the pelvis. If this can be done frequently during the day, it will do a good deal to prevent increase of the affection. The return of the blood may be still further facilitated by gentle *massage* of the limb from the foot to the groin. The rubbing should be very gently applied, otherwise it is apt to cause injury to the delicate walls of the veins, and may lead to phlebitis and thrombosis. All that is necessary is merely to rub the limb in the upward direction with the open hand, which should be well oiled. *Active exercise* in moderation is also of great value; moderate walking, bicycling, horse-riding, and golf may be indulged in without any fear of aggravating the disease, but the exercise should not be persisted in for too long at a time, and it should be varied as much as possible. The muscular contractions involved in these exercises help to force the blood onwards through the veins, while the exercise keeps the patient in better condition, makes him less flabby and prevents him from putting on too much fat. The point that should be specially provided against is continued standing, or sitting with the legs in the dependent position.

These methods, however, are but accessories to the most important part of the palliative treatment, namely, *mechanical support* to the veins. The support usually employed takes the form of bandages or stockings containing elastic material, which aim at supporting the vein and exerting equable pressure from below upwards. Formerly, localized pressure was employed over isolated veins by means of pads and strapping, but this is now practically abandoned in favour of more uniform compression of the whole limb by bandages or stockings.

**The India-rubber Bandage** (*Martin's*).—Of these two forms of compression the better is the application of a bandage, for by its means the pressure can be varied at will, and can be so regulated that it is uniform and is always exerted in the right direction. An elastic stocking, on the other hand, unless it be made with extreme accuracy, is apt somewhere to press injuriously on the limb, and the compression does not vary according to the needs of the case; the stocking, as usually made, constricts the limb at the upper part, and so actually aggravates the mischief it is designed to alleviate. Of bandages, the best is Martin's para-rubber bandage, perforated with numerous holes so as to provide for the escape of the perspiration. It is certainly the cheapest and best form of bandage upon the market; it is not so soon destroyed by use as elastic webbing, and it can be kept much cleaner. It should be applied the first thing in the morning while the patient is still in the recumbent position, and should reach from the instep, just behind the root of the toes, to just above the upper limit of the affected veins. Before the bandage is put on, the limb should be washed, thoroughly dried and powdered either with starch powder or with equal parts of oxide of zinc and starch. Many patients cannot bear the elastic bandage applied directly to the skin; the perspiration is confined, and eczema or intolerable pruritus is very apt to be set up. A white silk or cotton stocking should therefore first be drawn smoothly over the limb; it is well to order that this shall be washed at home so as to avoid any risk of irritation from chemicals employed at the laundry. The bandage is best applied over the stocking in the ordinary spiral form, care being taken not to put it on too tightly, but simply to unroll it around the limb. A little swelling of the limb is sure to occur when the patient gets up, and this renders the bandage sufficiently tight, whereas, if it be put on tightly at first, the pressure would soon become intolerable. Indeed, even when put on loosely, many patients find it necessary towards the middle or latter part of the day to remove and readjust it because it becomes too tight. The final turn of the bandage either above or below the knee, as the case may be, must not be drawn tight, as otherwise it will act as a garter and will constrict the limb. The pressure must be uniform, and if it varies at all it must be greatest at the foot, gradually decreasing as the knee is reached.

The cheapness, the durability, and the readiness with which it can be adjusted to alterations in the size of the limb make this form of rubber bandage the most widely popular one that we have at our command. It is especially suitable for hospital patients, and in private practice should always be employed where any great muscular exertion, such as walking, riding, shooting, or the like is being practised by the patient.

At bedtime the bandage should be left off, and it is always well to sponge it thoroughly over so as to remove all traces of perspiration, and then to hang it up to dry. Used in this way it causes a minimum amount of irritation.

**Elastic Bandages.**—Some patients cannot bear Martin's bandage for any length of time, even over a stocking, and in that case an elastic webbing bandage will suit them better. This has the advantage that it is much more porous and much more comfortable to the limb, but it is less easy to apply owing to its greater rigidity, it very quickly wears out, and will not stand much washing; as it requires frequent washing, because it readily becomes foul from the absorption of the sweat, it is a much more expensive bandage than Martin's.

**Elastic Stockings.**—Woven elastic stockings, made for each individual patient, are very largely worn, and no doubt, for those who have no one at hand to bandage the limb, they are the most satisfactory method of treatment. They do not, however, give nearly such good support as Martin's bandage. They are seldom made to fit the limb quite accurately, and instrument makers constantly make them somewhat narrower above, so as to prevent them from slipping down, and in this way they act practically as a garter. This is a very serious fault, and in ordering an elastic stocking special stress must be laid on the point that the upper part shall not be smaller and more elastic than the rest; if the stocking tend to slip down, it must be suspended from the waist. The best form is that known as the *spiral silk elastic stocking*, which practically consists of a long strip of elastic webbing encircling the limb spirally, the adjacent edges of the bandage being sewn together. These stockings have the advantage over the elastic bandage in being porous, and they are on the whole more comfortable. They are, however, more costly, less durable, more difficult to keep clean, and, as has just been said, are very seldom properly fitted to the limb.

The elastic stocking should extend to the upper limit of the disease; when the saphena vein is affected it must extend right up to the groin. Many patients, however, refuse to wear them as high as the groin, for they find that they constantly slip down and are extremely uncomfortable, while the thigh portion is apt to be inefficient. It is with the view of meeting the wants of these patients that in very bad cases of varicose veins of the leg, where there is no chance of curing the disease by operation, one nevertheless feels justified in obliterating the saphena vein, so as to avoid the necessity for a thigh-piece, and at the same time to relieve the pressure on the veins below.

# CHAPTER XX.

## THE SURGICAL AFFECTIONS OF ARTERIES.

### TRAUMATIC AFFECTIONS.

**WOUNDS** of arteries and their treatment have been already fully referred to in speaking of wounds in general (see Part I., p. 127), and we need not here go into the subject again. It may, however, be worth while to mention that quite recently Senn and others have united the cu ends of large arteries (which had been completely divided) by fine catgut stitches, instead of tying them as would be the ordinary procedure. They state that the results have been in some cases satisfactory; that is to say, instead of a thrombus forming and obliteration of the artery resulting as one would naturally expect, the lumen of the artery has remained patent, the blood has flowed on as before, and the wound in the vessel has healed. It is, of course, very seldom that the opportunity of carrying out such a procedure would present itself, and as the matter is quite in the experimental stage we need not do more than mention it as one that is worth while bearing in mind. Apart from transverse division of arteries, however, this point is also worth while remembering in the case of punctures of large arteries or secondary hæmorrhage at the point of origin of a branch from a main vessel. This especially applies to the common carotid artery at its bifurcation, ligature of which with one or other of its main divisions is very likely to be followed by hemiplegia and death. Thus, in hæmorrhage, after ligature of the external carotid, where the bleeding is practically from the wall of the main artery, it might be better to put one or two stitches (by Lembert's method) in the wall of the artery than to ligature the main vessel.

**INJURIES** of arteries, either in the form of contusion of the coats or subcutaneous rupture of the artery, unaccompanied by a wound in the skin, will be referred to immediately in speaking of aneurysm. Then also we shall speak of punctured wounds of the skin involving an artery.

## ARTERITIS.

Like other structures, arteries may be the seat of either acute or chronic inflammation.

**ACUTE ARTERITIS** involves all the coats of the artery, and usually results either from the presence of a septic thrombus in the interior, or from extension of inflammation from the surrounding tissues to the coats of the artery; in this instance a peri-arteritis occurs first.

Of **CHRONIC ARTERITIS** one of the most common forms is **end-arteritis obliterans**, in which the internal coat becomes very markedly thickened, and ultimately either obliterates the lumen of the vessel or leads to thrombosis, so that the artery is completely obstructed. This condition may occur in various diseases, more particularly in syphilis where it affects the small vessels, in alcoholism, in diabetes, etc.

**Atheroma.**—This is a still more chronic and limited form of end-arteritis which is of great importance in connection with aneurysm. In atheroma the inflammation occurs in the deeper part of the internal coat of the artery, and results in the formation there of a mass of young cells which tend to undergo organization into fibrous tissue. This attempt, however, usually fails; fatty degeneration takes place, and one of two things happens—either the degenerated mass bursts into the interior of the artery (the condition spoken of as *atheromatous abscess*), or lime salts are deposited in it and form *calcareous plates* which render the artery rigid and which also tend to project through the endothelial lining membrane; coagulation of blood subsequently takes place on the rough edges of the plates. This condition does not usually remain limited to the internal coat, but spreads to the middle one, and there leads to softening and partial destruction of the muscular tissue. The result is either weakening of the wall of the vessel, which dilates, or the deposit of lime salts and calcification of the middle coat, the vessel becoming converted into a calcareous tube. Atheroma is usually diffuse, and affects a number of vessels, especially the larger ones such as the aorta. It occurs chiefly in old people, more often in men than in women, and it seems to bear some relation to syphilis, gout, and the other conditions already mentioned as giving rise to end-arteritis.

**Treatment.**—There is practically no cure for these inflammatory conditions of arteries. The only thing left for the surgeon to do is to try to arrest the spread of the disease, and particularly to guard against the consequences that may ensue.

(a) **Acute Arteritis.**—The ordinary sequela of acute arteritis is the occurrence of *multiple abscesses* and *pyæmia*, which it is a matter of very great difficulty to avoid. Acute arteritis is usually part of an extensive septic process and is not a disease strictly limited to the coat of the artery itself; it is therefore only seldom that any treatment can be brought to bear directly upon the inflammation of the arterial coat. The chief attention must be directed to the general septic condition. The question of ligaturing the vessel above the seat of inflammation, in cases where acute arteritis affects the extremities, is one which must be carefully considered; the object of the procedure is to prevent the displacement of the breaking-down clot and to clear out clots already present, on principles similar to those that guide us in the treatment of septic phlebitis. When the case is one of *peri-arteritis*, the treatment of the inflammation in the vicinity of the vessel is of course the chief point; here there may be not only thrombosis and septic embolism, but softening of the vessel wall with rupture, and hæmorrhage into the tissues or through an open wound may ensue. Such an accident is, however, of extreme rarity. The general treatment must be that of pyæmia (see Part I., Chap. X.).

**(b) Chronic Arteritis.**—The chronic forms of arteritis are often associated with the various constitutional conditions already mentioned; when the arteries are becoming thick and hard, and when other signs, such as cold extremities, perverted sensations, etc., which betoken the occurrence of atheroma, are present, any constitutional affection which might lead to chronic arteritis must be sought for and, if possible, removed. Iodide of potassium should be given in the case of syphilis; suitable diet, drugs, and exercise in the case of gout; and the ordinary treatment must be employed for diabetes. The patient should also be specially warned against doing anything which might precipitate the onset of any of the ordinary sequelæ of the disease. One of the most common of these is gangrene, which may result either from thrombosis in the vessel, or from the gradual narrowing of its lumen without thrombosis; this has been already dealt with under the heading of gangrene (see Part I., p. 68). The other common sequela of chronic arteritis is aneurysm, with which we shall deal immediately. Anything, therefore, which injures parts already imperfectly supplied with blood, or which throws an extra strain on the walls of the vessel, must be rigorously avoided.

## ANEURYSM.

By the term aneurysm in its widest sense is understood a cavity containing blood communicating by an opening of variable size with the lumen of an artery. According to this definition, two conditions are met with which are spoken of respectively as true and false aneurysm. By a **true aneurysm** is meant one in which the sac was originally formed by dilatation of one or more of the coats of the artery; in other words, its formation was preceded by a weakened or diseased condition of the vessel wall. By a **false aneurysm**, on the other hand, is meant one in which the wall of the sac was never constituted by any part of the original vessel wall; in other words, there must have been solution of continuity of the wall of the artery in the first instance. A true aneurysm is thus of pathological, a false aneurysm of traumatic, origin.

## FALSE ANEURYSM.

**CAUSES.**—A false or traumatic aneurysm may arise in one of two ways; in the first there is a wound in the wall of an artery (it must be simply a hole and not complete division of the vessel), and the blood passing out through the aperture clots in the surrounding tissues and leads to condensation of the structures around; the result is that a sac is formed which prevents the further escape of blood into the planes of cellular tissue. The wall of this sac is composed of dense cellular tissue and organized blood-clot.

In the second, the wound in the wall of the artery may heal and leave a cicatrix. Dilatation of this cicatrix then occurs, with secondary condensation of the tissues around, and thus again a sac is formed, the wall of which is never composed of any portion of the original coat of the vessel. This mode of formation of a false aneurysm is, however, rare.

A false aneurysm may also result from a subcutaneous rupture of an artery, provided that the rupture be small. Usually, however, in such cases the rupture is of considerable size, and blood is poured out into the tissues very rapidly and in large amount; indeed, the bleeding may go on to such an extent that the patient may die directly from hæmorrhage into the cellular tissue, or, at a later date, from gangrene as the result of the pressure of the effused blood upon the collateral circulation. This condition has received the name of **diffuse aneurysmal hæmatoma**.

False aneurysm most frequently occurs when the wound in the artery is very small, and when the injured vessel is in the neighbourhood of structures that offer considerable resistance to the outflow of blood; it generally follows small punctured wounds of an artery. The blood which escapes clots in the tissues, and temporarily, at any rate, arrests the hæmorrhage; if, however, the wounded vessel be of any size, the blood pressure prevents proper cicatrization and as the result of fresh blood escaping during the systole of the heart the original cavity is gradually dilated, while at the same time the surrounding tissues become inflamed and thickened, and form a mass of dense fibrous tissue which constitutes the wall of the sac. This false aneurysm has all the ordinary clinical features of the true variety, with the important difference that the walls of the artery are healthy quite up to the point of communication with the aneurysm. Its further history is practically the same as that of true aneurysm. It gradually increases in size, fresh tissue becomes inflamed and condensed around it, bones and other structures become absorbed as the result of the pressure and inflammation it causes, until finally the aneurysm reaches the skin or some internal cavity, when the wall gives way and fatal hæmorrhage results.

Formerly, when venesection was much practised, false aneurysm was common, and it usually occurred in connection with the brachial artery at the bend of the elbow. The lancet was apt to go too deep in dividing the vein, and the artery was punctured; the immediate rush of blood was arrested by the pressure of the pad, but when the wound healed and the pad was left off, blood escaped through the incision in the artery, and led to the formation of a false aneurysm.

**TREATMENT.**—This will depend very largely upon the situation of the aneurysm. When it is in an extremity or an accessible part, the best treatment is—after controlling the circulation either by digital pressure or by a tourniquet (if there be room for one above the aneurysm)—to cut down and freely expose the sac, lay it open, turn out the clots, search for the opening in the vessel, and having cleared the artery above and below the sac, to tie it in both places. Any branch coming off between these ligatures must also be tied, as otherwise the collateral circulation will allow blood to escape into the remains of the sac. In fact, it is well, after ligaturing the vessel above and below the opening, to dissect out the intervening portion of the vessel and as much of the sac as possible.

This operation for false aneurysm has also been practised in situations where the vessel cannot be controlled on the proximal side of the sac. In such a case, after the sac has been thoroughly exposed, an opening is made into the aneurysm barely large enough to admit the finger, and the moment this is done the latter is thrust through it into the sac so as to form an efficient plug to check the escape of blood; the finger is then gradually insinuated through the clots, and the opening in the vessel is felt. This can usually be made out by the sense of touch, or if not it may be discovered by the stream of blood impinging on the finger as it escapes from the vessel. After the situation of the opening has been ascertained, the latter is firmly compressed with the finger against the underlying bone, and, while the pressure is maintained, the sac of the aneurysm is laid freely open, the clots turned out, and the artery cleared and tied above and below.

In cases of subcutaneous rupture of an artery, when the patient does not die at once, but a **diffuse aneurysmal hæmatoma** forms, the treatment is to compress the artery above, cut down at once upon the hæmatoma, clear out the clots and tie the vessel above and below the seat of injury. The wound is then stitched up, but it is well to put in a drainage tube for the first few days, as there is generally a good deal of oozing; these operations must of course be conducted with strict aseptic precautions. When the main artery of a limb is affected, the parts below the seat of ligature should be kept warm and somewhat elevated, and the general treatment is exactly the same as that which will be presently described in connection with the ligature of vessels for true aneurysm.

## ARTERIO-VENOUS ANEURYSM.

In connection with false or traumatic aneurysm must be considered another condition sometimes met with in which there is a communication between an artery and a vein—that known as arterio-venous aneurysm. This is also, in the great majority of cases, the result of direct injury, although instances have been met with where the communication has formed without any traumatism. There are two forms of arterio-venous aneurysm, namely, **Varicose Aneurysm**, in which an aneurysm (usually a false one) communicates with a neighbouring vein; and **Aneurysmal Varix**, in which there is a communication between an artery and a vein without any intermediate aneurysmal sac. The result of the communication in both cases (but most markedly in aneurysmal varix) is that arterial blood passes into the vein; this on the one hand interferes with the return of the venous blood, and on the other renders the latter partially arterial. As a consequence of the interference with the venous return the veins below the point of communication with the artery become dilated and elongated, and practically varicose; the result of the arterialization of the venous blood, if excessive, is manifested by irregularity of the heart's action.

Aneurysmal varix, beyond causing inconvenience to the patient, is not a source of any special danger, and may persist throughout life without any serious results. The veins below the communication become varicose, the limb is more or less swollen, the patient experiences a disagreeable thrill in the part, and the nutrition of the limb is interfered with; there is, however, no tendency for the affection to follow the ordinary course of an aneurysm, and to end in rupture on a free surface.

In varicose aneurysm, however, this tendency undoubtedly exists, although not to the same extent as in true aneurysm; the aneurysm increases in size very slowly, and may ultimately burst and lead to fatal hæmorrhage. Hence, it is essential to do something for varicose aneurysm if possible, and it is advisable to treat aneurysmal varix, but in the latter case operation cannot be urged as being a matter of life and death.

**TREATMENT.—Aneurysmal Varix.**—When the communication between the artery and the vein is in an accessible region, the treatment, if a cure be desired, must be operative; the exact procedure will depend very much on the particular vessels involved. In the most usual case, namely, a communication between the brachial artery and the median basilic vein at the bend of the elbow, the best treatment is to ligature both the artery and vein immediately above and below the point of communication (see Fig. 96, *A*). In this way, even without opening and dissecting out the communicating part, the disease is completely cured. When a large vein, such as the femoral, is involved, it is sufficient to tie the artery above and below the communication, and to tie also any arterial branches which may come off between the ligatures; the vein may be left untouched. This is a matter of considerable importance in a vein such as the femoral, as ligature of it might cause œdema of the limb, and lead to a long and tedious convalesence.

**Varicose Aneurysm.**—The treatment here is practically the same as for aneurysmal varix, with the exception that in all cases it is well to open the sac and to turn out the clots. When the vein is large, as for instance the femoral, the proper treatment is to control the circulation, expose the sac, lay it open, turn out the clots, tie the artery above and below, and any arterial branches which may be connected with the aneurysm (see Fig. 96, *B*), and then to sew up the opening in the sac with a Hagedorn needle and fine catgut. In this way the vein is left undisturbed, blood escapes from it into the aneurysmal sac but quickly coagulates and leads to obliteration of the sac, while at the same time there is as a rule no interference with the flow of blood through the vein; if the vein be a small and unimportant one, it also should be ligatured; in fact, the whole aneurysm may then be dissected out. Of course, even in the case of the femoral vein, there need be no hesitation should it be absolutely essential to tie it. If the wound be kept aseptic, gangrene will not occur, but nevertheless a very marked and prolonged œdema of the leg may result and therefore ligature of the vein should, if possible, be avoided.

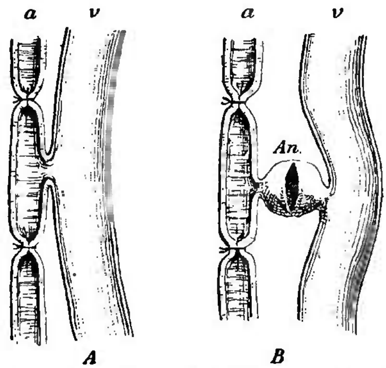



FIG. 96.—DIAGRAM SHOWING METHODS OF TREATMENT FOR ANEURYSMAL VARIX AND VARICOSE ANEURYSM.—*A*, Treatment of aneurysmal varix by ligature of artery *a* above and below communication with the vein *v*. *B*, Treatment of varicose aneurysm by ligature of artery above and below, and incision of aneurysm. In neither case need the vein be tied as a rule, except when the vein is small.

It is not always necessary to open the sac, but if there be any reason to believe that branches come off from the artery between the points at which the ligatures are applied (as in the case of the femoral opposite the origin of the profunda), this is more conveniently ascertained, and the branches are more easily got at if the sac be opened than if an attempt be made to tie them without disturbing it. Such an attempt is very difficult on account of the matting together of the tissues, and may very likely end in injury to the vein elsewhere, or, in the example before us, in injury to the profunda vein. On the other hand, if the sac be opened the orifices of the branches can be seen, and by introducing a bougie or a probe into them they can be readily isolated with a dissector, and a ligature passed round them without including or injuring other structures. Quite apart from the question of branches, it is best when the aneurysmal sac is large to open the sac, and introduce a bougie into the ends of the artery, so as to render its separation from the vein and surrounding structures easier and safer.

When the vessels involved are the subclavian artery in its first part, or the lower part of the common carotid, with their accompanying veins, it is in most cases advisable to leave matters alone. In the case of an arterio-venous aneurysm in these regions, the chances of rupture are comparatively slight, and it will usually suffice to protect the parts from violence and to treat any symptoms of cardiac irregularity by suitable medicinal means.

## TRUE ANEURYSM.

**CAUSES.**—By a true aneurysm is meant a sac communicating with the lumen of the vessel, the wall of the sac having in the first instance been formed by one or more of the arterial coats. We say "in the first instance," because when the aneurysm becomes very large the remains of the original coats of the artery are practically unrecognizable, and, as a matter of fact, the sac of the aneurysm is then formed solely of the condensed cellular tissue around. Before a true aneurysm can be produced, some disease or injury must weaken the wall of the vessel at the spot where the dilatation is to occur; this generally takes the form of chronic end-arteritis or atheroma. When an atheromatous patch bursts into an artery the blood finds its way into the little ulcer thus formed, and, by its impact on the middle coat, leads to inflammation and loss of elasticity of the tunica media, and gradual expansion of the arterial wall. In other cases, the atheromatous process extends to the middle coat, weakens it, and causes dilatation of that part of the artery without any rupture of the internal coat; dilatation does not occur as a rule until the middle coat becomes weak. A similar weakening of the middle coat may result from contusions or sudden strains of the coats of the artery which cause rupture of some of the fibres of the middle coat and consequent loss of strength; as the result of the rupture cellular infiltration of the coat in the vicinity occurs, followed by the formation of cicatricial tissue and dilatation of the weakened part.

In whichever way the damage be done, the weakened part of the wall gradually dilates, until ultimately there is a cavity communicating with the vessel by an orifice of variable size; this is known as a sacculated aneurysm. The lining membrane of this cavity loses its smooth healthy character, and the blood stream in it is more sluggish than in the vessel itself; the result is that a white clot forms on the wall, and as time goes on becomes more or less completely decolourized, firmly adherent to the wall, and in part organized. After a time the clot in the interior of the sac presents a laminated appearance; this often results from tearing up either of the connection between the original layer of clot and the sac wall or of the substance of the white clot by the blood current and simple coagulation of blood there. Thus an aneurysm which has existed for any length of time will often contain masses of clot arranged in layers and spoken of as laminated clot; this clot usually consists of more or less alternate layers of red and white clot. Coincidently with the formation of laminated clot in the aneurysm, the wall of the aneurysm is becoming steadily dilated, and the surrounding tissues partly atrophy as the result of pressure, and partly become condensed as the result of inflammation.

It is important to remember that the endarteritis which leads to the formation of an aneurysm is not limited to the actual spot at which the aneurysm occurs, but is usually diffused over the wall for a considerable distance, and in the immediate vicinity of the aneurysm there may be, and frequently is, considerable general dilatation of the vessel.

It may also be pointed out that while the sac is increasing in size, the flow of blood through the main artery beyond the aneurysm is delayed and sometimes considerably interfered with; as a consequence, branches which come off above the aneurysm are dilated, more blood flows through them, and their communications with branches below the aneurysm also become enlarged; in this way a free collateral circulation is established. This is a point of great importance both with regard to treatment and also with regard to the risks of gangrene should the aneurysm become diffuse.

**RESULTS.**—**Spontaneous Cure.**—In some cases this *formation of clot* may go on until the aneurysmal sac becomes entirely filled up and a spontaneous cure results; such an event is, however, comparatively rare. Perhaps the most common condition under which it arises is when the sac bulges upwards along the course of the artery, and, as it becomes larger, presses upon the latter above the aneurysm and diminishes, or, indeed, altogether arrests the flow of blood through it; the result is that the cavity becomes completely filled up with clot and ultimately obliterated. Spontaneous cure of an aneurysm may also result from *suppuration of the sac* and the discharge of its contents. This very rarely takes place spontaneously, but in former times, when sepsis was frequent, it sometimes followed operations in the vicinity of the sac. Instead, however, of leading to a spontaneous cure of the aneurysm, suppuration in the sac may lead to a fatal termination from hæmorrhage, or from general septic infection as the result of the escape of septic emboli into the lumen of the vessel.

Generally, however, the clinical history of an aneurysm is that it gradually increases in size, causes absorption of the tissues around until it reaches a free surface, and then bursts and leads to fatal hæmorrhage. Sometimes, however, it may rupture subcutaneously, and then death may ensue either from an extensive escape of blood into the cellular tissue, if this be very loose, or from gangrene of the parts below from pressure of the effused blood upon the arterial trunk and the collateral circulation. This condition is spoken of as **diffuse aneurysm**. Another condition, which, however, hardly comes under the notice of the surgeon, seeing that it is limited to the aorta, is that known as **dissecting aneurysm**, in which the blood burrows between the external and middle coats of the artery for some distance, and then again finds its way back into the general blood stream at a point lower down in the wall of the vessel.

**VARIETIES.**—Two forms of aneurysm are generally met with, viz. (1) **sacculated aneurysm**, in which the dilatation occurs on one side only of the artery, and in which the sac communicates with the artery by a comparatively narrow opening; or (2) **fusiform aneurysm**, in which there is a general dilatation of the whole circumference of the artery, giving rise to a fusiform swelling. In this form of aneurysm there is not, at first at any rate, any formation of the laminated clot described in connection with sacculated aneurysm. The fusiform variety enlarges more slowly than the sacculated, although it follows the same course in the main; towards the end of its existence it may become more or less sacculated owing to greater dilatation of one part of the wall than of another, or from a localized rupture.

**SYMPTOMS.**—Aneurysm gives rise to various more or less serious symptoms. Apart from the presence of an expansile tumour, pulsating synchronously with the heart and associated with a bruit, much pain may be caused from pressure on sensory nerves surrounding it, paralysis from pressure on motor nerves, and marked œdema of the limb if the main vein of the limb be pressed upon.

**TREATMENT.**—The treatment of true aneurysm may be divided into medical and surgical. Medical treatment is of course the only possible form when the aneurysm is internal, that is to say, in one or other of the great cavities of the body; surgical treatment is employed wherever possible in external aneurysm. Surgeons have, however, occasionally to do with aneurysms which are on the border line between internal and external, for example, aneurysm of the innominate artery. In these cases, whether surgical treatment be carried out or not, medical treatment must always be employed. It will, therefore, be well to indicate very briefly the chief points in the medical treatment of aneurysm.

**(a) Medical Treatment of Aneurysm.**—This has for its object the production of a condition of affairs which will favour the occurrence of coagulation in the sac and spontaneous cure of the aneurysm. This end is of course most likely to be obtained when the aneurysm is of the sacculated variety; it is hardly likely to occur when it is fusiform. The first point of importance is to diminish the force and rapidity of the circulation, and for this object the amount of food taken, and more particularly the fluid part of it, are much restricted; a second point which is also of great importance is to increase the coagulability of the blood.

**Tufnell's Method.**—The plan originally described by Tufnell is that most commonly employed, but its stringency is such that it can seldom be strictly adhered to for any length of time. According to this method the patient is confined strictly to bed in the horizontal position and is forbidden to make the slightest movement. He is put on a very limited diet with the object not only of diminishing the force of the circulation, but of rendering the blood more fibrinous and thereby favouring the deposition of clot. The diet Tufnell recommended consists of ten ounces of solid food in the 24 hours, and about eight ounces of fluid. This is given in three meals a day, which are ordered as follows:—For breakfast, two ounces of bread and butter and two ounces of milk or tea; for dinner, three ounces of mutton and three of potatoes or bread with four ounces of claret or water; two ounces of bread and butter and two of milk or tea are given for supper.

The confinement to bed upon the strictly limited diet should be kept up for at least two or three months; should improvement occur it should be persisted in as long as the patient can tolerate it. This plan can seldom be strictly adhered to, and some relaxation of it, particularly with regard to the amount of fluids administered, soon becomes necessary. The thirst rapidly becomes intolerable, and in many cases it is found that all that can be done is to restrict the diet as much as possible without running the risk of depressing the patient unduly and thus exciting the irritability of the heart.

**Drugs.**—In addition to the restriction of the diet, various drugs are administered which have for their main object the increase of the coagulability of the blood. The chief of these is *iodide of potassium*, which is best administered in large doses, commencing with fifteen grains three times a day and increasing rapidly to thirty or forty if no marked effect is produced. *Chloride of calcium* in cachets or pills of from five to ten grains may also be given twice daily with the same object. The fluidity of the blood may be markedly diminished, and therefore its coagulability increased, by the administration twice or three times a week of twenty grains of *compound jalap powder* so as to produce copious watery evacuations.

**Valsalva's Method.**—In stout plethoric patients the method named after Valsalva, namely, the withdrawal of blood by frequent venesection (see Part I., p. 4) is recommended; eight or ten ounces of blood are withdrawn daily for about the first ten days of the treatment, but this method is one which must be very carefully used, as it is not to be recommended for the majority of patients, especially those who are old or anæmic. In these latter *iron* is beneficial, and the administration of *opium* for the relief of pain produces a markedly good effect. For further details as to the more strictly medical part of this treatment we would refer the reader to text-books on medicine.

**(b) Surgical Treatment of Aneurysm.**—The selection of the line of treatment to be followed in any particular case will depend largely upon the character and seat of the aneurysm. The following are the chief methods of treatment.

(1) **Ligature of the Artery Affected.**—This procedure may be divided into four different groups according to the site at which the ligature is applied, and the treatment of the sac of the aneurysm. They are:

(*a*) *Ligature of the artery in close proximity to the sac*; this is commonly known as "Anel's operation" (see Fig. 97, *A*).

(*b*) *Ligature of the artery at such a distance from the sac that at least one branch intervenes between it and the ligature*; this is usually known as the "Hunterian operation" (see Fig. 97, *B*).

(*c*) *Ligature of the artery or its main branches on the distal side of the aneurysm*; this is known as "Brasdor's or Wardrop's operation" (see Fig. 97, *C*).

(*d*) *Incision of the sac, evacuation of the clots and ligature of the artery above and below the orifice of communication with the aneurysm*; this is often spoken of as the "old operation" (see Fig. 97, *D*).

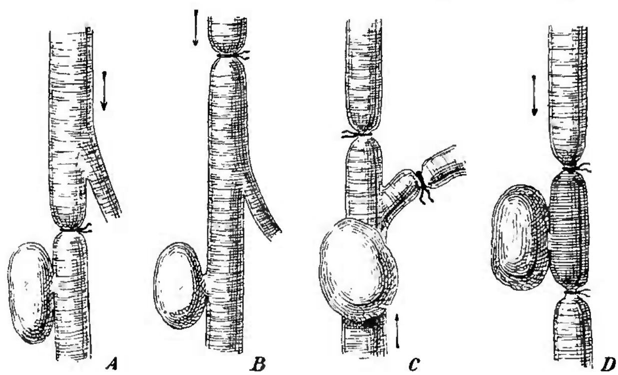



FIG. 97.—METHODS OF APPLYING A LIGATURE TO AN ANEURYSM.—
*A*. Anel's operation.
*B*. Hunterian ligature.
*C*. Distal ligature—Brasdor's and Wardrop's operation.
*D*. The "old" operation; the portion between the ligatures (including the aneurysm) is dissected away.
The arrows show the direction of the blood stream.

(2) **Compression of the arterial trunk,** which may be either *digital* or *instrumental*, and may be applied either on the proximal or the distal side of the aneurysm.

(3) **Galvano-puncture** by means of needles introduced into the sac and connected with the poles of a constant current battery.

(4) **The introduction of foreign bodies into the sac.**

(1) **Ligature of the Artery.**—In applying a ligature to an artery for aneurysm various points must be carefully attended to if success is to be obtained. The essential points are, firstly, the determination of the exact situation at which the ligature should be applied; secondly, the method of applying it; and thirdly, the material of which the ligature should be composed. Special reference must also be made to the risks of secondary hæmorrhage and gangrene. After discussing these we shall proceed to describe the various operations for ligature in the order given above; we shall then describe the other three methods of treatment.

**The Point at which the Ligature should be applied.**—Apart from the old operation of opening the sac, turning out the clots and tying the artery above and below, the older method of treatment of aneurysm by ligature was by applying the latter immediately above the sac—"Anel's operation." As a result of this, secondary hæmorrhage frequently occurred, and suppuration in the sac was not at all uncommon. These accidents were at that time attributed partly to the diseased condition of the vessel at the seat of ligature, and partly to the direct irritation caused by the ligature upon the diseased vessel. Therefore, as time went on, the modification of ligaturing the artery at a distance from the sac, known as the "Hunterian operation," was substituted. The object of this was partly to ligature the vessel where it was quite healthy, partly to avoid irritation in the neighbourhood of the sac, and partly to favour the deposition of firm laminated clot by allowing a certain amount of the circulation to be carried on through the aneurysm by the agency of the smaller collateral branches. In other cases, when it was found impossible either to open the sac and tie the vessel on each side of the opening into it, or to apply a ligature on the proximal side, the artery has been tied on the distal side only,—"Wardrop's operation." The choice between the operation of proximal and distal ligature is practically determined entirely by the situation of the aneurysm and the possibility of applying the ligature on the proximal side. Wherever proximal ligature is feasible it should be chosen in preference to the distal one.

**The Force with which the Ligature should be tied.**—This is a matter of some moment in the larger arteries, particularly the innominate, but in those of the size of the femoral downwards it does not seem to be a matter of great consequence so long as the ligature is tied sufficiently tightly to occlude the vessel. When a single round ligature is applied to a vessel it is found that, as it is tightened, the internal and middle coats give way and curl up within its lumen, whilst the external coat remains constricted by the ligature. Hence at first the only obstacle to the escape of blood is this constricted external coat. Very shortly, however, blood-clot forms in the vessel, and this afterwards becomes organized and connects the divided internal and middle coats, while lymph is poured out and embeds the ligature, and later on organizes and offers a still further obstacle to the escape of blood.

Some days or even weeks must however elapse before the organizing material inside and outside the vessel is sufficiently firm to resist the high blood pressure which exists for instance in the innominate artery. Hence the view is steadily gaining ground that in the larger arteries, such as the innominate, the ligature should not be tightened sufficiently to divide the internal and middle coats, but should only be drawn close enough to bring the walls of the vessel firmly together, and so to occlude its lumen. As the ligature is tightened, the artery folds up in pleats, which, as the tightening is continued, come into absolute contact (see Fig. 98). It is only when the force is carried still further that rupture of the internal or middle coat occurs, but even when this is avoided a sufficient amount of irritation results if the surfaces of the internal coat be brought firmly in contact by the ligature, and proliferation of the endothelium occurs, and leads to union between the opposed surfaces. While this is going on, the entire wall of the artery remains as a firm obstacle to the escape of blood, instead of only the external coat, as is the case when the two inner ones have been divided.

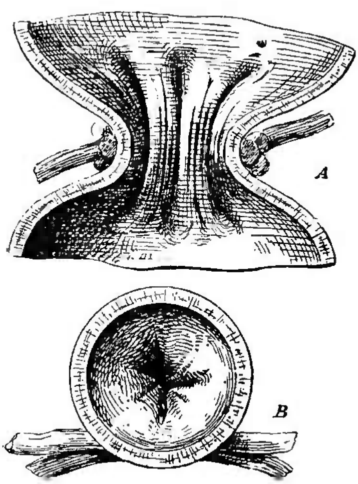



FIG. 98.—OCCLUSION OF AN ARTERY WITHOUT DIVISION OF ITS WALLS. *A* is a vertical section of a large artery thus tied, showing the pleating up of its walls. *B* shows the appearances presented on looking down upon the occlusion from above. (*Ballance and Edmunds.*)

Extensive experiments have been carried out by Ballance and Edmunds[1] as to the amount of force required to constrict a vessel without rupturing the internal coats, and also as to the exact method in which a ligature should be applied so as to effectually occlude the lumen without rupturing the coats. Naturally the amount of force varies according to the particular artery in question, and there is also a very marked difference between that necessary to bring the walls into contact and that required to rupture the coats. The exact degree of force required under these circumstances in the large arteries has been accurately estimated by these authors, but in actual practice it can of course only be gauged by experience. As a matter of fact it is almost always possible to tell when the internal and middle coats rupture, as they can be distinctly felt to give way.

In large vessels such as the innominate it is very difficult to avoid a certain amount of relaxation of the first half of the reef or surgical knot

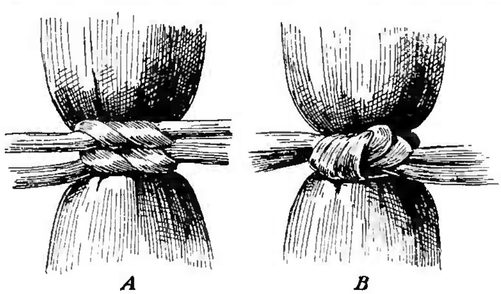



FIG. 99.—METHOD OF TYING A "STAY-KNOT." In *A* the first loop of two ligatures lying side by side on the vessel has been tied. *B* shows the mode of finishing the knot. The two ends on each side are seized together as one and tied into the second loop of the knot. (*Ballance and Edmunds.*)

at the moment of tying the second half when a single round ligature is used, and Ballance and Edmunds have therefore recommended that in its place two at least should be used, and should be applied in the following manner. The two ligatures are first of all passed around the vessel side

[1] *Ligation in Continuity*, London 1891, Macmillan & Co.

by side, and the first loop of a reef or surgical knot is made in each separately in the same direction without constricting the vessel. The two ends of the ligatures on each side are then seized together and tightened simultaneously. In an artery such as the innominate it will be found that with the ligatures so applied and tightened simultaneously instead of independently, it is as much as the surgeon can do to rupture the coats. Hence, if they be tied firmly until as far as can be judged the coats are well pressed together, the lumen of the artery will be obliterated without any risk of rupturing the coats. The knot is then completed by tying the two ends on each side together in the second half instead of separately as is done in the first half (see Fig. 99). There is no risk of a knot of this kind—which Ballance and Edmunds call a "stay knot"—undergoing relaxation as the second half of the knot is tied, and therefore no channel is left in the artery through which blood can find its way.

**The Material for the Ligature.**—This should be very pliable, soft, and slowly absorbable. Absorption should take place in from three to six months. Of the various materials recommended we need only mention silk, catgut, and kangaroo tendon. Of these, *silk* is the most certain as regards the firmness of the knot and the slow absorption of the ligature, but at the same time it sometimes happens that this material causes more irritation than is quite desirable, and the majority of surgeons therefore employ either catgut or kangaroo tendon for ligature of arteries in continuity. In the ordinary twisted or plaited silk a hard knot is formed, which is undoubtedly a source of irritation, and therefore if silk is to be employed, the soft floss silk ligature is the best, as it overcomes these objections very largely. Unless *catgut* be specially prepared, it is apt to be too quickly absorbed, but with the firm, thick, chromic catgut which is at present on the market, three months or more may elapse before absorption is complete, and this material is sufficiently pliable and much less irritating than silk; it can therefore be safely used for arteries of moderate size. *Kangaroo tendon*, which has come much into favour with many surgeons, has the disadvantage of being extremely slippery, and the first half of the knot is much more likely to relax during the tying of the second than when other materials are used. At the same time the tendon has the advantage of being a flat instead of a round ligature, and is probably therefore more suitable when it is desired to avoid division of the internal coats of the artery, for example, in the ligature of such vessels as the innominate; a double ligature must always be used here in order to avoid relaxation. It is of course of the utmost importance to remember that, whatever material be employed, it must be rendered absolutely aseptic, as asepsis is the great point to be aimed at in avoiding any risk of separation of the ligature, and therefore of secondary hæmorrhage.

**Risks of Ligature.**—The chief of these are ($\alpha$) the occurrence of secondary hæmorrhage, and ($\beta$) the risk of gangrene in the parts supplied by the ligatured artery.

(a) *Secondary hæmorrhage* was of frequent occurrence after ligature of the larger arteries in former days, when it was attributed variously to a diseased condition of the artery at the seat of ligature, to the too free detachment of the sheath of the vessel at the point at which the ligature was applied, to too early separation of the ligature, or to too small an amount of clot within the vessel. As a matter of fact we now know that this accident depends essentially upon a septic condition of the wound which is necessarily followed by separation of the ligature. When the wound is absolutely aseptic it would appear that it is not a point of very great importance that the vessel should be perfectly healthy at the seat of ligature, nor does the freedom with which the sheath is detached from the artery seem to matter much. Formerly in all treatises upon ligature of arteries the greatest stress was laid upon the necessity of making a minute hole in the sheath of the vessel, and gradually insinuating a fine aneurysm needle around it so as to avoid any risk of raising the artery from its bed. While, of course, it is well to avoid denuding the artery of its sheath for a greater distance than is necessary, we have ample experience to show that the arterial sheath can be stripped off for a very considerable distance in an aseptic wound without the slightest risk of secondary hæmorrhage occurring.

As has been said, the real cause of secondary hæmorrhage in former days was septic infection of the wound, which necessarily entailed the separation of the ligature; whenever silk ligatures become septic, they must be extruded from the wound like any other foreign body before healing can take place. The result of this is that the vessel in the immediate neighbourhood of this foreign body becomes inflamed and converted into granulation tissue, and suppuration ultimately occurs; when this has taken place, the ligature becomes loose and can be pulled out. The only obstacle to the escape of blood from the vessel at this period is the granulation tissue into which the vessel wall has become converted, and the blood-clot deposited in the interior of the artery. Should the granulation tissue be soft and weak and the plug of clot small in amount, secondary hæmorrhage is very likely to occur. The amount of clot formed upon the distal side of the ligature is generally small, and, as a matter of fact, it is from this and not from the proximal side that secondary hæmorrhage generally occurs. At the present day, when wounds are kept rigidly aseptic, ligatures do not separate at all; the wound heals rapidly, and there is very little formation of granulation tissue in the wall of the vessel, and consequently only slight softening of the coats. Further than this the ligature becomes buried in lymph which undergoes organization, and thus serves as material to strengthen the artery. Hence the fear of secondary hæmorrhage after ligature of any artery, except the largest, such as the innominate, is not one which need trouble the surgeon. In the latter case, however, there still seems to be a distinct danger of such an occurrence. This is due not to septic accidents so much as to a mechanical rupture of the vessel wall, and special precautions must be taken to avoid it. These have already been outlined in speaking of the method of application of the ligature (see p. 305), and will be referred to again in dealing with ligature of the individual vessels.

($\beta$) *Gangrene.*—The chances of gangrene after ligature of an artery in its continuity depend upon the rapidity with which the collateral circulation is developed; this in its turn is influenced by two points. The first is whether the collateral circulation has been established before the ligature is applied: the second is whether it is possible for collateral circulation to be properly established; it may fail from the presence of a diseased condition of the smaller arteries which prevents their proper dilatation or from some pressure which is exerted upon the collateral vessels as they arise from the main trunk or from pressure from œdema, etc., of the limb, which offers a physical obstacle to the circulation. Bearing this in mind, the Hunterian operation is not the best in those cases in which the aneurysm is very large, where there is extensive disease of the arteries or where the aneurysm has become diffuse. Under these circumstances, and especially in the latter case, the clot may seriously interfere with the secondary circulation, and therefore the old operation of opening the sac, clearing out the clots, tying the vessel above and below, and extirpating the sac itself is less likely to lead to gangrene than is the Hunterian operation. In the old operation the clots which are infiltrating the tissues when the aneurysm has become diffuse can be removed at the same time.

**Anel's Operation.**—Upon the question of applying the ligature in the immediate vicinity of the aneurysm or at some distance from it, our views have lately undergone considerable alteration. It is now found that the opinion formerly held as to the diseased condition of the artery in the neighbourhood of the sac was not absolutely correct, and in a large number of cases the artery is quite as healthy close to the aneurysmal sac as it is at some distance from it; moreover, the risk of secondary hæmorrhage and suppuration in the sac is now known to be the result of sepsis and not of the irritation of the ligature. Hence the exact point at which the ligature should be applied depends more upon the anatomy of the part (particularly of the branches arising from the artery), and on the size and condition of the aneurysm, than on any other consideration; we now apply the ligature at the point which will interfere least with the blood-supply to the parts below.

The rules formerly laid down as to avoiding ligature of an artery in the immediate vicinity of a collateral branch, and the exact position at which it should be applied from the aneurysm, are also of very little consequence. Formerly it was found that when a ligature was applied in the immediate neighbourhood of a branch the clot in the interior of the vessel did not extend further up than that branch, and consequently if the latter were too close to the ligature, the amount of clot available for the prevention of secondary hæmorrhage was too small. Nowadays this is a point of no importance, because, as has just been said, sepsis does not occur, the ligature does not separate, and consequently there is no need for a protecting clot.

**The Hunterian Operation.**—In this operation the artery is ligatured at some distance above the aneurysm. In the earlier operations done by John Hunter popliteal aneurysm was the affection treated, and the femoral artery was ligatured in Hunter's canal. At the present time the usual situation for the application of the Hunterian ligature for popliteal aneurysm is the apex of Scarpa's triangle, where the artery is quite superficial and readily accessible. After the vessel has been ligatured, pulsation in the aneurysm ceases, the blood comes to a standstill in the sac, and, being in contact with a foreign body in the shape of clot, it undergoes coagulation. Changes then take place in the coagulum which lead to the entire obliteration of the aneurysm and its conversion into a fibrous mass, which ultimately shrinks and almost entirely disappears. While this is the usual result, it occasionally happens that the Hunterian operation fails to cure the aneurysm, and this is most likely to occur where the collateral circulation has developed to too great an extent before operation, and where consequently blood freely re-enters the artery below the ligature and the circulation through the aneurysm is thus rapidly restored. It is not uncommon in popliteal aneurysm treated by the Hunterian ligature to find that pulsation recurs in the sac after two or three days, from the establishment of the collateral circulation, but this as a rule gradually ceases, and the aneurysm ultimately consolidates. In some cases, however, the amount of blood which passes into the sac is excessive, and the cure fails.

**Distal Ligature.**—The application of a distal ligature, that is to say, one applied to the trunk of the vessel or its main branches on the distal side of the aneurysm, is useful in cases in which neither the old operation nor the proximal ligature can be employed. It is, for example, specially suitable for aneurysms at the root of the neck, particularly when the innominate artery or the first part of the subclavian or the carotid arteries are implicated, and it has been used in some cases of aneurysm of the arch of the aorta. The object of the procedure is either to arrest the current of blood circulating through the aneurysm entirely by cutting off the branches which emerge from it, or at any rate to retard it to such an extent that the deposition of laminated clot can go on more rapidly and thus bring about a cure.

**The "Old Operation."**—In this operation the sac is opened, the clots cleared out, and the wall of the aneurysm dissected away as completely as possible after the vessel has been ligatured above and below the orifice of communication. This operation has come into favour of recent years for two principal reasons: in the first place it absolutely cures the aneurysm; in the second, it is less likely to be followed by gangrene than any other procedure in the case of a large aneurysm or one which has become diffuse.

In all cases of traumatic aneurysm where the affection is situated in the extremities, and where the circulation can be controlled by an Esmarch's bandage, it is by far the most satisfactory procedure. Even for a traumatic aneurysm of vessels which cannot be controlled satisfactorily by an Esmarch's bandage, the operation should be performed wherever it is possible to ligature the vessel upon the proximal side before the sac is opened, as by this means the risk of hæmorrhage on opening the sac is largely avoided.

In order to perform the operation, an incision extending for some distance above and below the sac is made over the aneurysm, the sac wall is exposed at the upper part, the artery is defined as near to the aneurysm as possible and a ligature applied. The sac may then be laid freely open and the clots turned out. If any blood escapes it will come from the lower end or from some branch opening into the sac, and should this happen, the finger should be placed over the aperture from which it comes, whilst the lower end of the vessel or any of the branches emerging from the sac are sought for and tied. Should there be any difficulty in defining the artery below the sac, valuable aid may be gained by passing a sound or bougie into its orifice through the sac. When the bleeding has been arrested the sac should be dissected out as completely as possible; should, however, any portion of the latter be adherent to the main vein or to important nerves in the neighbourhood, it should be left behind. A wound is thus left which will heal by first intention, the aneurysm is entirely got rid of, and the pressure it exerted on the collateral circulation (which sometimes increases considerably as consolidation occurs) is entirely done away with. It is well in all these cases to insert a drainage tube (about No. 14) into the wound; this may be removed in about four or five days.

*After-treatment.*—After all operations for ligature of arteries in the extremities every precaution should be taken to diminish the risk of gangrene. The whole limb should be thoroughly disinfected by scrubbing with strong mixture (see Part I., p. 161), wrapped up in a thick mass of salicylic wool and kept slightly elevated on a pillow, especial care being taken to avoid pressure over any bony points, notably the heel. The nurse in charge of the case should be specially warned against applying hot bottles to the feet.

When the old operation has been performed the patient may be allowed to get up in about three weeks. When however the Hunterian ligature has been employed, as for example in popliteal aneurysm, it is well to keep the patient in bed for six weeks or two months.

(2) **Compression.**—The artery may be compressed either by the fingers or by special instruments. This method of treatment is now rarely resorted to, but at one time it was much in favour, because in it all risks of secondary hæmorrhage, pyæmia, etc., were avoided. The method consists in applying pressure to the artery, if possible upon the proximal side of the aneurysm and at some distance from it, and maintaining that pressure either continuously or intermittently for from 24 to 36 hours or even

longer. It has been found in practice that a number of aneurysms are cured by pressure, even when applied intermittently. The objections to the procedure are first of all that it is difficult to satisfactorily compress the vessel, in the second place it causes great pain to the patient, and in the third place there is risk of injury to the vessel itself at the seat of compression; aneurysms have developed later on at the point of pressure.

(*a*) **Digital Compression.**—Wherever it can be employed digital compression is far preferable to that exerted by instruments. By its means the assistant can gauge the amount of pressure which is necessary to arrest the circulation much better than can be done by screwing down an instrument, and, as the fingers soon get tired, there is not the same risk of applying too much pressure; the result is that the pain is considerably less. Besides this, it is necessary to frequently change the assistant who is applying the pressure, and as a result, the compression is not applied continuously to the same part of the artery, and thus less damage is done. Finally, there is not the risk of the artery escaping pressure for a considerable time as would be the case should the instrument slip.

If digital compression is to be employed, a relay of assistants is necessary, for, as a rule, it will be found that one cannot keep up satisfactory compression for more than from fifteen to twenty minutes at a time. It is well to reinforce the compression exerted by the fingers by means of a bag of shot or a suitable leaden weight laid upon them, so that there is not so much muscular exertion required, and the compression can therefore be persevered with longer. The point at which the artery is compressed should be varied so as to relieve the pain, and each fresh assistant should compress the artery either above or below the point at which the compression is being applied, before the fingers of his predecessor are removed. If possible, the pressure should be maintained continuously for from 12 to 24 hours; when this is impossible, it may be employed for from four to six hours daily for two or three days.

Before commencing the compression, the skin over the part should be shaved, washed with alcohol, and powdered with equal parts of boracic acid and starch, and a piece of boracic lint should always be interposed between the fingers and the skin. It is generally necessary to keep the patient under the influence of morphine when compression is employed; sometimes it is even necessary to resort to the administration of a general anæsthetic when the pain is intense. This is not, however, generally called for when digital compression is employed.

(*b*) **Instrumental Compression.**—In some cases it is absolutely necessary to employ instrumental pressure, notwithstanding the greater pain that it causes, and notwithstanding that the tourniquet must be screwed down so tightly in order to prevent it from slipping, that there is greater pressure on and risk of damage to the tissues and the vessel itself, and notwithstanding also that there is less chance of cure, because the pressure cannot be maintained for so long as in the digital method. These cases will be indicated when describing the treatment of special aneurysms. When instrumental pressure is employed, the tourniquet should not be kept on for more than five or six hours at a time, and the position of the instrument should be varied during that period. If it be kept on longer than this there is a considerable risk of injuring the soft parts, or even the artery itself, and cases are known in which aneurysms have formed later on at the seat of pressure, owing to the bruising of the artery caused by the instrument. In the abdomen also the pressure on the intestine has led to sloughing and perforation of the bowel. Should the femoral artery require instrumental compression, it is well to have two instruments—one which exerts pressure over the brim of the pelvis, and another which compresses the vessel against the shaft of the bone; after the first instrument has been in position for an hour or so, the second one may be screwed down and the first relaxed.

In order to relieve the pain, it is well in all cases in which there is no renal affection to put the patient well under opium, and in some cases where instrumental pressure is used and the pain is excessive the patient may have to be kept lightly under the influence of chloroform. The preliminary preparation of the skin at the seat of compression is the same as for digital compression (*vide supra*).

When, in cases such as the femoral artery, the compression, either digital or instrumental, is given up, a bag containing sand or shot may be laid over the artery so as to diminish the flow of blood through it, and thus to prolong the effect of the compression. If coagulation does not take place the compression may be renewed daily for two or three days, for, as we have already said, experience shows that an aneurysm may be completely cured by pressure which is very intermittent. It is not, however, necessary to say more about this question of compression, because, with the exception of pressure on the distal side of aneurysms, such as those of the abdominal aorta, the method cannot be recommended in comparison with the safe and satisfactory methods of ligature which are practised at the present day.

(3) **Galvano-puncture.**—This method is only resorted to when there is no chance of employing one of the others already mentioned. Hence its use is generally confined to cases of sacculated aortic aneurysms which project externally, or for large innominate aneurysms. The object of the procedure is to cause the deposition of clot in the sac by the direct action of the galvanic current on the blood, and in order to carry it out several needles connected with the positive pole of a constant battery are introduced into the sac. The negative pole is connected with a large wet pad, which should be applied to the skin in the vicinity of the aneurysm. The skin of course must be scrupulously purified before the needles are introduced.

It is best not to introduce both poles into the sac; a large amount of gas is disengaged at the negative pole, and the clot which forms there is quite soft and frothy, and of no use, and besides this a considerable amount of heat may be generated, should the points of the needles come into contact. The clot formed at the positive pole is firm, and is of great use in the cure of the aneurysm, whilst the amount of gas disengaged is comparatively small. Only the finest needles should be employed, and they should be carefully insulated to within a very short distance of their points, and the uninsulated portion should be thrust entirely into the interior of the aneurysm, so that only the insulated part is in contact with the skin and the wall of the sac. Unless this be done, the naked portion of the needle as it passes through the skin and the wall of the aneurysm may burn a whole in the sac, and the aneurysm may thus become diffuse. The needles of course should be thoroughly disinfected by boiling, before they are introduced; they should not be immersed in the strong carbolic solution, as that is likely to destroy the insulating material. If more needles than one are introduced, they should be kept parallel to one another, as they thus produce the greatest effect. The strength of the current employed may be varied, but it should not be stronger than about 50 milliampères to begin with, and it should be continued until the sac is felt to become firm under the finger. Usually, this occurs in about a quarter to half an hour; the needles may be then withdrawn and the punctures painted over with collodion. The operation may be repeated once a week if necessary, and no anæsthetic is required.

(4) **The Introduction of foreign bodies into the Sac.**—This method was at one time largely employed. The materials introduced were generally either fine iron or silver wire or horsehair, and the object of the procedure was to produce clotting in the aneurysm around these foreign bodies. In a certain number of cases, no doubt, success followed this method, but in others no cure was effected, although large quantities of the foreign body were introduced. In some cases the latter has been known to pass from the aneurysm into the general arterial system, and to have caused serious results.

*Macewen's Method.*—In place of the introduction of foreign bodies into the sac of the aneurysm and leaving them *in situ*, Macewen has recently suggested the insertion of fine steel needles through the wall of the sac in such a manner as to scratch or scarify the wall on the opposite side over a considerable area, and thus to produce a rough surface upon which clot will be deposited. The pins should be of tempered steel as fine as possible, and should taper to a point like the ordinary sewing needle; on the opposite extremity is a rounded head. Before performing the operation the skin and the pins are thoroughly disinfected; the pin or pins are then made to penetrate the sac and pass right through its cavity until the point is felt to come into contact with the opposite side, which it should be made touch but not to penetrate. The point of the pin is then moved over the surface of the wall upon which it has impinged so as to scratch it freely, and this should be done over as large an area as possible. Sometimes the blood current can be felt to move the pin about, and in that case it may be left *in situ* so that its oscillations will mechanically lead to the necessary scarifications of the wall (see Fig. 100).

Macewen recommends that the scarification should be carried out for about ten minutes at one spot, and then the position of the point of the pin should be shifted so as to do the same at another point; in this way the greater part of the sac wall should be gone over. To do this the pin need not be withdrawn from the puncture in the skin; it may be left in the aneurysmal sac for some hours, but the longest time that Macewen recommends is 48 hours. While *in situ* the pin should be surrounded with a piece of antiseptic gauze, and when it is withdrawn a small antiseptic dressing is applied, fixed on with collodion and kept in place for several days. Should the aneurysm be very large, several pins may be introduced at different points, a suitable interval being left between each so as not to do too much damage to the wall at any one point. The action of this procedure is slow; sometimes it may be weeks before any noticeable thickening of the coats is made out; sometimes, on the other hand, it may be much more rapid. The pins may be introduced on several occasions; it is well to leave an interval of a week to a fortnight between each introduction.

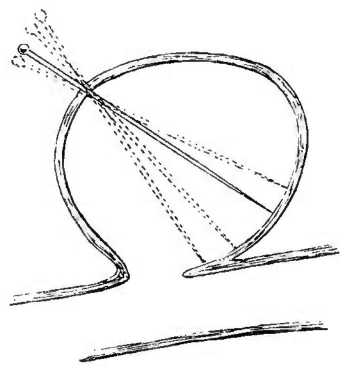


FIG. 100.—MACEWEN'S METHOD OF TREATING LARGE ANEURYSMS. The method is explained fully in the text. The dotted lines show the position of the steel pin as it is made to scarify fresh portions of the sac wall.

In several cases this plan has resulted in marked improvement; in one or two it has even produced an apparent cure of the aneurysm. In all cases, however, where either galvano-puncture or the introduction of needles is to be employed, it should be used at an early period in the disease before the sac has become too large and its coverings too much thinned.

**Summary.**—It will be evident from what has gone before that in a **sacculated aneurysm** any of the above methods are applicable according to the circumstances of the case and the anatomical relations of the part. The precise indications for the choice of any one particular method in individual cases will be discussed in detail when we deal with the various aneurysms. It is here sufficient to say that, wherever it can be employed, the best method is the old operation of removing the sac, and ligaturing the vessel above and below; failing that, the next best is Anel's or the Hunterian ligature. Where these are not applicable, distal ligature should be resorted to, and failing any of these we can only fall back upon galvano-puncture, or the use of Macewen's needles, and the cmployment of general medicinal treatment.

In cases of **fusiform aneurysm** the Hunterian operation is practically the only method which offers a reasonable prospect of success, except in those cases in which the aneurysm involves a short extent of the artery and is situated in the extremities, when of course it can be dissected completely out. Fusiform aneurysm, however, is comparatively rare in the extremities, and, as has been said, there is little or no tendency in it to the deposit of clots upon the wall.

In cases of **diffuse aneurysm** the old operation is the one which should be employed wherever it is possible, on account of the great risk of the compression exerted by the effused blood upon the collateral circulation producing gangrene of the limb should the pressure not be relieved by the removal of the clots.

## CIRSOID ANEURYSM.

By the term cirsoid aneurysm, or aneurysm by anastomosis, is meant a condition in which an artery or group of arteries is much enlarged, dilated, and tortuous; this forms a vascular mass consisting of numerous anastomosing branches, which may in fact be roughly described as an arterial nævus. The veins and capillaries in the neighbourhood are also enlarged in a similar manner. The affection may occur in almost any situation, but it is generally met with about the head and face, especially in the area of the temporal artery and its branches or upon the hand and lower part of the forearm.

There is generally very free communication between the arteries and veins; the skin may become adherent to the tumour, and ulceration may ultimately occur, and repeated and even fatal hæmorrhage ensue. Owing to the free communication with the veins, it may happen when the aneurysm is situated in the extremity that there is considerable interference with the return of blood.

**TREATMENT.**—This is often a matter of considerable difficulty. Ligature of the main arterial trunk leading to the aneurysm has been tried in many cases, but has proved almost uniformly futile. The only method that offers any prospect of success is **complete excision** of the whole tumour. The aneurysm is cut down upon, the vessels entering and leaving it are clamped and tied, and the tumour is then carefully isolated from its blood supply, and dissected completely out. This operation is comparatively simple when the mass is small, but even then the number of large vessels requiring ligature may be very considerable.

When the tumour is large the difficulties are enormously increased, and in some cases removal by operation is quite impossible. Recourse may then be had to **electrolysis** (see Part I., p. 266), which should be applied whilst the circulation through the aneurysm is controlled by pressure upon the main artery leading to it. The results, however, are seldom entirely satisfactory.

In some cases of aneurysm by anastomosis about the wrist and palm of the hand, where the tumour threatens to rupture, it has actually proved necessary to perform **amputation** of the limb.

# CHAPTER XXI.

## SURGICAL TREATMENT OF SPECIAL ANEURYSMS.

### ANEURYSM OF THE THORACIC AORTA.

THESE aneurysms seldom come under the notice of the surgeon until they have become so large as to project from the wall of the thorax and threaten to burst through the skin.

**Treatment.**—Under such circumstances all that can be done to reinforce the medical treatment is to promote coagulation within the sac-wall by one or other of the methods already described—preferably by **galvano-puncture** or by the introduction of **Macewen's needles.** This treatment, however, is very seldom successful in completely arresting the progress of the disease; to some extent no doubt this is because the surgeon is seldom called in until the last stage of the disease has been reached.

**Distal ligature.**—In cases of aneurysm of the arch of the aorta, some degree of success has occasionally followed ligature of one or more of the large vessels of the neck. Complete cure cannot, however, well be expected from this method because, of course, the circulation through the aneurysm must remain free in spite of the operation. The vessels on the left side of the neck are usually tied, and the best success seems to have followed **ligature of the left common carotid.** In some cases the **left subclavian artery** has also been tied, either alone or in addition to the carotid; when it is decided to tie both vessels it is well to do it simultaneously. This operation is unsuited for cases in which there is valvular disease of the heart, in which the aneurysm is not definitely sacculated or in which it is of very large size, and especially when it presses upon the bronchi.

### ANEURYSM OF THE ABDOMINAL AORTA.

**Compression.**—Here the aid of the surgeon is also sometimes sought, and in most cases this is the only method which can be employed. Compression of the abdominal aorta on the proximal side of the aneurysm is seldom feasible on account of the size and situation of the tumour, whilst distal compression has very rarely produced any beneficial result. Should it be decided to employ compression, the force used should not be more than is absolutely necessary to arrest the current of blood, and the pressure should not be continued for more than three or four hours at a time, nor renewed at more frequent intervals than three or four days. If these rules be neglected there is great risk of injury to the small intestine, where it is caught between the pad of the tourniquet and the vertebræ.

The most convenient method of applying **distal pressure** to the abdominal aorta is by Lister's abdominal tourniquet (see Fig. 101). When the instrument is screwed down it causes considerable pain, and in all cases it will

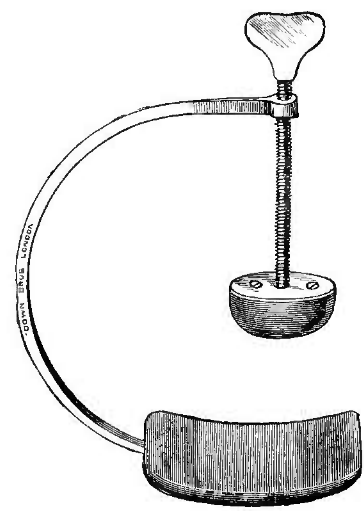



FIG. 101.—LISTER'S ABDOMINAL TOURNIQUET.

be necessary either to keep the patient fully under the influence of morphine or to administer chloroform, which need not be carried to the full surgical degree. The bowels should be freely cleared out for two or three days beforehand, and when the tourniquet is applied the abdominal muscles should be relaxed as much as possible by flexing the thighs upon the pelvis by large pillows placed under the knee, and by raising the thorax in the same way. The pad of the tourniquet is applied immediately below the aneurysm and a little to the left of the middle line.

It is important to watch carefully the effects produced by the use of this instrument. Should it be doing good, the aneurysm will be felt to become firmer and after a time somewhat smaller. On the other hand, intense pain, abdominal colic, and the passage of blood per rectum should be looked upon as indications for the immediate removal of the pressure. The general medical treatment — restricted diet, the administration of drugs, etc. (see

p. 302)—should be persevered with while the surgical treatment is being carried out.

In the rare cases in which there is room enough between the xiphoid cartilage and the aneurysm to allow of **proximal compression,** this should of course be attempted, the pad of the instrument being screwed down just above the sac.

## ANEURYSM OF THE INNOMINATE ARTERY.

Aneurysm of the innominate is not a frequent affection, and it is one that is by no means easy to diagnose with certainty. An aneurysm of the arch of the aorta or of the lower part of the right carotid or subclavian arteries may readily simulate an aneurysm of the innominate trunk. When the aneurysm is small, the situation of the tumour may assist the diagnosis. In an innominate aneurysm the swelling rises in the neck above the supra-sternal notch, whilst in an aneurysm of the first part of the carotid it usually appears between the sternal and clavicular heads of the sterno-mastoid muscle; in an aneurysm of the first part of the subclavian it is on the outer side of the latter. When the aneurysm is large, however, the swelling in each case comes to occupy about the same position, and then the diagnosis is mainly made by observing the character of the pulsation in the terminal branches of the innominate. If the pulses in both the axillary and the carotid are delayed and feebler than on the opposite side, it is probable that the innominate trunk is affected, whereas if the pulses in these two arteries differ from one another it shows that the aneurysm affects one or other of the branches.

The history of an innominate aneurysm is practically the same as that of an aneurysm elsewhere. It steadily increases in size and gives rise to various pressure symptoms, which chiefly manifest themselves in the neighbourhood of the trachea. It enlarges in an upward and forward direction, eroding the sterno-clavicular joint, and giving rise to a swelling at the root of the neck on the right side. It most frequently bursts through the skin, but in some cases the rupture may take place into the trachea or the pleural cavity.

**TREATMENT.—Distal Ligature.**—Of late years numerous attempts have been made to cure innominate or supposed innominate aneurysm by the employment of the distal ligature, and in cases of the sacculated variety these attempts have sometimes been followed by success. The distal ligature is applied to the common carotid and the third part of the subclavian artery on the right side and the ligature of the two vessels should be performed simultaneously. If an interval be allowed to elapse between the performance of the two operations the collateral circulation is generally so far enlarged that there is comparatively little diminution in the flow of blood through the aneurysmal sac. In some cases it has also been found necessary to ligature the vertebral artery at the same time, but there is considerable risk attending the performance of this operation, as it interferes markedly with the cerebral circulation, which is already considerably diminished by the ligature of the common carotid. It is moreover an operation which is extremely difficult of performance, because the sac gets in the way of the operator, and not only prevents the proper identification of the vessel, but runs considerable risk of being punctured. On the whole, it is best not to attempt to ligature this vessel for an innominate aneurysm.

When the aneurysm is of the *fusiform* variety these operations will do no good; should, therefore, the diagnosis of a fusiform aneurysm have been made beforehand, the best plan is to leave the patient alone.

**Ligature of the Common Carotid Artery above the Omohyoid.**—Ligature of the common carotid trunk for innominate aneurysm is performed as follows; the skin is shaved and disinfected, and the patient placed on his back, with the shoulders somewhat raised upon a sandbag

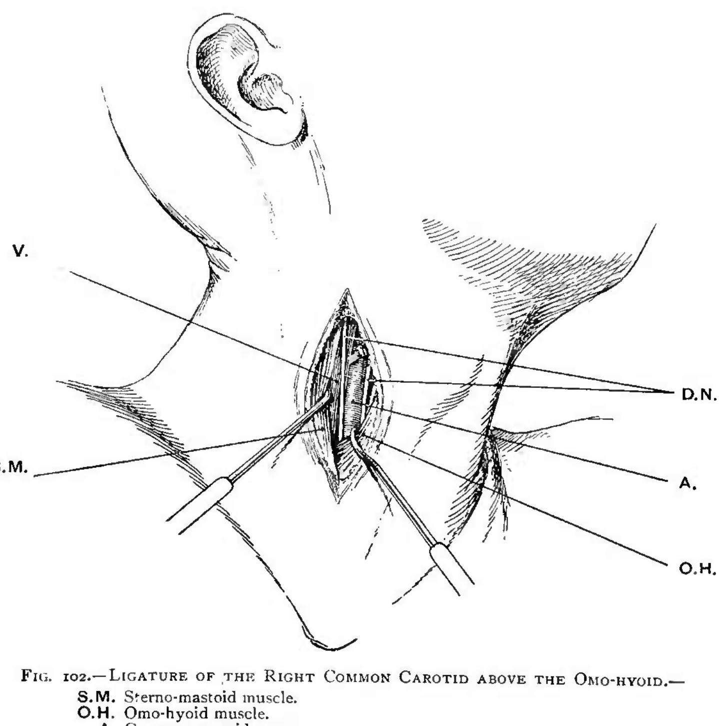



FIG. 102.—LIGATURE OF THE RIGHT COMMON CAROTID ABOVE THE OMO-HYOID.—
S.M. Sterno-mastoid muscle.
O.H. Omo-hyoid muscle.
A. Common carotid artery.
V. Internal Jugular vein. The superior thyroid vein is ligatured and divided.
D.N. Descendens noni nerve.

so as to throw the head slightly back, the chin being turned towards the opposite side. An incision about three inches in length is made along the line of the artery, that is to say, in a line from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process. The centre of this incision should be opposite the cricoid cartilage. The skin, platysma, superficial and deep fascia are divided, and the sterno-mastoid muscle is pulled outwards. On dividing the deep layer of the deep cervical fascia the omo-hyoid will be brought into view crossing the wound obliquely from above downwards and outwards. With regard to its effect upon the aneurysm it is a matter of no importance where the ligature is applied to the carotid, and as it is easier to tie the vessel above the omo-hyoid that is the point which is usually chosen. The omo-hyoid is, therefore, defined, the fascia enveloping it being divided in a direction parallel to its muscular fibres, and care is taken not to divide the descendens noni nerve which supplies it. The muscle is then pulled downwards and inwards by a retractor; at this stage branches of the dilated superior and middle thyroid veins may require ligature. This exposes the sheath of the carotid vessels, in front and towards the outer side of which is seen the descendens noni. The artery lies in the inner compartment of the sheath, being usually overlapped by the jugular vein to a greater or less extent, according to the distension of the latter (see Fig. 102). The exact position of the carotid can be readily determined by the pulsation; when this is weakened by the pressure of the aneurysm, its characteristic glistening white appearance and its flat ribbon-like feel will serve to identify it.

The general sheath is opened well to the inner side, so as to avoid the compartment containing the vein; this is done by picking up a small portion of it with forceps and incising it with the blade of the knife held on the flat, so as to avoid puncturing the vessel. The sheath of the artery is opened in a similar manner, and the two edges of the opening are picked up with catch forceps. The sheath is then gradually detached from the artery by insinuating between them an unthreaded aneurysm needle or a suitable bent probe. The best way to do this is to detach the sheath first on one side, whilst the corresponding edge of the incision in the sheath is steadied by the catch forceps, and then to treat the sheath on its other side in a similar manner, until gradually the needle is able to slip right round the vessel and its point emerges again through the opening. These manipulations must be most gently and carefully carried out, for it is very easy to puncture the sheath and to wound the vein if too much force be used. Moreover, carelessness in this particular may result in the inclusion of the vagus in the ligature. The general rule is to pass the aneurysm needle from without inwards so as to avoid the possibility of puncturing the vein with the point of the instrument. The needle should be passed unthreaded, and after it has been made to encircle the artery it is threaded with stout catgut or silk and withdrawn.

Before the ligature is tied care should be taken to see that nothing but the artery is included in it and that no injury has been done to the vein. Should by any chance the latter be punctured, the vessel should be somewhat cleared by enlarging the opening in the sheath, and the puncture in the vein may then be picked up with a pair of forceps and a lateral ligature applied. Should the rent be too large for the application of a lateral ligature or should the latter not hold properly, there is no objection to tying the internal jugular above and below the opening and dividing it between. A single ligature is quite sufficient to occlude the common carotid, and the method of tying it has already been referred to.

*Difficulties and Dangers.*—This operation is, as a rule, quite a simple one; the chief trouble met with is that bleeding sometimes occurs from the branches of the superior or middle thyroid veins, which are dilated by the pressure of the aneurysm, and this may considerably obscure the view while the omo-hyoid muscle is being defined. It is, however, usually perfectly easy to either avoid the veins or to clamp them between two pairs of pressure forceps before they are divided. Another difficulty sometimes met with is that, as a result of the interference with the venous return by the pressure of the aneurysm, the internal jugular may be so much distended as to overlap the artery almost completely; this complication is best met by opening the sheath well towards the inner side. Wound of the vein and inclusion of nerves in the ligature are avoided by care in clearing the artery. When the thyroid gland is enlarged it may get in the way, but it can easily be pulled downwards or inwards.

**Ligature of the Third Part of the Subclavian Artery.**—This operation is done as follows. The patient should lie on the back, with the shoulders supported on a suitable sand-bag, the head being turned towards the opposite side, and the arm firmly drawn down by an assistant or by a bandage fastened to the foot of the operating table. The clavicle is thus depressed, the posterior triangle enlarged, and the artery rendered much more accessible. After disinfection of the skin, the soft parts are pulled down over the clavicle, and a transverse incision is made immediately over that bone, from the inner margin of the trapezius muscle to the outer margin of the sterno-mastoid. This incision should go directly down to the clavicle and divides the skin, platysma, and superficial and deep fasciæ; as soon as it is made, the skin is released, when the incision will be found to occupy the lower part of the posterior triangle, and in most cases to give sufficiently good access to the vessel. Should it be found during the course of the operation that more room is required, a vertical incision may be made upwards along the outer margin of the sterno-mastoid, taking care in doing this not to injure the external jugular vein; a triangular flap is thus formed, which is turned upwards, and stitched or hooked out of the way.

The tissues at the base of the posterior triangle are separated with the handle of the knife, when the omo-hyoid muscle will be seen crossing the space obliquely above the clavicle; the fascia along its lower edge must be divided in a direction parallel with the muscular fibres. The suprascapular and transversalis colli veins and the termination of the external jugular vein will be seen running inwards beneath the posterior edge of the sterno-mastoid. These vessels are usually very distended, and some of them at least will require ligature and division; care should be taken of course, to clamp them in two places before they are divided. The sterno-mastoid muscle with the fat and the veins beneath it are then drawn inwards, and the omo-hyoid upwards by means of retractors. This exposes a triangular space which is bounded above and on the outer side by the omo-hyoid, on the inner side by the edge of the anterior scalene muscle, and below by the first rib. In this space will be seen the cords of the brachial plexus above, and the subclavian artery below as it passes over the first rib Below the subclavian artery, but separated from it by the

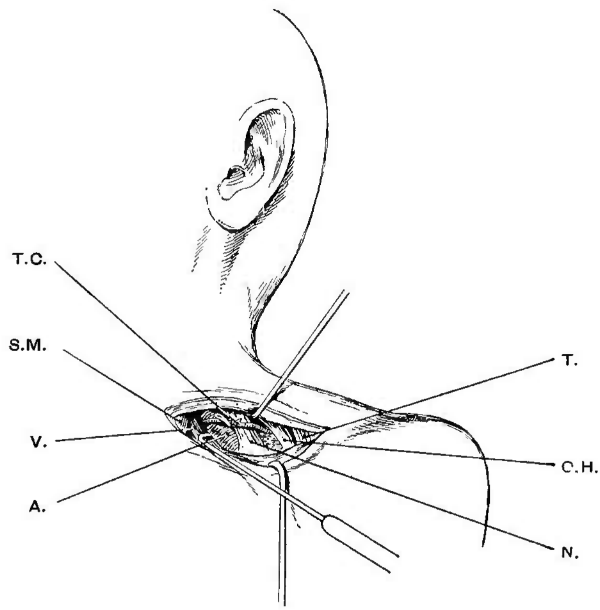



FIG. 103.—LIGATURE OF THE THIRD PART OF THE LEFT SUBCLAVIAN.—
S.M. Sterno-mastoid.
T. Trapezius.
O.H. Omo-hyoid.
A. Subclavian artery.
T.C. Transversalis colli artery.
V. External jugular vein.
N. Brachial plexus—the lowest cord is seen almost in contact with the artery.

anterior scalene muscle, is the subclavian vein, which should not, however, be seen during the course of the operation. Behind the artery is the lowest cord of the brachial plexus (see Fig. 103).

The finger is next introduced into the wound and the outer edge of the anterior scalene muscle is felt for and traced downwards to the scalene tubercle on the first rib. When the tip of the finger rests upon this tubercle, the artery can be felt pulsating under its pulp. After the vessel has been identified, the sheath is opened where the vessel lies upon the first rib, the opening seized with catch forceps in the manner described for the ligature of the carotid artery (see p. 321), and a blunt probe, or, better, an unthreaded aneurysm needle is insinuated between the sheath and the vessel. The needle is then threaded and passed around the vessel, from before backwards and from below upwards so as to avoid the possibility of puncturing the vein with the point of the needle. In order to do this, however, a specially constructed needle with a double bend, the second one corresponding to the bend of the clavicle (see Fig. 104) is necessary; otherwise, the needle must be passed from above downwards. Some authorities recommend that the needle should always be passed in the latter direction in order to avoid inclusion of the lowest cord of the brachial plexus. It should, however, be easy to avoid doing this if ordinary care be exercised in clearing the vessel.

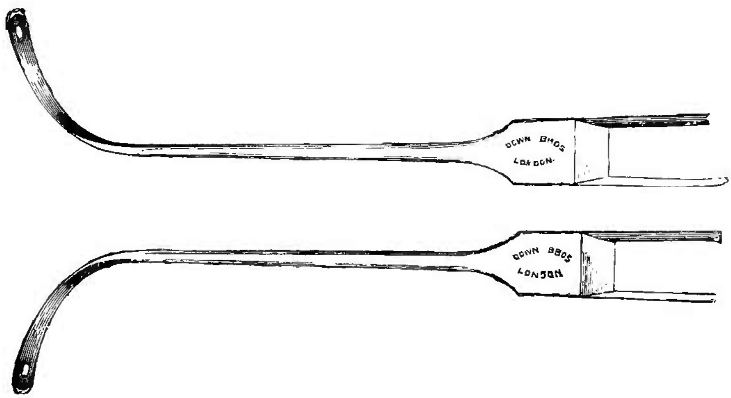


FIG. 104.—DUPUYTREN'S ANEURYSM NEEDLE.

After having tied the ligature, which should consist of a single thread of silk or stout catgut, the wound is stitched up without the intervention of a drainage tube. Sponge pressure (see Part I., p. 170) is applied over the base of the posterior triangle so as to obliterate any cavity left, and the ordinary antiseptic dressings put on. The arm should be well wrapped up in cotton wool and bound lightly to the side for the first week or ten days; it should not be flexed at the elbow, but should lie on a pillow parallel with the trunk. The patient must of course remain in bed, and any pressure symptoms which may arise during consolidation of the aneurysm must be relieved by appropriate measures.

*Difficulties and Dangers.*—The operation of ligature of the third part of the subclavian artery is one which is by no means easy even in the dissecting room, and may in actual practice be one of excessive difficulty. The following are the chief difficulties. In the first place there is nearly always very considerable *engorgement of the veins*, and this may be complicated with marked *œdema* of the cellular tissue, so that, unless the surgeon be very careful, he may be confronted with a wound from which blood wells up copiously, and in which the normal structures of the part cannot be at all easily identified. It is of the greatest importance to have as bloodless a wound as possible; otherwise the difficulties in finding the artery are enormously increased. This is best assured by taking care that every vessel is clamped in two places, and, if necessary, ligatured before it is cut. Careful sponging and the sparing use of the point of the knife also greatly facilitate matters. The lower edge of the dilated external jugular vein may project well into the field of operation. As a rule, division of this should be avoided; it can generally be drawn inwards by a retractor, but should it get in the way, it must be divided between two ligatures. Care should be taken not to cut into it before it has been ligatured, as the cardiac end of the vein usually stands rigid and widely open as it passes through the fascia, and air may therefore be sucked into it. The arteries do not as a rule give rise to any trouble. The transverse cervical is generally well above the incision, and the suprascapular usually lies behind the clavicle, well out of the way; should they come into the field of operation, they can be easily drawn aside with retractors, and should not be divided unless it is absolutely necessary, as they are important agents in carrying on the collateral circulation.

Perhaps the most important point in the operation is not to mistake *the lowest cord of the brachial plexus* for the vessel, as a ligature placed upon it would entail the most serious and painful consequences. This cord lies in close connection with the artery and is a good guide to it; in an œdematous and blood-infiltrated wound there is some danger of mistaking the one for the other, more particularly as the artery may communicate a spurious pulsation to the nerve. As long as the possibility of confounding the two is recognized, it should be easy to avoid such a mistake, as the firm rounded nerve cord is quite different to the feel of the flat, ribbon-like artery; besides which, the pulsation should be felt in the vessel and digital pressure applied to it should at once stop the pulse in the artery below. The only other point that need be mentioned is the *necessity for keeping the needle close to the vessel* as the ligature is passed, and it is always best where possible to pass the needle round the artery from below upwards and from before backwards; the lowest cord of the plexus can be kept out of the way of the needle by a finger introduced as a guide into the wound. *Wound of the pleura*, which is usually described as a complication of the operation, need hardly be mentioned; it should never occur where ordinary care is employed, and even should it happen no serious harm results.

## ANEURYSM OF THE COMMON CAROTID ARTERY.

This affection is not at all frequent. It may be met with in any portion of the vessel, but is most common at the upper extremity close to its bifurcation, or at the lower end immediately above the origin of the carotid trunk. Its symptoms and course are similar to those of aneurysm elsewhere. The diagnosis is usually simple, but the affection requires to be distinguished from a tortuous condition of the artery, which is sometimes met with close to the bifurcation, and sometimes it may be confounded with glands, tumours, or abcesses which lie over the vessel and receive pulsation from it.

**TREATMENT.**—It is generally advisable to employ operative interference, the exact operation depending of course upon the situation of the aneurysm. **Digital compression** of the artery has been tried, with success in some cases, but it is extremely difficult to perform effectually, and

FIG. 105.—METHOD OF APPLYING DIGITAL COMPRESSION TO THE COMMON CAROTID.

causes great pain to the patient. It can only be continued for quite a short time at each sitting—something like half an hour to an hour at a time—and must be carefully watched, as the pressure which must necessarily be also exerted upon the vagus is apt to give rise to serious cardiac symptoms. The pressure is made directly backwards by the fingers against the transverse processes of the fifth and sixth cervical vertebræ (see Fig. 105).

**Ligature.**—(a) **Proximal.**—This is the best method to employ whenever it is feasible, which of course will be in all cases where the aneurysm is situated near the bifurcation. When, however, the aneurysm is situated near the origin of the vessel, the distal operation must be performed, because the proximity of the aneurysmal sac and the disturbance to the soft parts caused by the aneurysm renders ligature of the innominate artery impossible. When the aneurysm involves the bifurcation of the carotid or is quite close to it, it is generally advisable to ligature the internal and the common carotid simultaneously, because the free anastomosis of the branches of the external carotid would otherwise tend to defeat the operation.

**Ligature of the Common Carotid below the Omo-hyoid.**—The operation for ligature of the common carotid trunk above the omo-hyoid muscle

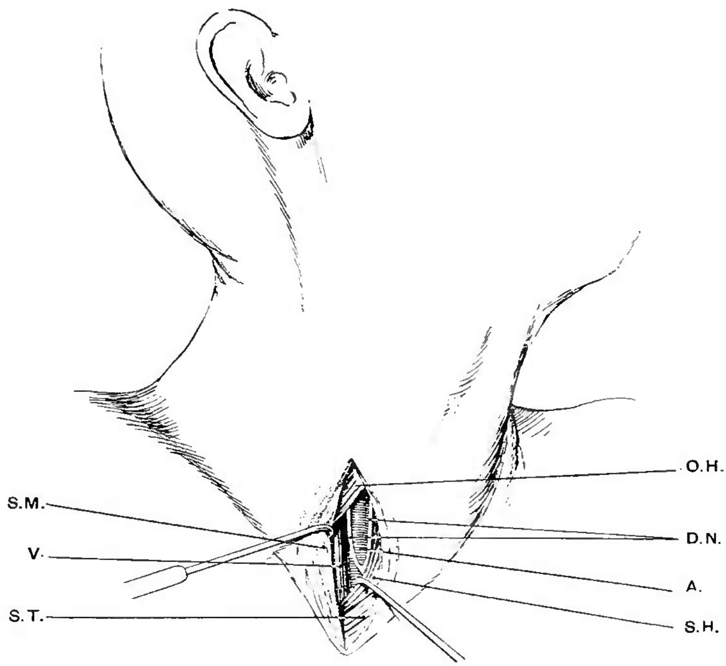



FIG. 106.—LIGATURE OF THE RIGHT COMMON CAROTID BELOW THE OMO-HYOID.—
S.M. Sterno-mastoid.
O.H. Omo-hyoid.
S.H. Sterno-hyoid.
S.T. Sterno-thyroid.
A. Common carotid artery.
V. Internal jugular vein.
D.N. Descendens noni nerve.

has already been described (see p. 320), but when the aneurysm is situated at the upper part of the vessel, it is usually advisable to apply the ligature to the vessel below the point at which the omo-hyoid crosses it. In order to do this, the patient is placed in the same position as for ligature above the omo-hyoid, and an incision about three inches in length is made in the line of the artery commencing immediately above the sterno-clavicular articulation, and extending upwards to the level of the cricoid cartilage. In this incision the anterior jugular vein may be exposed and will require ligature; it should be seized with forceps in two places, divided between them, and secured by catgut ligatures. Sometimes the inferior thyroid vein may get in the way and may be considerably dilated; if so, it must be divided between two ligatures. The inner margin of the sterno-mastoid muscle is then defined, the deep cervical fascia incised parallel with it, and the muscle pulled outwards with retractors. The lower part of the sterno-hyoid and sterno-thyroid muscles will then come into view, and should be drawn inwards towards the middle line, the cervical fascia being incised sufficiently for the purpose. The omo-hyoid muscle is also seen and drawn upwards. By this means a triangular space is left which is bounded by the omo-hyoid muscle above and externally, the sterno-hyoid muscle internally, and the sterno-mastoid muscle below and externally (see Fig. 106); in it the carotid sheath is exposed. Should the lateral lobe of the thyroid overlap the sheath it must be freed and drawn inwards into a retractor. The artery is then cleared and ligatured in an exactly similar manner to that already described for ligature of the vessel above the omo-hyoid. Should the situation of the aneurysm necessitate more room, it can be obtained by detaching the sternal origin of the sterno-mastoid by means of a transverse incision running outwards from the lower end of the vertical one. The muscle is pulled outwards, and after the operation is stitched in position by one or two catgut stitches.

*Difficulties and Dangers.*—Ligature of the common carotid, whether done above or below the omo-hyoid muscle, is always a very serious procedure from the frequency with which it is followed by cerebral complications. When the artery is ligatured, the collateral circulation through the middle cerebral artery is very often imperfect, and portions of the brain supplied by it may undergo softening; the consequence is that hemiplegia occurs, frequently with a fatal result. The percentage of cases in which this occurs is something like 10%; it is still greater if branches of the external carotid or the trunk of the internal carotid are also ligatured simultaneously. Under these circumstances, something like 25% of the cases suffer from hemiplegia, and of these nearly one half are fatal. These cerebral complications may occur immediately after the application of a ligature, or they may not appear until after the lapse of 24 to 36 hours, or even longer. Usually they begin in about twelve hours, the patient complaining of a feeling of giddiness and weakness on one side. This gradually increases, and is generally accompanied by a considerable mental disturbance, which finally ends in coma and death.

*The treatment of an aneurysm situated at the bifurcation of the common carotid* by simultaneous ligature of the common and internal trunks may be an operation of the greatest difficulty, owing to the small space available above the aneurysm. The first step is of course to tie the common trunk on the proximal side of the aneurysm; this has the advantage that, unless there are many clots in the sac, the tumour will collapse sufficiently to enable the surgeon to get satisfactory access to the internal carotid, and it has the still further advantage that, should the sac be ruptured during the manipulations necessary for ligature of the internal trunk, it will not be a matter of such great importance, as the sac can then be excised and the branches of the external carotid also tied.

**Ligature of the Internal Carotid.**—The line of this artery is the same as that of the common trunk, and the vessel should be tied near its origin, as it passes beneath the posterior belly of the digastric. The position of the patient is the same as for the operation just described (*vide supra*). The incision is made parallel with and just over the anterior border of the sterno-mastoid, and should be about three inches in length, extending as low as the middle of the thyroid cartilage. The platysma and the deep fascia of the neck are divided, the anterior margin of the

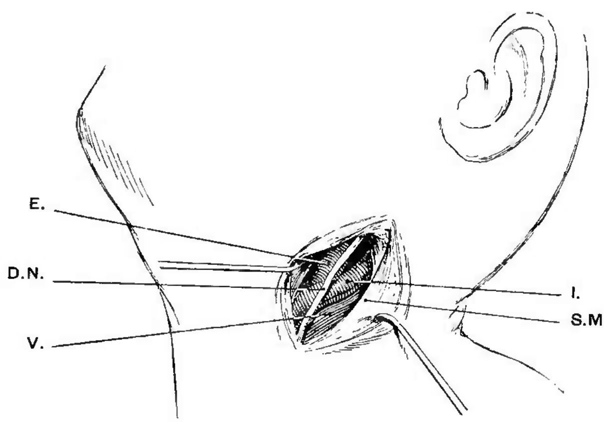



FIG. 107.—LIGATURE OF THE LEFT INTERNAL CAROTID.—
S.M. Sterno-mastoid.
I. Internal carotid.
E. External carotid.
V. Internal jugular vein.
D.N. Descendens noni nerve.

sterno-mastoid muscle defined, and the band of fascia running from it to the angle of the jaw is cut through. The muscle can then be drawn outwards by a blunt hook, and the tissues cleared with the handle of the knife or a blunt dissector. This exposes the digastric muscle above, with the parotid gland overlapping it, the sterno-mastoid muscle on the outer side, with the spinal accessory nerve entering it above, whilst the vessels are seen at the bottom of the wound, the external carotid lying in front of and to the inner side of the internal (see Fig. 107). The former vessel must then be drawn inwards. The sheath of the internal carotid is opened towards the inner side and cleared in the usual manner, care being taken not to injure the jugular vein which overlaps the artery. The needle is passed from without inwards so as to avoid the vein, and again care must be taken not to include the vagus nerve. Should the aneurysm not have been injured during the operation, it is unnecessary to remove the sac unless it be of considerable size, and has caused much pain from pressure. In the latter case it is well to open it and clear out the contents, and to ligature the external carotid beyond the sac and any branches given off from it.

(b) **Distal.**—When the aneurysm is situated at the commencement of the carotid trunk, distal ligature (above the omo-hyoid muscle) is the only operation that can be performed. The success of this procedure is of course not nearly so certain as when the proximal ligature is employed. In it also there are the same risks of subsequent cerebral disturbance.

## ANEURYSM OF THE EXTERNAL CAROTID ARTERY.

The external carotid is very rarely affected except as the result of extension of an aneurysm of the common trunk; when therefore aneurysm is met with in this vessel, it is usually situated in its lower part, just above the bifurcation. In other cases it may be situated somewhat higher up, and then shows itself as a swelling about the angle of the jaw. The pressure effects produced by it are not so severe as in the case of aneurysm of the common carotid, the most striking being those due to pressure upon the hypoglossal nerve.

**Treatment.**—The treatment of this affection should if possible be ligature of the artery below the aneurysm; if the aneurysm be small, the artery may be tied at its origin, the aneurysmal sac opened, and a ligature applied to any branches given off from it. Wherever it can be avoided the surgeon should not ligature the common carotid trunk, but sometimes this will be absolutely necessary. When it is possible to get at the external carotid and apply a ligature to it, this should be done between the bifurcation of the common trunk and the origin of the first branch of the external. On account of the free collateral circulation it is also generally advisable to tie the more accessible branches of the external carotid, more particularly the superior thyroid and the lingual vessels at the same time; if possible the facial should also be included.

**Ligature of the External Carotid.**—The operation for ligature of the artery is done as follows. The neck should be thrown well back over a sandbag and the head turned towards the opposite side. An incision is made over the line of the artery which runs from the angle of the jaw downwards and forwards to join the line of the common carotid trunk opposite the upper part of the thyroid cartilage. The incision divides the skin, platysma, and superficial fascia. A few superficial veins are secured, the deep fascia opened, and the guides to the artery felt for. The first guide is the great cornu of the hyoid bone, above which the surgeon should make out the posterior belly of the digastric muscle (see Fig. 108). The cellular tissue is then separated with a blunt dissector, so as to expose the vessel, which can generally be readily traced from its point of origin upwards and inwards towards the belly of the digastric; its pulsation can be easily felt. The needle should be passed from without inwards, and care must be taken to keep it closely in contact with the artery so as to avoid taking up the superior laryngeal nerve, which is somewhat behind the vessel.

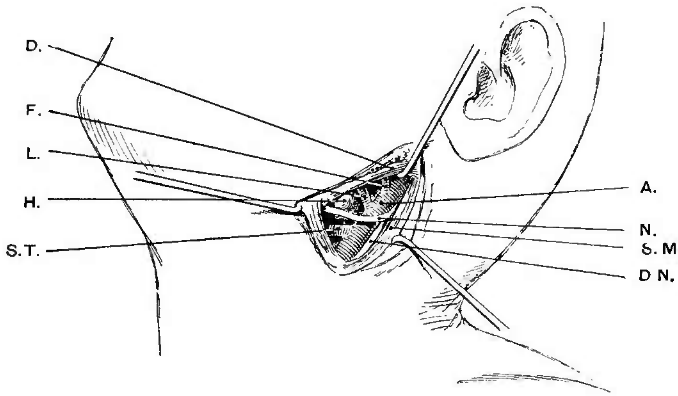



FIG. 108.—LIGATURE OF THE LEFT EXTERNAL CAROTID—

S.M. Sterno-mastoid.
D. Digastric.
H. Great cornu of hyoid bone.
A. External carotid artery.
F. Facial artery.
L. Lingual artery.
S.T. Superior thyroid artery.
N. Hypoglossal nerve, giving off the descendens noni, D.N.

## ANEURYSM OF THE INTERNAL CAROTID ARTERY.

The symptoms of aneurysm of this vessel are very similar to those occurring in the common trunk near its bifurcation, but the swelling is rather higher up in the neck, and the tumour projects beneath the mucous membrane of the pharynx, and indeed generally ruptures into the throat.

**Treatment.**—The treatment should be ligature of the internal carotid artery just above its origin if possible, and if not, both the common and external carotid vessels should be tied (*vide supra*). A fatal result is very apt to occur in these cases from the cerebral complications which have already been alluded to (see p. 328).

## ANEURYSM OF THE SUBCLAVIAN ARTERY.

Aneurysms in this situation are more frequently met with on the right side than on the left, and are more common in men than in women. They mostly occur in the third part of the artery, but they may also be met with in the first part and still more rarely in the second. An aneurysm in the first part of the right subclavian artery is often associated with a similar condition in the trunk of the innominate, and the symptoms of these two forms of aneurysm are very similar. When the aneurysm occurs in the third portion of the artery it spreads downwards towards the axillary trunk, and gives rise to pressure symptoms upon the brachial plexus and severe pain about the shoulder; there is also engorgement of the veins in the arm, with very considerable œdema from pressure upon the veins in the vicinity.

**TREATMENT.**—The treatment of aneurysm of the third part of the subclavian has up to the present been very unsuccessful. Of the measures employed, we may mention ligature of the innominate, the first part of the subclavian artery or of the axillary; amputation of the upper extremity; and various palliative measures, such as galvano-puncture, the introduction of needles, etc., which are employed when ligature in continuity is not feasible.

Ligature of the innominate artery or the first part of the subclavian has proved almost invariably fatal from secondary hæmorrhage, but there seems reason to believe that, with the more recent advances in surgery, this risk will not be so great in future, and, as a matter of fact, the first part of the subclavian has now been tied with success. Ligature of the innominate artery is much more easily done in these cases than ligature of the first part of the subclavian, on account of the proximity of the aneurysm; if the innominate be tied it is well also to tie the common carotid at the same time. Unless this be done, blood passes down the carotid into the subclavian and so on to the aneurysm, while the risk of hæmorrhage from the seat of ligature of the innominate is also greater.

**Ligature of the Innominate Artery,** combined with a similar operation on the common carotid, is performed as follows. The shoulders are raised by a sandbag of suitable size which throws the head and neck well back and brings the innominate artery to some extent up into the neck. It is essential for the success of the operation that the light should be good, and a powerful electric light will be required in the later stages to illuminate the depths of the wound. It is most convenient for the surgeon to stand on the patient's left side, as a better view of the wound will be thus obtained. The incision should be made in the middle line, the advantage of this being that the muscles are then merely pulled aside; after the operation they resume their place and leave no cavity behind, so that drainage is not necessary and primary union occurs rapidly—a point of very considerable importance in these cases. The median incision also gives better access to the vessel than any other, and it is quite easy to tie the carotid artery through it as well.

The incision should commence at the cricoid cartilage, and extend downwards in the middle line to a little below the sternal notch. The skin, the cervical fascia, and often the communicating branch between the anterior jugular veins, are divided and the handle of the knife is sunk into the division between the laryngeal muscles. Some of the inferior thyroid veins which lie upon the front of the trachea, and run downwards to the innominate, may require ligature and division. If a thyroidea ima artery be present it will also require to be tied. If the muscles on the right side of the neck be now retracted very firmly by a large retractor, the lower part of the carotid sheath will come into view; if this be traced downwards the bifurcation of the innominate into the carotid and subclavian immediately above the upper border of the sternal extremity of the clavicle will be felt. About half an inch, or sometimes more, of the innominate artery can thus be exposed in the sternal notch at the lowest part of the wound. (See Fig. 109.)

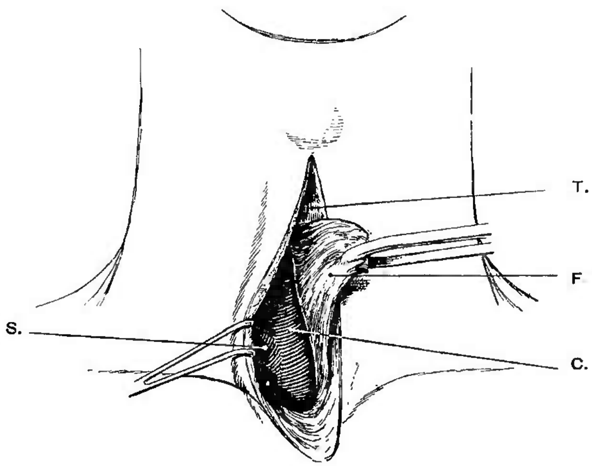



FIG. 109.—LIGATURE OF THE INNOMINATE ARTERY THROUGH A MEDIAN INCISION. The soft parts are forcibly pulled to the right after the interval between the sterno-thyroids has been opened up. The process of deep cervical fascia **F.** covering in the vessels is seen pulled over to the left side in front of the trachea **T.** This brings into view the Innominate artery bifurcating into the Common Carotid **C.** and the Subclavian **S.**

The sheath of the vessel is next opened carefully, as far down as possible, over the front, or rather towards the left side of the artery; an aneurysm needle is carefully insinuated around it in the manner already described (see p. 321), and finally passed around the vessel from the outer side. Great care must be taken to avoid puncture of the innominate vein which lies to the outer side and somewhat in front of the vessel, and aneurysm needles of varying curves and lengths should always be at hand when this operation is performed. Wound of the pleura is avoided by keeping close to the vessel.

The materials used for ligature of the innominate artery should be silk (either floss silk or the ordinary Chinese twist, both of which are better than the plaited variety) or kangaroo tendon which has been kept in a 1-1000 solution of perchloride of mercury in glycerine. Two ligatures should be applied side by side, and tightened up and tied in the manner described on page 306, care being taken in doing so not to divide the coats of the vessel. In order to tie these ligatures so as to insure complete obliteration of the vessel, the surgeon may use a considerable amount of force when two ligatures are employed, without running the risk of rupturing the coats.

The old incision used for ligature of the innominate artery consisted of a ⅄-shaped cut, one limb being parallel with the anterior border of the sterno-mastoid muscle, while the other ran outwards along the clavicle. The sternal origin of the sterno-mastoid was then divided, and the attachments of the sterno-hyoid and sterno-thyroid muscles similarly treated. The result of this was to create a cavity which filled up with clot and required drainage; if this method be employed, a longer time will be required for the healing, and the ligature does not get support from the new cicatricial tissue so early as it does after the median incision when the whole wound heals by first intention.

After the innominate trunk has been tied, a ligature should be applied to the common carotid, close to its origin, and this can be readily done through the same wound. Before the wound is closed, all hæmorrhage should be absolutely arrested by pressure and ligature, and the muscles are then allowed to fall back into their proper position. If necessary, they may be secured by fine catgut stitches, but this is usually not required. In some cases it may be thought advisable to ligature the vertebral artery, but this is very difficult to do through a median incision unless the patient be very spare, and then it can only be done when the aneurysm does not bulge much towards the inner side.

*Ligature of the Vertebral Artery.*—The artery enters the foramen in the transverse process of the sixth cervical vertebra behind the sterno-mastoid muscle, which must be pulled well outwards so as to expose the transverse processes of the sixth and seventh cervical vertebræ. The carotid sheath should be pulled inwards, and the vertebral vein which lies over the vessel should be kept out of the way. Great care must be taken in clearing the artery to avoid including branches of the sympathetic nerve in the ligature.

**Ligature of the first part of the Subclavian Artery.**—In aneurysms of the third part of the *left* subclavian artery the first part of the vessel may be reached by a median incision and a ligature applied to it immediately after its origin from the aorta as it lies over the front of the trachea, and before it gives off any branches (see Fig. 110). On the other hand, it can be reached further out by a vertical incision, between the two heads of the sterno-mastoid muscle, and from this incision it may be tied either close to or beyond the origin of its branches. On the *right* side, the first part of the subclavian may be exposed and tied by a vertical incision between the two heads of the sterno-mastoid muscle. The patient is placed upon his back with the shoulders raised by a sandbag, and the head turned to the opposite side. The interval between the clavicular and sternal heads of the sterno-mastoid is then identified, and an incision is made over it parallel with the long axis of that muscle, about four inches in length, and with its centre about an inch above the clavicle. After the fascia has been divided, the interval between the two heads of the muscle is made out,

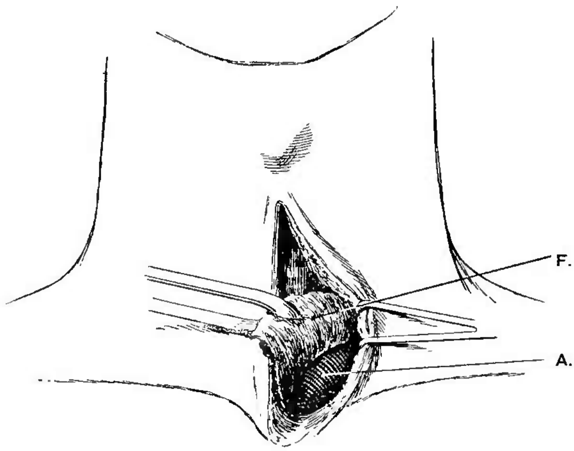



FIG. 110.—LIGATURE OF THE FIRST PART OF THE LEFT SUBCLAVIAN THROUGH A MEDIAN INCISION. Here the soft parts are pulled over to the left.
F. Deep cervical fascia. A. Subclavian artery.

the tissue filling it is opened up, the muscle split upwards as far

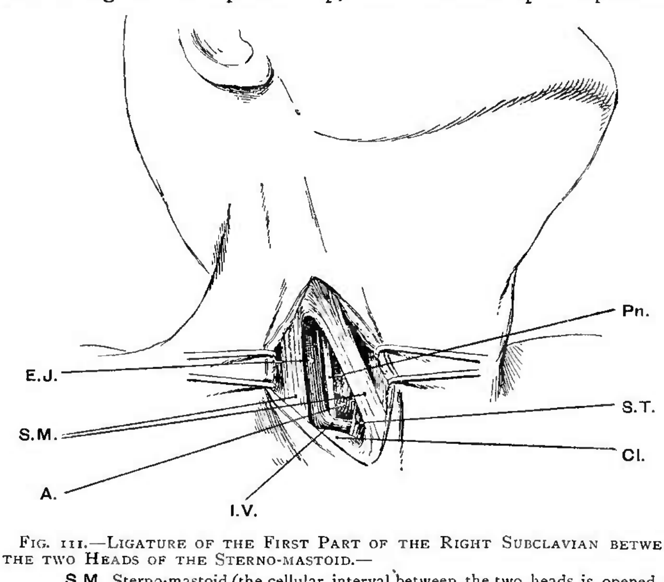



FIG. 111.—LIGATURE OF THE FIRST PART OF THE RIGHT SUBCLAVIAN BETWEEN THE TWO HEADS OF THE STERNO-MASTOID.—
S.M. Sterno-mastoid (the cellular interval between the two heads is opened up and the muscle split upwards).
E.J. External jugular vein.
I.V. Right innominate vein.
A. Subclavian artery.
Pn. Pneumogastric nerve.
S.T. Sterno-thyroid muscle.
Cl. Clavicle.

as may be necessary, and the two portions held aside by retractors Immediately beneath the fascia connecting the two heads of the muscle will be found the sterno-thyroid muscle at the inner side, and the internal jugular vein towards the outer (see Fig. 111). In dividing this fascia, great care must be taken not to puncture the internal jugular vein, which is very large, and which lies immediately underneath it; hence, the division of the fascia and muscle should only be carried out during inspiration, when the vein is not so full. The latter is pulled to the outer side, whilst the sterno-thyroid is retracted towards the middle line, and then the first part of the artery can readily be seen and cleared, and a double ligature of floss silk or stout catgut passed around it; the coats should not be divided. The vessel should if possible be tied on the proximal side of the thyroid axis, and that vessel should also be ligatured.

## ANEURYSM OF THE AXILLARY ARTERY.

This may be either spontaneous or traumatic; the latter variety is sometimes met with in connection with dislocation of the shoulder joint. It may occur at any part of the vessel; generally it is either in the first or the third part.

**Treatment.**—For axillary aneurysm affecting the first part of the vessel, the best treatment is ligature of the first part of the subclavian. When it affects the third part of the vessel the sac enlarges downwards into the loose cellular tissue of the axilla and only rarely extends upwards towards the clavicle, so that the third part of the subclavian can then be ligatured without any real risk of rupturing the aneurysm.

*Ligature of the third part of the subclavian* has already been described (see p. 322), but it is usually much more difficult of performance under these circumstances than when it is tied for aneurysm of the innominate, because if the axillary aneurysm be large the shoulder is pushed up, and there may be great difficulty in exposing the artery; indeed, in some cases it may be absolutely necessary to divide the clavicle and to pull the two ends aside in order to get at the artery as it crosses the first rib. If this has to be done the two fragments of the clavicle should, of course, be wired together after the ligature has been applied.

If an aneurysm of the third part of the axillary has resulted from injury, or has become diffuse, it may be advisable to perform **the old operation** of opening the sac, turning out the clots, and tying the vessel above and below. To do this an incision should be first made into the lower part of the posterior triangle so as to expose the subclavian artery (see p. 322) and to enable the assistant to compress it against the first rib either with the finger or by means of an instrument called a key. This is a ⊥-shaped piece of wood, the cross piece being short, and covered with india-rubber; this is the part which compresses the vessel against the first rib; before use it should, of course, be disinfected by boiling. After the subclavian has been controlled, an incision is made along the line of the axillary artery (which is from the centre of the clavicle to the junction of the upper with the middle third of a vertical line between the two folds of the axilla, when the arm is fully abducted), and if necessary the pectoralis major may be divided so as to obtain better access to the aneurysm. When the sac has been exposed, a small opening is made into it, and this is immediately plugged with the finger, which is introduced through it, and which feels for the opening in the artery. When this is identified, the finger is thrust into it and plugs it, and the sac is laid freely open, the clots turned out, the artery defined, cleared, and tied above and below the opening. If possible, it is well to dissect out the sac, but as a rule, owing to the situation of the vessel and its close relation to the brachial plexus and the axillary vein, it is advisable to leave the sac alone after the clots have been removed. A drainage tube (No. 14) should be inserted well into the cavity left, the pectoralis major muscle, if divided, should be sewn together in the manner described for suture of muscles (see p. 199), the wound stitched up and antiseptic dressings applied. The arm is then wrapped in salicylic wool and lightly fastened to the side. The drainage tube may be left out after three or four days.

## ANEURYSMS OF THE UPPER ARM AND FORE-ARM.

Spontaneous aneurysms of the upper extremity below the axilla are of very rare occurrence. As a rule they result from injuries, usually from puncture of the vessel, and belong to the class of traumatic aneurysms.

**TREATMENT.**—Whenever it is possible the treatment consists in opening the sac, turning out the clots, tying the vessel above and below, and excising the sac completely. This can usually be done without any risk, because the brachial artery can be easily controlled either by the fingers or by an Esmarch's bandage. The actual steps of the procedure depend, of course, upon the particular vessel involved. We shall here shortly describe the operations for ligature of the chief arteries of the upper extremity.

**Ligature of the Axillary Artery.**—(*a*) **Of Third Part.**—The old operation for ligature of the axillary has already been described (see above); the ordinary operation for ligature of the third part of the vessel is sometimes called for in cases of aneurysm of the brachial artery high up in the arm, and is done as follows. The patient lies with the arm abducted to a right angle and the shoulders somewhat raised upon a pillow. An incision is made along the line of the artery, which corresponds to the inner border of the coraco-brachialis muscle, for about three inches. After the deep fascia has been divided, the inner margin of the coraco-brachialis comes into view and is pulled aside with a retractor. The axillary artery with its vein and the median nerve are at once exposed, and the vessel can be cleared and tied. The median nerve lies on the outer side, the ulnar nerve and the vein on the inner; sometimes there are two venæ comites in place of the large axillary vein (see Fig. 112). The ligature is passed from within outwards, the vein being pulled downwards and the median nerve upwards.

(*b*) **Of First Part.**—In some cases this is necessary either because the vessel has been injured lower down or more generally because there is an aneurysm situated on the lower part of it. In its first part the vessel may be reached either by a transverse incision below the clavicle, which divides a portion of the clavicular origin of the pectoralis major, or by an oblique incision running downwards in the interval between the pectoralis major and the deltoid. In the latter situation no muscular fibres are

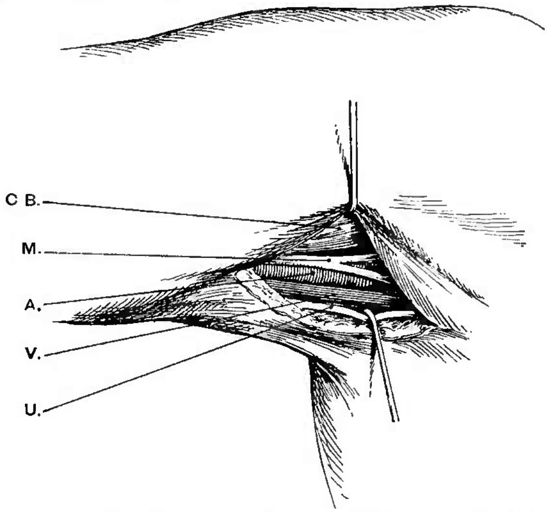



FIG. 112.—LIGATURE OF THE THIRD PART OF THE RIGHT AXILLARY.—
C.B. Coraco-brachialis muscle. M. Median nerve.
A. Axillary artery. U. Ulnar nerve.
V. Axillary vein.

divided. The first of these methods is the one that is more commonly practised and the easier of performance (see Fig. 113).

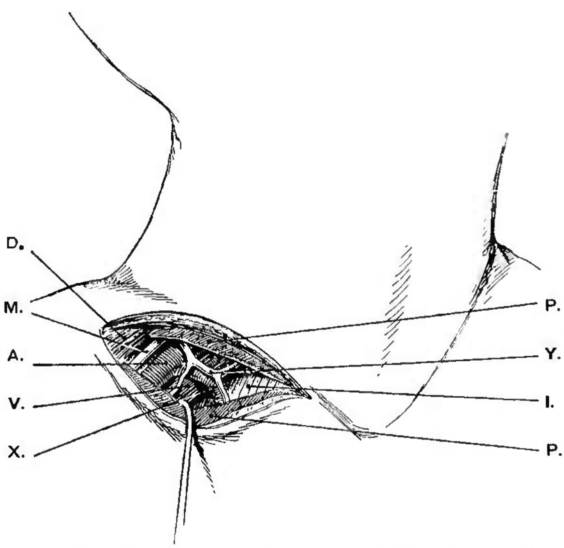



FIG. 113.—LIGATURE OF THE FIRST PART OF THE RIGHT AXILLARY.—
P. Pectoralis major muscle, divided. A. Axillary artery.
D. Deltoid. V. Axillary vein.
I. Intercostal muscle. M. Median nerve.
X. Acromio-thoracic artery. Y. Branches of the cephalic vein.

After the skin has been disinfected the arm is pulled forcibly down, whilst the skin is pulled well upwards over the clavicle, along which an incision about four inches in length is made down to the bone, running inwards from the level of the coracoid process. The skin is then relaxed and the shoulder pushed up, when the wound in the skin and fascia is found to lie from a quarter to half an inch below the level of the clavicle. This exposes to view the clavicular attachment of the pectoralis major, which is divided in the line of the wound and to the same extent as the skin. The lower portion of the muscle is then pulled well downwards by a retractor, and the costo-coracoid membrane (which is perforated by the cephalic vein, the branches of the acromio-thoracic artery and the anterior thoracic nerves) comes into view. These structures should be pulled to one side, generally outwards and upwards, and special caie must be taken to avoid injury to the cephalic vein and the anterior thoracic nerves. A small incision is made into the costo-coracoid membrane, which is slit up in the direction of the external wound. This brings into view the edge of the pectoralis minor, which is pulled downwards, whilst the costo-coracoid membrane, and the vessels perforating it are pullcd upwards and outwards. After clearing away some fat the axillary vein appears as a large distended vessel at the lower part of the wound, whilst above the artery are the cords of the brachial plexus. The first of these cords which runs alongside the vein is the outer head of the median nerve, and in order to bring the artery into view this should be freed along its lower border and pulled well outwards while the vein is pushed inwards. The artery can now be seen and cleared. The aneurysm needle should be passed from within outwards so as to avoid the vein. The divided pectoralis major should then be stitched together in the manner already described for wounds of muscles (see p. 199); as a rule no drainage tube is required unless the patient be very fat.

**Ligature of the Brachial Artery.**—(*a*) **In the Middle of the Arm** the brachial artery is usually tied in its middle third as it lies over the insertion of the coraco-brachialis

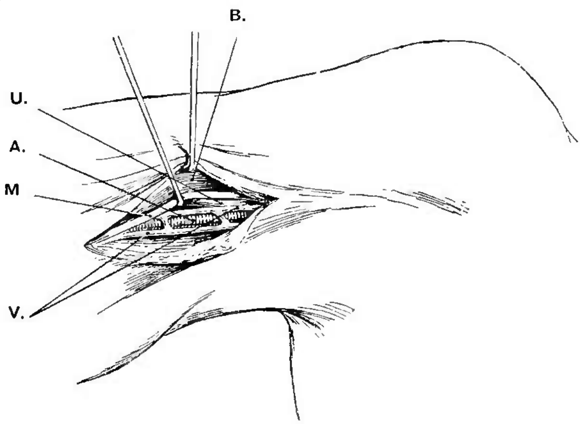



FIG. 114.—LIGATURE OF THE RIGHT BRACHIAL IN THE MIDDLE OF THE ARM.—
B. Biceps muscle. M. Median nerve.
A. Brachial artery. U. Ulnar nerve.
V. Venæ comites.

muscle. The line of this artery is from the junction of the anterior and middle thirds of a line connecting the two folds of the axilla downwards and forwards to the middle of the bend of the elbow. The vessel is overlapped to some extent by the inner edge of the biceps, and is generally crossed about its centre by the median nerve.

The incision for ligature of the vessel should be about three inches in length and situated about the centre of the arm over the inner border of the biceps; the arm should be at right angles to the trunk. After the skin and fascia have been divided, the edge of the biceps usually comes into view, particulaıly if it be at all well developed. This muscle should be freed and pulled upwards, when the artery will be felt beating immediately beneath the finger. After the fascia over it has been divided, the median nerve will be seen crossing the vessel in front, and when this is drawn upwards the artery accompanied by a vein on each side will be brought into view (see Fig. 114). It must be remembered that it is not at all uncommon for the brachial artery to divide into its radial and ulnar branches at this point, or even higher up the arm, and cases have happened in which one of these two branches has been mistaken for the main trunk, with a disappointing result. Hence, if the artery appear to be very small, or, if the bleeding or pulsation do not stop when the vessel is tied, the surgeon should always suspect the possibility of the artery having bifurcated higher up and should look for the other branch of the vessel towards the inner side.

(*b*) **At the Bend of the Elbow.**—The brachial artery may also require ligature at the bend of the elbow; this is generally done for aneurysmal varix or punctured wounds. The vessel here lies about the middle of the front of the elbow, being crossed in front by the bicipital fascia, which in its turn supports the median basilic vein. Externally to the vessel lies the tendon of the biceps, whilst a little to its inner side is the median nerve. The vessel is tied through a longitudinal incision or one slightly oblique from above downwards and outwards over the course of the artery, and having its centre opposite the middle of the bend of the elbow. The median basilic vein with the branches of the

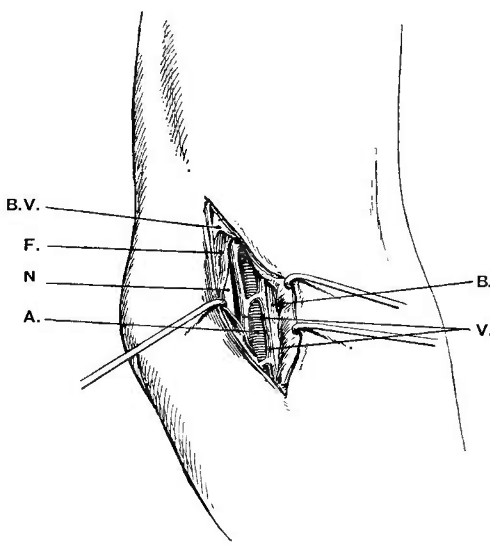



FIG. 115.—LIGATURE OF THE LEFT BRACHIAL AT THE BEND OF THE ELBOW.—
F. Bicipital fascia. A. Brachial artery.
B. Biceps tendon. N. Median nerve.
B.V. Median basilic vein. V. Venæ comites.

internal cutaneous nerve will generally be seen when the skin is divided; these should be pulled inwards and the bicipital fascia running downwards and inwards then comes into view. The upper part of this structure should be divided by a vertical incision, but it is usually not necessary to divide it completely. Immediately beneath will be found the brachial artery along with its venæ comites, somewhat overlapped by the biceps muscle (see Fig. 115).

**Ligature of the Radial Artery.**—This artery runs a superficial course down the outer side of the forearm, being overlapped above by the supinator longus muscle. The line of the vessel is from the centre of the bend of the elbow to the prominent part of the trapezium. The vessel may be ligatured at any part of its course, the most frequent situation being, however, the upper third. In that situation the artery lies upon the supinator brevis, and lower down upon the pronator radii teres, and is overlapped by the supinator longus muscle. Lower down still it lies to the outer side of the flexor carpi radialis.

(*a*) **In the Upper Third of the Forearm.**—To ligature the vessel in the upper third of its course, an incision should be made along the line of the artery, and, after division of the skin and fascia, the interval between the supinator longus and the pronator radii teres is identified. The elbow is then flexed, the two muscles separated and the supinator longus pulled firmly outwards by a retractor, when the artery will be at once exposed (see Fig. 116). The radial nerve here lies from a quarter to half an inch on the outer side of the vessel and should not come into view.

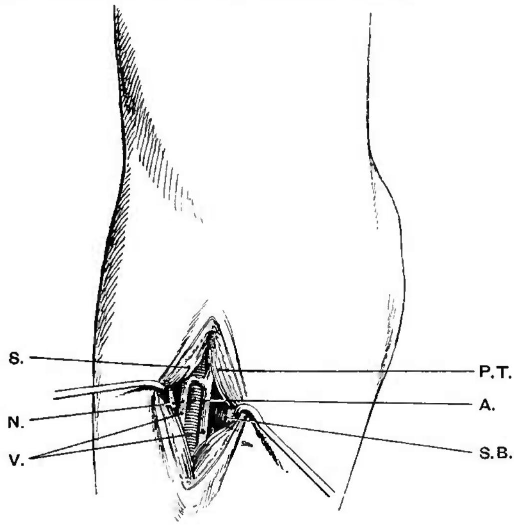



FIG. 116.—LIGATURE OF THE RIGHT RADIAL IN THE UPPER THIRD.—
P.T. Pronator radii teres. N. Radial nerve. S.B. Supinator brevis.
S. Supinator longus. A. Radial artery. V. Venæ comites.

(*b*) **In the Middle Third of the Forearm.**—If the vessel is to be tied in the middle third of the forearm the incision should be made along the line of the artery in that situation; the division between the supinator longus and the flexor carpi radialis is identified and the muscles separated, the former being pulled outwards and the latter inwards, when the vessel will be seen lying upon the radial origin of the flexor longus pollicis and flexor sublimis digitorum. The radial nerve is still to the outer side of the vessel, but in somewhat closer proximity to it (see Fig. 117).

(*c*) **In the Lower Third of the Forearm.**—Just above the wrist joint the artery lies on the radial side of the flexor carpi radialis, and can usually be felt as it rests upon the pronator quadratus muscle. An incision is made over it along the outer border of the tendon of the flexor carpi radialis, and this will immediately expose the vessel which lies upon the pronator quadratus with a vein on each side of it (see Fig. 118). The radial nerve has left the artery and is here on the back of the forearm.

(*d*) **On the Back of the Wrist.**—At the lower border of the pronator quadratus the artery dips down deeply to the back of the hand, and passes beneath the extensor tendons of the thumb. It then turns forward to pass through the first interosseous space into the palm of the hand, and may be reached by an incision on the back of the hand extending from the upper end of the first interosseous space along the ulnar side of the tendon of the extensor secundi internodii pollicis. When this tendon is pulled outwards the artery will be found between the bases of the first and second metacarpal bones dipping down beneath the tendinous arch joining the two heads of origin of the first dorsal interosseous muscle (see Fig. 119).

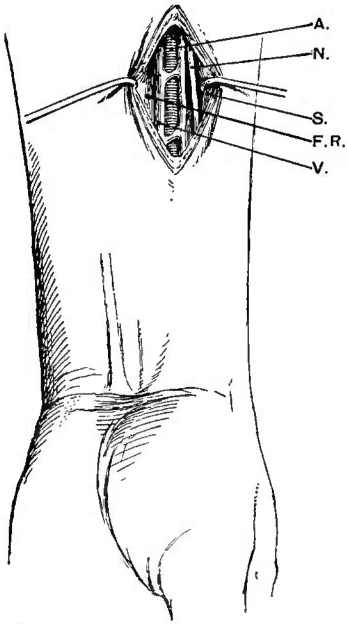



FIG. 117.—LIGATURE OF THE LEFT RADIAL IN THE MIDDLE THIRD.—

S. Supinator longus.
F.R. Flexor carpi radialis.
A. Radial artery. V. Venæ comites.
N. Radial nerve passing beneath supinator longus.

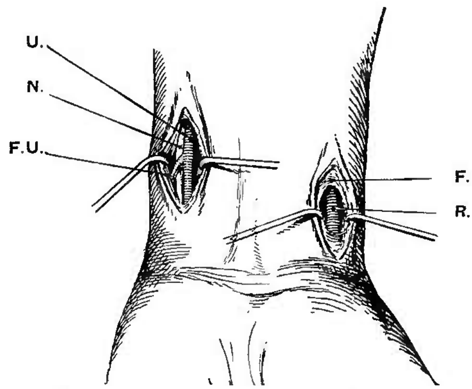



FIG. 118.—LIGATURE OF THE LEFT RADIAL AND ULNAR IN LOWER THIRD.—

F.U. Flexor carpi ulnaris.
U. Ulnar artery.
N. Ulnar nerve.
R. Radial artery.
F. Fascia lata.

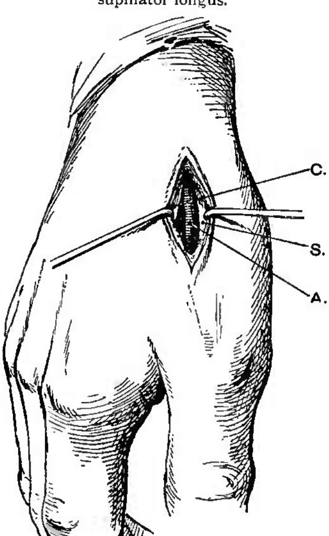



FIG. 119.—LIGATURE OF THE RIGHT RADIAL ON THE BACK OF THE WRIST.—

S. Tendon of ext. sec. internodii pollicis.
A. Radial artery and venæ comites dipping down between bases of first two metacarpal bones.
C. Outermost tendon of ext. communis digitorum.

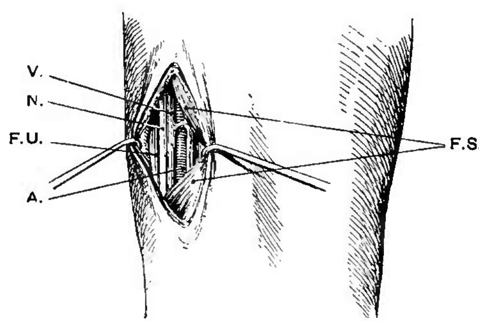



FIG. 120.—LIGATURE OF THE LEFT ULNAR IN THE MIDDLE THIRD.—

F.S. Flexor sublimis digitorum.
F.U. Flexor carpi ulnaris.
A. Ulnar artery.
N. Ulnar nerve.
V. Venæ comites.

**Ligature of the Ulnar Artery.**—The ulnar artery lies deeply at the upper part of the forearm, and is usually only tied in the lower third. The incisions for ligature of the vessel are made along a line extending from the internal condyle of the humerus to the radial side of the pisiform bone.

(*a*) **In the Middle Third of the Forearm.**—Should it be necessary to tie the artery in its middle third, an incision is made in the line of the vessel commencing at the junction of the upper and middle thirds of the forearm, and running downwards for about three inches. After the fascia has been divided, the radial border of the flexor carpi ulnaris muscle is identified, and the intermuscular septum between it and the flexor sublimis digitorum is opened up. The flexor carpi ulnaris is pulled inwards, and the flexor sublimis outwards, when the ulnar nerve will be seen lying upon the flexor profundus digitorum; the ulnar artery lies somewhat external to it (see Fig. 120).

(*b*) **In the Lower Third of the Forearm.**—Just above the wrist the artery lies to the outer (or radial) side of the flexor carpi ulnaris with the flexor sublimis digitorum immediately external to it. An incision should be made along the outer border of the tendon of the flexor carpi ulnaris, the deep fascia divided, the tendons of the flexor sublimis digitorum and palmaris longus pulled outwards and that of the flexor carpi ulnaris pulled inwards, when the artery will be at once exposed (see Fig. 118). The ulnar nerve lies to the inner (or ulnar) side of the vessel and is not usually seen.

## ANEURYSMS OF THE LOWER EXTREMITY.

### ANEURYSM OF THE EXTERNAL ILIAC ARTERY.

Aneurysm of the external iliac is generally met with in the lower part of the vessel and is of the sacculated variety, although rarely it may be fusiform; in the latter case it generally spreads downwards and affects the common femoral trunk. The symptoms and course are those usually met with in aneurysm elsewhere, the pressure symptoms being chiefly referred to the anterior crural and genito-crural nerves.

**TREATMENT.**—**Instrumental compression**, by Lister's abdominal tourniquet, for example, has been employed in some cases, but this if persisted in for any length of time, is very apt to cause serious bruising of the intestines, and seldom succeeds in effecting a cure. Undoubtedly the best treatment is to apply a **proximal ligature** wherever it can be done. The exact spot at which the ligature is applied will depend upon the situation of the aneurysm. If possible the external iliac trunk should be tied, but where the aneurysm is situated so high up that there is no room for the application of a ligature between it and the bifurcation, the common iliac may be tied.

The iliac vessels run along the brim of the pelvis; the right common iliac artery crosses both the right and left common iliac veins above, while lower down the vein of the right side lies behind and somewhat external to it. In front of the vessel is the peritoneum, the lower attachment of the mesentery being situated close to its origin, whilst the artery is crossed by the ureter at or near its bifurcation. On the left side the iliac vein lies internal to and behind the artery throughout the greater part of its course, and the latter is crossed by the ureter and the inferior mesenteric vessels, whilst in front of it also lie the sigmoid flexure and the commencement of the rectum. The external iliac artery on the right side has the vein behind it above, while below the vein passes to its inner side. On the left side the vein lies to the inner side throughout. In front of the artery on both sides below are the spermatic artery, the vas deferens, and the genital branch of the genito-crural nerve. On the right side the ureter may cross the upper part of the external iliac artery instead of the lower part of the common trunk.

**Proximal Ligature.**—There are two principal methods by which the iliac arteries may be tied, which are termed respectively the trans-peritoneal and the extra-peritoneal methods. The *trans-peritoneal*, or direct ligature of the artery, is performed by opening the abdominal cavity either in the linea semilunaris or in the middle line, and reaching the artery through the posterior layer of the peritoneum after pushing the intestines out of the way. In the *extra-peritoneal* method, on the other hand, the peritoneum is stripped up from the iliac fossa, and the vessel is thus exposed without opening the abdominal cavity. There can be no doubt that with proper antiseptic precautions the trans-peritoneal method is the better and simpler of the two methods in the majority of cases. In aneurysm of the external iliac artery there is considerable risk of rupturing the sac when the peritoneum is stripped up from the iliac fossa in the extra-peritoneal operation, and in order to avoid this risk it is necessary to make a very extensive incision through the abdominal walls, which may of course lead to considerable weakening of them subsequently.

(a) **Trans-peritoneal Method.**—To reach the vessel by the trans-peritoneal method an incision should either be made in the middle line or through the linea semilunaris on the affected side. Unless the patient be very fat it is always better to make the incision in the middle line. With a median incision of suitable length it is quite easy to pull the margins of the wound to one side so as to bring it over the brim of the pelvis. The skin is thoroughly disinfected in the usual manner, the pelvis well raised so that the intestines are displaced upwards, and then an incision is made four to five inches in length, beginning a little below the umbilicus and extending vertically downwards. The skin, superficial fascia, and the front layer of the sheath of the rectus are divided, the latter muscle is pulled aside and the posterior layer of its sheath is opened. After division of the transversalis fascia the peritoneum is slit up throughout the whole extent of the skin wound (see Fig. 121).

In stout subjects, and in cases in which the external iliac artery is to be tied, it is better to make the incision through the linea semilunaris. The great objection to doing this is, however, that the nerves supplying the rectus muscle are necessarily divided. A slightly curved incision of about four inches in length is made through the linea semilunaris, commencing about half an inch below the level of the umbilicus. The skin, superficial fascia, and anterior part of the sheath of the rectus are divided, and the rectus is either pulled inwards, or, if very well developed, its fibres may be separated a little to the inner side of the linea semilunaris. The posterior sheath of the rectus is then divided, and after that the transversalis fascia and the peritoneum. By making the incision a little to the inner side, opening the sheath of the rectus, and either splitting it up or pushing it aside, the chance of hernia after the operation is somewhat less than where the incision is carried accurately through the linea semilunaris; this incision gives good access to the external iliac vessel

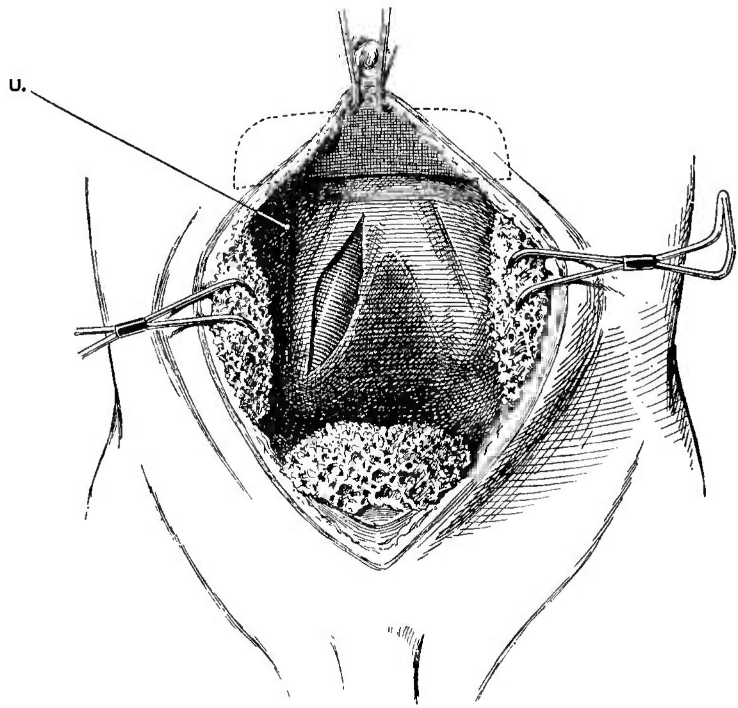



FIG. 121.—LIGATURE OF THE COMMON ILIAC ARTERY THROUGH THE LINEA ALBA.—The pelvis is raised, the intestines kept up by Maunsell's intestine guard and sponges kept in place by retractors. An incision has been made in the peritoneum over the artery, preparatory to clearing the vessel for ligature. The ureter (U) is seen just over the bifurcation of the vessel.

(see Fig. 122). Should it be found during the course of the operation that it is necessary to tie the common trunk, perfectly satisfactory access to it can be gained by prolonging the upper end of the incision in the abdominal wall somewhat inwards towards the middle line.

After the abdomen has been opened by either of these incisions the intestines are carefully pushed upwards to the opposite side and kept in position by means of suitable flat abdominal sponges or a special intestine retractor (see Fig. 123). On the right side the cæcum and the adjacent part of the ileum are displaced upwards, and on the left the sigmoid flexure of the rectum. The direction and extent to which this latter structure can be displaced will depend upon the position of the meso-sigmoid in relation to the external iliac artery;

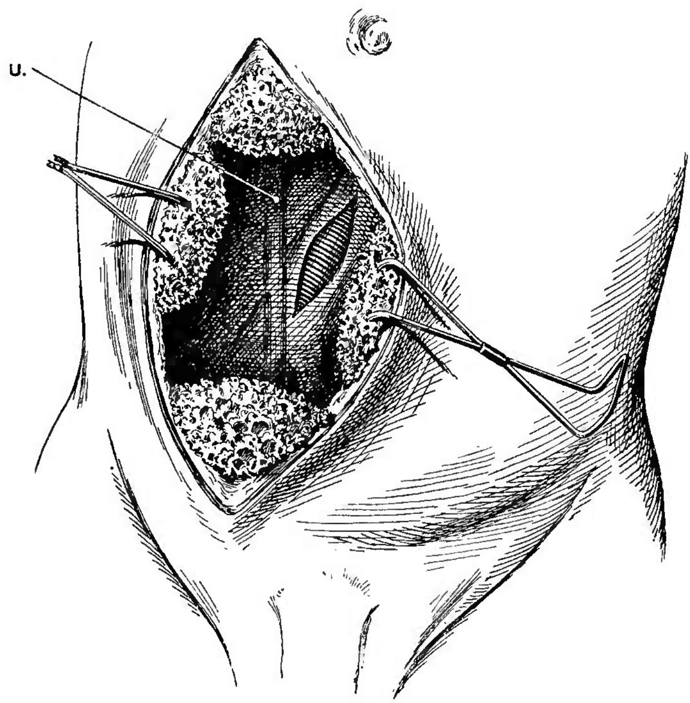



FIG. 122.—LIGATURE OF THE RIGHT EXTERNAL OR INTERNAL ILIAC THROUGH THE LINEA SEMILUNARIS. This incision comes more directly over the point at which the ligature is to be applied. The ureter (U) is seen crossing at the bifurcation.

usually it can be displaced upwards. The limits of the aneurysm are next defined with the finger and the pulsation of the artery felt for above the point where the dilatation commences. It is also important that the position at which the ureter crosses the vessel should be made out. An incision is then made in the peritoneum over the vessel, the latter is carefully cleared and the ligature passed from within outwards.

On the right side the artery is readily accessible, and the peritoneum may be incised directly over it without fear of bleeding; on the left side there may be many large arterial branches running in the meso-sigmoid, and in that case it is better to incise the peritoneum near the middle line, and to raise it outwards over the vein until the artery is reached. In the iliac vessels, as in the innominate, it is well to employ the double ligature recommended by Ballance and Edmunds (see p. 306), at any rate for the common iliac artery, so as to avoid complete division of the coats of the vessel. Great care must be taken in clearing the vessel on the right side to avoid puncturing the vein.

After the vessel has been tied, the opening in the peritoneum over it should be closed by a catgut stitch, and the abdominal incision sutured in the usual manner, the peritoneum being first stitched up with a fine continuous catgut suture, the muscles on either side being brought together

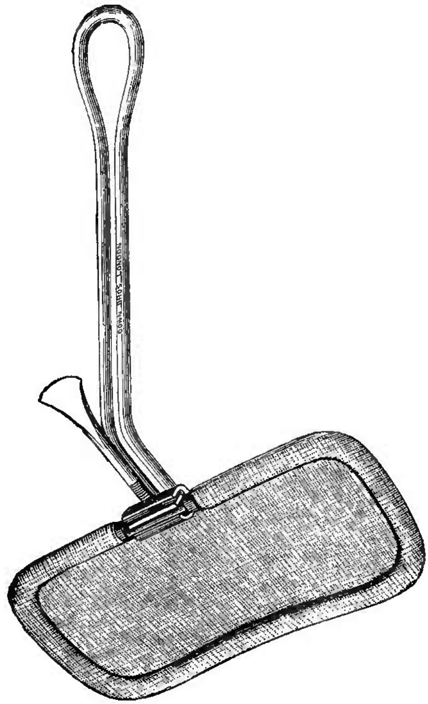


FIG. 123.—MAUNSELL'S INTESTINE GUARD. The wire frame is covered with gauze. The handle can be set at any angle.

by two or three silk sutures inserted after the style of Macewen's hernia stitches—commonly spoken of as the "mattrass stitch" (see Figs. 124 and 125)—and the skin being united with a continuous silk suture.

(b) **Extra-peritoneal Method.**—The extra-peritoneal ligature of the external or common iliac artery is not in our opinion a good method for cases in which the aneurysm is situated upon those vessels. It may, however, be employed with advantage when the aneurysm is situated high up on the superficial femoral. There are two methods of performing this operation, which are known respectively as Abernethy's and Astley Cooper's.

**Abernethy's Operation.**—In Abernethy's operation a curved incision from four to five inches in length with its convexity downwards and outwards is made from about an inch and a half external to the centre of Poupart's ligament, and the same distance above it, upwards and outwards, to a point about an inch above and internal to the anterior superior spine of the ilium (see Fig. 126). Should it be necessary to tie the common iliac, the incision is simply extended further upwards.

**Astley Cooper's Operation.**—Astley Cooper's operation is performed through an incision extending from a point an inch internal to the anterior superior iliac spine to another half an inch outside the external abdominal

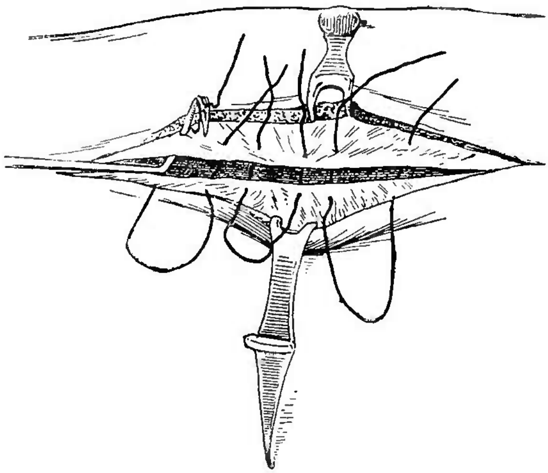


FIG. 124.—MATTRASS SUTURE FOR USE IN LAPAROTOMY. This stitch is merely an application of Macewen's hernia stitch. The method of passing the thread is shown in the sketch. It may be introduced either by an ordinary surgical needle or, better, by the handled needle shown in the figure. A very simple plan of introducing the suture is to pass the needle unthreaded through the two opposing cut surfaces, pass the thread through the eye and withdraw the needle, carrying one end of the thread with it. This leaves the needle threaded to a suture which traverses both lips of the wound. The threaded needle is now thrust through the edge of the incision from which it last emerged, carried across the wound, made to pierce the opposite side, and the suture unthreaded. The needle is now withdrawn, leaving the loop shown above *in situ*. This is not the method of inserting the stitch illustrated above.

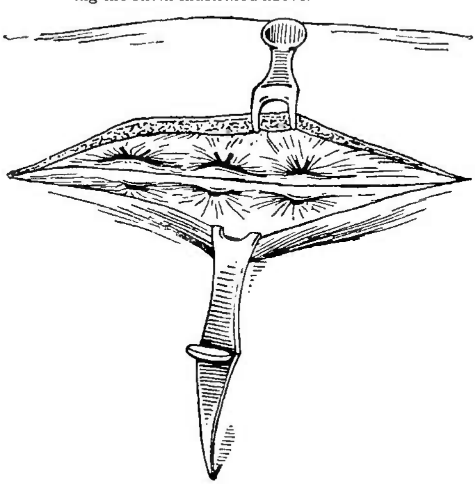


FIG. 125.—MATTRASS SUTURE FOR USE IN LAPAROTOMY. The three sutures are tied. The sketch shows the thick ridge formed by the approximation of the tissues, which are in contact over a comparatively wide area. The ends of the sutures are cut short, and the skin is afterwards united by a separate continuous suture.

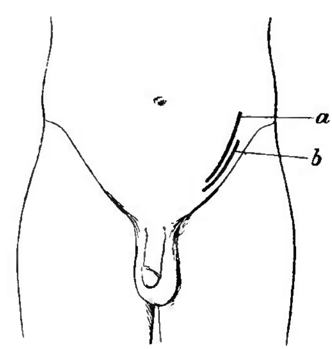



FIG. 126.—INCISIONS FOR EXTRA-PERITONEAL LIGATURE OF THE EXTERNAL OR COMMON ILIAC ARTERIES. *a*, Abernethy's. *b*, Astley Cooper's.

ring. This gives an incision about three inches in length, about an inch above Poupart's ligament, and almost parallel to it; the centre of the incision lies over the artery (see Fig. 126). By this method the artery is freely exposed below, and should the case be one in which the ligature can be applied to the lower part of the external iliac trunk this incision is the better one, because it causes the least weakening of the abdominal wall and the smallest amount of disturbance of the soft parts. When, however, the artery requires to be ligatured high up, or when there is a possibility of the common or the internal iliac requiring ligature, Abernethy's incision is the better.

In both operations the muscles are divided to the full extent of the skin incision and any bleeding points are secured as they are cut.

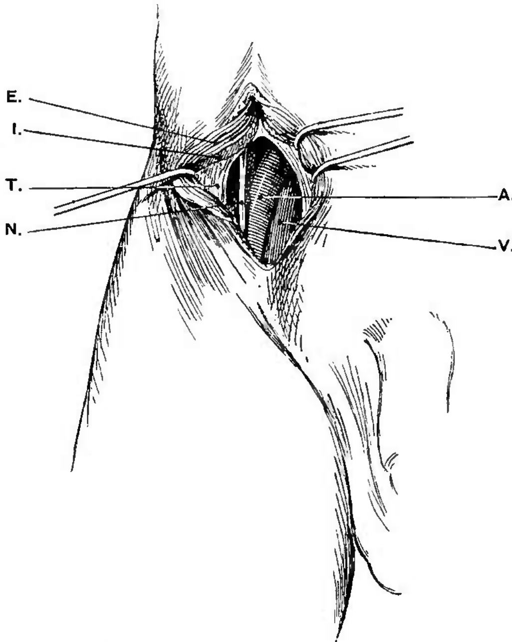



FIG. 127.—ASTLEY COOPER'S OPERATION FOR LIGATURE OF THE RIGHT EXTERNAL ILIAC ARTERY.—

E. External oblique.
I. Internal oblique.
T. Transversalis fascia.
A. External iliac artery.
V. External iliac vein.
N. Genito-crural nerve.

After the muscles have been divided, the transversalis fascia is opened below, and the opening then extended to the full extent of the external wound. This exposes the sub-peritoneal fat and fascia which lies immediately over the peritoneum. Care must be taken to identify these structures, as it is very common in ligaturing these vessels to mistake the transversalis fascia for the peritoneum, and to strip it up from the iliac fossa, carrying with it of course the vessels, so that they are in front of the finger; then, when the surgeon desires to pass the ligature he cannot find the vessels. After the transversalis fascia has been divided throughout the whole length of the wound, the patient is rolled over towards the sound side, and the peritoneum is gently separated from the psoas and iliacus muscles until the vessels are fully exposed (see Fig. 127). The wound is then retracted by broad copper spatulæ, the sheath of the artery opened in front by a small incision, and the aneurysm needle gradually insinuated around it from within outwards.

In Astley Cooper's operation the cord and the vas are displaced upwards and inwards along with the transversalis fascia, and the only structure requiring special attention is the genito-crural nerve. After the vessel has been ligatured the peritoneum is replaced and the muscles stitched up in layers by means of mattrass stitches of silk (see Figs. 124 and 125), and the skin brought together by a continuous suture. No drainage tube is required.

**After-treatment.**—After the operation the whole lower extremity should be carefully disinfected with turpentine and strong mixture in the usual manner (see Part I., p. 161), wrapped up in a large mass of salicylic wool and somewhat elevated upon a pillow; sandbags are applied along the side of the trunk to keep the patient still, while great care is taken to see that there is no constriction anywhere in the limb and no undue pressure, especially about the heel. The object of this is of course to obviate or delay the occurrence of sepsis should gangrene result from the ligature of the main vessel. The time at which the patient may be allowed to move about and sit up will be mentioned when we speak of popliteal aneurysm.

*The collateral circulation* after ligature of the external iliac artery is carried on essentially by means of the internal iliac trunk, the branches of which anastomose below with branches of the common femoral, the profunda femoris, and the popliteal. The circulation is still further aided by the deep epigastric and the circumflex iliac arteries which communicate with the internal mammary and the lumbar vessels. When the common iliac trunk is ligatured, the anastomosis is particularly bad, and it depends essentially upon anastomosis between the internal mammary artery above with the deep epigastric below, on that of the lumbar arteries with the circumflex iliac, and on the communications between the two internal iliac vessels.

## FEMORAL ANEURYSM.

This may be situated upon the common or the superficial femoral artery, but as a rule when the term "femoral aneurysm" is used an aneurysm of the superficial femoral artery is implied, the term generally applied to aneurysm of the external iliac trunk or the adjacent part of the common femoral artery being "inguinal aneurysm." Aneurysm of the profunda branch of the femoral artery is extremely rare.

Aneurysm of the superficial femoral may occur either in Scarpa's triangle or in Hunter's canal; it is perhaps more frequent in the former situation. In either case, when it attains any large size, it may cause serious pressure symptoms and may produce marked œdema of the limb from pressure on the femoral vein. It also gives rise to considerable pain, especially referred to the inner side of the thigh and upper part of the leg, which is due to pressure upon the long saphenous nerve. Aneurysms of the femoral artery either in Scarpa's triangle or in Hunter's canal not infrequently become diffuse, and it will therefore be necessary to consider the treatment of aneurysm in this situation according as the affection is circumscribed or diffuse.

(1) **TREATMENT OF CIRCUMSCRIBED FEMORAL ANEURYSM.**—Here there is a choice between two methods of treatment, namely, compression (either continuous or intermittent, digital or instrumental) and ligature. The relative value of these two methods has already been discussed on page 311, and what is there said is meant to refer to this particular form of aneurysm.

(a) **Compression.**—We are of opinion that treatment by compression is not nearly so satisfactory as that by ligature, and that it can be but rarely called for. In fact it should only be employed when the patient refuses operation, or when he is suffering from some grave constitutional affection, such as cardiac disease, diabetes, etc. The vessel compressed is generally the common femoral at the groin; or, should there be sufficient space above the aneurysm, the superficial femoral may be controlled in Scarpa's triangle.

**Digital Compression.**—This should always be chosen in preference to the use of instruments, because the compression can be kept up much more satisfactorily and intelligently, and with less pain to the patient. The great disadvantage of digital compression is that a number of assistants are required; it is impossible for any individual to keep up satisfactory pressure upon a vessel for much longer than fifteen minutes at a time, and in some cases the aneurysm may require continuous pressure for many hours before a cure is effected.

For some days before the compression is carried out the patient should be confined to bed, the bowels freely cleared out, and a preliminary course of medical treatment, having for its object the lowering of the blood pressure and the promotion of the coagulability of the blood, employed (see p. 302). The skin of the groin should be carefully shaved, and for several days before the compression it should be sponged over with spirits of wine or whisky three or four times a day so as to increase its resisting power. The shaving is of importance, as it minimizes the danger of pustular eruptions, which are otherwise likely to result from the friction of the compression, and which might interfere considerably with its proper performance. To still further aid this, the skin should also be disinfected, so as to remove organisms which might possibly be rubbed into the hair follicles. Immediately before the compression is commenced, the skin should be thickly dusted with a powder consisting of equal parts of oxide of zinc and boracic acid, and a large piece of boric lint should be applied just over the part of the vessel to which the pressure is to be applied.

In employing compression the assistant first feels for the pulsation of the artery as it passes over the brim of the pelvis at a point midway between the anterior superior iliac spine and the symphysis pubis, and when this is found he exerts pressure directly backwards. When the superficial femoral is compressed in Scarpa's triangle, the pressure should be directed backwards and outwards against the shaft of the femur. The simplest way to employ compression is for an assistant to sit in a chair upon the affected side and to place two or three fingers of the right hand directly over the line of the artery, and make pressure with them against the brim of the pelvis until pulsation in the aneurysm ceases. The pressure may be reinforced by two or three fingers of the left hand applied over those of the right (see Fig. 128). Upon the fingers may be laid a bag containing two or three pounds of shot, or a leaden weight of suitable size and shape, so as to diminish the amount of muscular effort required; with this aid it may be possible to maintain compression for a longer

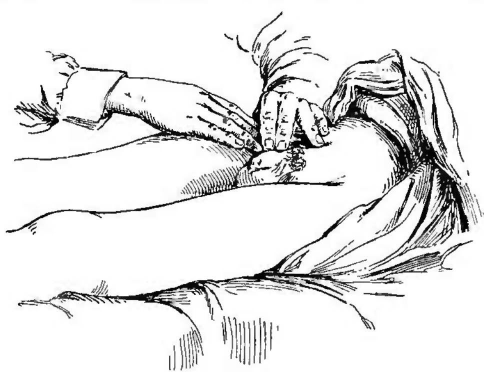
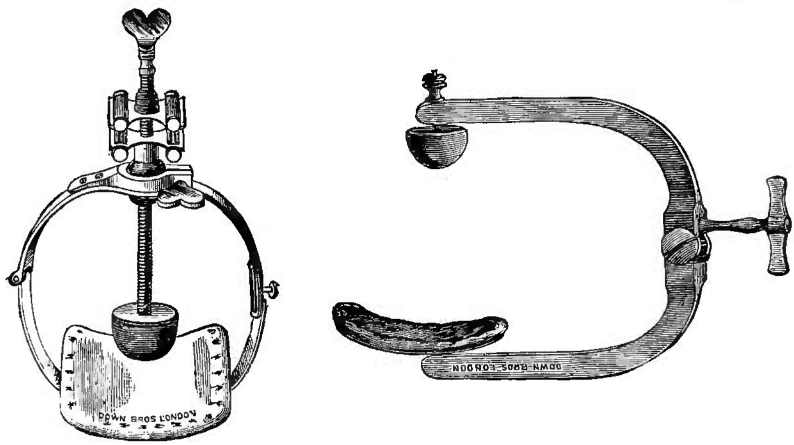


FIG. 128.—DIGITAL COMPRESSION OF THE COMMON FEMORAL ARTERY. The pressure of the fingers may be reinforced by a leaden weight or a bag of shot. The method illustrated is better than compression by encircling the limb with the two hands and making pressure with the thumbs, as less muscular effort is required.

period than fifteen minutes. When the assistant becomes tired, a second should apply pressure higher up or lower down over the vessel, and should control the circulation before the first assistant relaxes his pressure. Pressure may thus be kept up by a relay of men until either coagulation in the aneurysm is complete or the patient can tolerate the pressure no longer.

It is difficult to say exactly how long pressure should be kept up, as so much depends upon the individual patient; cases are known in which a cure has resulted after the application of pressure for as short a time as four hours, whilst in others the duration of the treatment has had to be measured by days. Speaking generally perhaps we might say that pressure should be maintained for from four to eight hours in the first instance, and then the patient may be left alone for a day or two, so as to give the skin and soft tissues time to recover from the pressure to which they have been subjected. It not infrequently happens under these circumstances that although pulsation returns in the vessels when the pressure is first relaxed, coagulation still continues in the sac, and the aneurysm may be cured without any second compression being required; should this not happen, however, and should the patient be able to bear it, the compression may be resumed the following day for four or five hours. It is well to keep the patient fully under the influence of morphine by repeated hypodermic injections so as to diminish the pain which accompanies the treatment and which is often very severe; this must not be used, however, when there is renal disease. If, in spite of morphine, the pain becomes intolerable, ligature had better be employed. It has been suggested that chloroform should be administered in place of morphine, but if this is to be done the chief objection to operation is done away with, and it is then much better to tie the artery.

**Instrumental Compression.**—When it is deemed advisable to employ compression and a relay of assistants cannot be obtained, the pressure




*A* *B*

FIG. 129.—TOURNIQUETS FOR COMPRESSION OF THE FEMORAL ARTERY. *A*, *Carte's*, for use in the thigh. *B*, *Signorini's*, for use at the groin.

may be applied by a suitable tourniquet. For this purpose *Carte's* or *Signorini's* (see Fig. 129) is the best. Before the instrument is applied the same preliminary measures should be adopted as in the case of digital compression: namely, the limb should be shaved, disinfected, dusted over with a drying powder, and a piece of lint applied over the point of compression. It is also well to get the patient fully under the influence of morphine. When instrumental compression is employed great care must be exercised, because it is easy to use more force than is absolutely necessary without the surgeon being aware of it, and thus very serious damage may be inflicted upon the vessel. In order to avoid this as much as possible it is best, wherever sufficient space is obtainable, to employ two tourniquets; in the example before us, one may be used to compress the vessel at the groin and the other in the upper part of the thigh. The first tourniquet is screwed down very gradually so as to just compress the artery, and when the patient finds that the pain is becoming unbearable the second is tightened up and the first relaxed. In this way the pressure may be alternated, and may be rendered bearable for a considerable period.

*After-treatment.*—When the compression is over, the limb should be disinfected, wrapped up in cotton wool, and elevated as after digital compression. The contact of anything hot (particularly hot-water-bottles) with the leg or foot should be studiously avoided in all cases, either of compression or ligature. It is not at all uncommon for the patient to complain of the feet being cold and to beg for a hot-water-bottle, but this should be absolutely prohibited, as a slough is very apt to form from the application of even a very moderate degree of heat.

(b) **Ligature.**—In the large majority of cases, as we have already said, the surgeon will resort to ligature of the femoral artery in preference to either digital or instrumental compression, and wherever it is feasible the superficial femoral should be the vessel tied. Should, however, the aneurysm happen to affect the upper part of the superficial femoral or the profunda femoris, it will be necessary to ligature the common femoral artery, and we shall describe this operation first.

**Of the Common Femoral Artery.**—After the skin has been shaved and rendered thoroughly aseptic, the thigh is somewhat abducted and

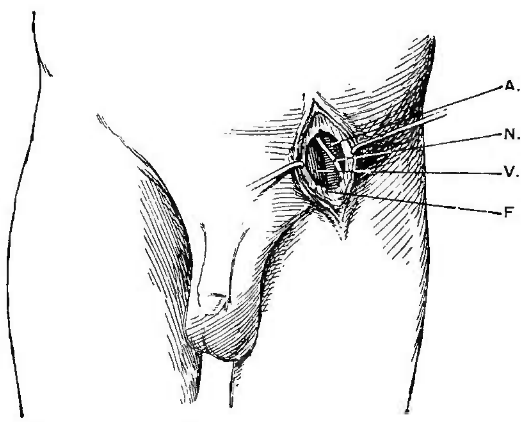



FIG. 130.—LIGATURE OF THE LEFT COMMON FEMORAL.—
A. Femoral artery. N. Crural branch of genito-crural nerve.
V. Femoral vein. F. Fascia lata.

rotated outwards with the knee in the semi-flexed position supported by a suitable sandbag. The line of the artery is from a point midway between the anterior superior iliac spine and the symphysis pubis to the adductor tubercle of the femur. An incision two or three inches long, with its centre about half an inch below Poupart's ligament is made along this line (see Fig. 130); this divides the skin and superficial fascia, in which lymphatic glands are often met with; they should be pulled aside, or removed if unduly large. A few superficial veins may also require ligature. The deep fascia is then incised along the incision, and the pulsation of the artery felt for. When this is made out, a small incision is made in the sheath of the vessel, and an aneurysm needle inserted around it. The ligature should be passed from the inner side so as to avoid the vein; as a rule, a single ligature suffices for tying the femoral artery and any of the vessels lower down in the limb, and there is no particular objection to division of the internal and middle coats, provided always the wound be kept aseptic. Care must be taken not to include in the ligature the crural branch of the genito-crural nerve, which descends upon the front of the artery, otherwise excruciating pain may result. The skin wound is closed without a drainage tube, the usual antiseptic dressings applied, the limb disinfected and wrapped up in cotton wool, and placed in a slightly elevated position.

**Of the Superficial Femoral.**—The seat of election for ligature of this vessel is the apex of Scarpa's triangle, but when the aneurysm occurs in that situation it may be necessary to tie the vessel higher up, that is to say about the middle or even the upper part of the triangle. The line of the vessel is the same as that of the common femoral.

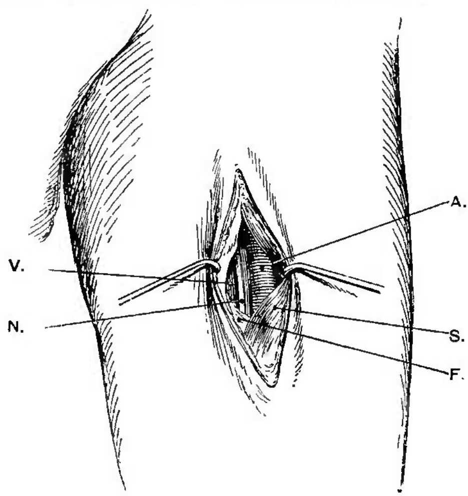



FIG. 131.—LIGATURE OF THE LEFT SUPERFICIAL FEMORAL AT THE APEX OF SCARPA'S TRIANGLE.—
S. Sartorius. A. Femoral artery. V. Femoral vein. F. Fascia.
N. Internal saphenous nerve. It will be seen that the nerve here lies rather internal to the artery; it is usually in front and to its outer side.

In ligaturing it *at the apex of Scarpa's triangle*, an incision is made in the line of the vessel with its centre about the apex of the triangle, dividing skin, superficial and deep fascia. The inner border of the sartorius should then come into view, but care must be taken not to mistake the adductor longus for this muscle, as it may be exposed should the incision be made rather too far inwards. The identification should be quite easy, as the fibres of the sartorius run downwards and inwards, whilst those of the adductor longus run directly downwards, or downwards and slightly outwards. The sartorius should be drawn outwards with a retractor, and should the adductor longus be at all prominent it should be drawn to the inner side (see Fig. 131). The fascia over the femoral artery is then divided, the sheath opened, the vessel cleared, and the artery ligatured, the needle being passed from the inner side. No drainage tube is required, and the limb is treated in a similar manner to that after ligature of the common trunk. The artery usually lies somewhat in front of the vein, with the long saphenous nerve on its outer side.

*After-effects.*—The first subjective result of ligature of either of these vessels is a feeling of coldness with considerable pain and painful cramp in the lower extremity. These sensations usually pass off during the first twenty-four hours, and are due to deficiency in the circulation of the limb; sometimes also there is pain about the seat of the aneurysm as a result of its distension by clot when coagulation takes place. Should this pain be excessive, there is no objection to the administration of full doses of morphine unless there should be other features in the case which specially contra-indicate the use of the drug. After the lapse of twenty-four hours the toes should be examined to see whether the circulation is maintained or not. As a rule the toes will be warm and of good colour by that time. The simplest way to ascertain whether the circulation is maintained is by pressing upon the point of the nail and forcing the blood out of the matrix; on relieving the pressure the blood ought to flow back again immediately, and should it be slow in doing so it is a sign that the circulation is much impaired. Should impairment of the collateral circulation last for forty-eight hours, it is highly probable that gangrene has occurred, and as soon as this happens there is no object in waiting for a line of demarcation; the surgeon knows where the obstruction is, and also knows that amputation must be performed within the area of distribution of the branches of the profunda femoris and their anastomoses, that is to say, at the knee joint.

When gangrene does not take place, the consolidation and shrinking of the aneurysm go on rapidly. Consolidation is usually accompanied by a good deal of pain radiating from the seat of the aneurysm down the leg; this may continue for months, or until the aneurysm has completely disappeared. In any case the patient should be kept in bed for from four to six weeks after the operation, so as to allow a certain amount of consolidation of the clot to take place, and it is well to restrict the movements of the knee afterwards until such time as the aneurysm has almost disappeared. With this object the patient should go about upon crutches, and the knee should be fitted with a suitable casing which may be prolonged upwards so as to protect the aneurysm from contusion. This fixation of the knee joint is more especially important in cases of popliteal aneurysm.

*Complications.*—Should the surgeon happen to *puncture the vein* during the operation for ligature, the best plan is to apply two ligatures to the artery, and divide it completely across between them, and in this way the puncture in the vein is easily exposed. It is impossible to employ pressure to stop the bleeding from the vein, as would be done under ordinary circumstances, on account of the risk of gangrene from interference with the collateral circulation. The surgeon has choice of two methods in which he will be influenced by the size of the aperture in the vein; should it be quite small, a lateral ligature will suffice to close it; should the wound be too large for this, the vein may be stitched up in the manner described for the treatment of wounds of veins (see p. 277). The entire lumen of the vessel should never be occluded if it be possible to avoid it, as such a procedure would offer a markedly increased difficulty to the return of blood, and where the tissues are feeble this might just turn the scale in favour of gangrene. In vigorous, healthy individuals, however, complete transverse ligature of the vein does not seem to materially complicate matters.

**The Old Operation.**—The old operation in this situation is performed as follows. After the limb has been disinfected and prepared in the ordinary manner it is placed in the position for ligature of the femoral vessel, and the circulation is controlled by the fingers of an assistant who compresses the common femoral as it passes over the brim of the pelvis. The surgeon then makes a free incision of sufficient length, according to the size of the aneurysm, along the course of the superficial femoral artery, and if there be sufficient room between the aneurysm and the assistant's finger it is well before opening the sac to tie the femoral artery above it. The assistant may then be allowed to relax the pressure, the aneurysmal sac is laid freely open throughout its whole length, all the clots are turned out with the finger or a spoon, and the bleeding from the lower end is arrested at first temporarily by digital pressure, and subsequently by clearing the vessel and applying a ligature on the distal side of the opening. When all the clots have been turned out, it is well to isolate as much of the sac as possible, and this should be clipped away. The posterior part of it, however, is best left behind, as the dissection needed to separate it from the vein might easily injure the latter.

When it is impossible to secure the artery on the proximal side of the aneurysm before opening the sac, a small incision must be made into the sac and plugged at once by introducing the finger into it. The finger feels for the opening of the vessel, occludes it by pressure, and the artery on the proximal side is rapidly cleared and a ligature applied to it. The finger is then withdrawn, the sac laid freely open, and the operation is finished as above described. It is sometimes possible, when the aneurysm is small and well-defined, to cut down upon the femoral immediately above the sac, and ligature it before incising the aneurysm. This simplifies the operation. The old operation is most suited for circumscribed aneurysms of small size or those that have become diffuse.

**(2) TREATMENT OF RUPTURED (DIFFUSE) FEMORAL ANEURYSM.**—Should the sac of the aneurysm have ruptured, the best treatment will be the old operation (just described) of cutting down upon the tumour, turning out the clot from the sac and the tissues around, ligaturing both ends of the vessel, and, if possible, excising the sac wall. In former times rupture of a femoral aneurysm was regarded as an accident which necessitated amputation, partly on account of the great risk of gangrene if the artery were ligatured, owing to the collateral circulation being interfered with by the clots infiltrating the tissues around, and partly on account of the risk of suppuration in the limb which resulted from septic infection of the clot. At the present time this latter risk is of course entirely avoided by adequate antiseptic precautions, and the clots which occur as the result of rupture of the aneurysm may therefore be safely turned out; the pressure upon the collateral circulation is thereby relieved, and the risk of gangrene from this cause avoided. Hence amputation should not be performed in these cases unless it is evident that gangrene has set in.

It will often be found that, in spite of ligature of the main artery above and below the aneurysm, oozing still takes place into the sac; this generally comes from small branches given off from the aneurysm which must be isolated and tied, as otherwise very considerable bleeding into the cavity caused by the extravasation of blood may occur, and serious pressure upon the collateral circulation may result. Any clots present in the tissues around are turned out, a drainage tube or tubes (No. 14-18) are inserted and the wound is stitched up. The usual antiseptic dressings are applied, the limb is put up on a splint in the elevated position and watched carefully for signs of gangrene (see p. 356). It is necessary to employ a drainage tube in these cases because of the oozing that must necessarily occur into the large cavity left. This latter cannot be obliterated by sponge pressure in the ordinary way, as that would entail too much interference with the collateral circulation and a serious risk of gangrene.

## POPLITEAL ANEURYSM.

The popliteal artery is one of the most common seats of aneurysm, and it is most prone to occur in men whose occupations lead to frequent, rapid, and violent flexion of the knee. In former times it was very common in conductors of coaches, and it is also not at all infrequent in soldiers and sailors. The aneurysm gives rise to difficulty in using the knee, and pain along the course of the nerves, especially the internal popliteal; it is particularly liable to become ruptured and diffuse from the forcible flexions of the knee. The posterior ligaments of the knee joint may be eroded and the aneurysm may burst into the articulation, or it may become diffused into the popliteal space itself, or may make its way through the skin over it.

**TREATMENT.**—The procedures employed for the treatment of popliteal aneurysm may be either compression or ligature. We have already discussed the relative merits of these two plans, and have described in detail the method of carrying out **compression**, which should be applied to the upper part of the femoral artery (see pp. 351-4). Amongst operative procedures for the cure of popliteal aneurysm, the surgeon has the choice between the old operation of incising the sac and tying the vessel above and below, ligature of the popliteal artery at its commencement, or ligature of the femoral artery in Hunter's canal or Scarpa's triangle.

**Ligature.**—(a) **Of the Superficial Femoral Artery.**—In the ordinary cases of popliteal aneurysm proximal ligature is perhaps the safest plan, as it does not involve any risk of injury to the nerves or the vein. At the same time surgeons are beginning to consider the question as to whether the old operation may not be applicable not only to cases of diffuse aneurysm in the popliteal space but to all cases of aneurysm in that region, and this is a point which will probably have a good deal more attention paid to it in the near future.

*At the Apex of Scarpa's Triangle.*—When proximal ligature is determined upon, the point at which the artery is tied will depend to some extent upon the situation of the aneurysm. It is generally done at the apex of Scarpa's triangle, an operation which we have already described (see p. 355). John Hunter, in introducing his operation, tied the artery in what is known as Hunter's canal, and some surgeons, with whom we are inclined to agree, tie the vessel whenever it is possible at the upper part of the popliteal space.

*In Hunter's Canal.*—Ligature of the artery in Hunter's canal is per-

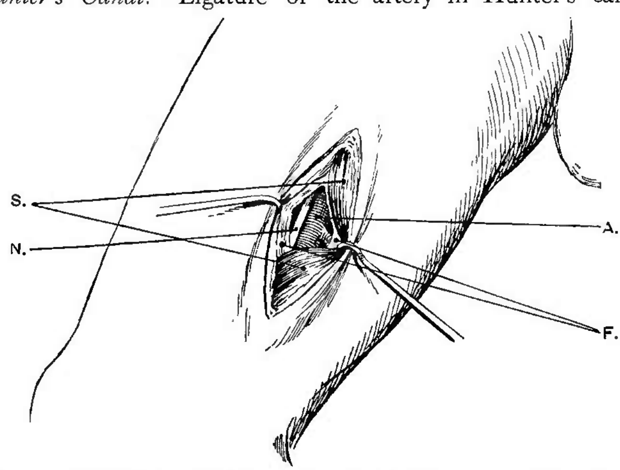



FIG. 132.—LIGATURE OF THE RIGHT SUPERFICIAL FEMORAL IN HUNTER'S CANAL.—
S. Sartorius. A. Femoral artery giving off anastomotica magna.
F. Fascia covering canal. N. Long saphenous nerve.

formed as follows. After the limb has been rendered aseptic, the knee is somewhat flexed, the thigh rotated outwards, and an incision from three to four inches in length is made in the line of the artery over the middle third of the thigh in the situation of Hunter's canal. After the skin and fascia have been divided the sartorius will be exposed as it crosses the space obliquely from without inwards (see Fig. 132). It is usually most convenient to draw this muscle to the inner side, but should the surgeon be operating at the upper part of the canal he will find it more easy to pull it outwards. This exposes the fibrous connection between the adductor longus and the vastus externus which forms the roof of the canal. A portion of this should be picked up in dissecting forceps and nicked, and the canal then laid open throughout the whole length of the incision upon a director or by means of the finger guiding a probe-pointed bistoury. This will expose the artery which runs along the floor of the space, with the saphenous nerve on its outer side and the femoral vein behind it. At the lower part of the canal the latter passes somewhat to the outer side of the artery. In this situation also the saphenous nerve crosses the front of the vessel from the outer to the inner side, close to the spot at which the artery passes through the opening in the adductor magnus. Here also the anastomotica magna comes off and runs downward towards the knee. The artery in Hunter's canal is always tied above the origin of this branch. To do this the sheath of the artery is opened, the vessel cleaned, and the needle passed from the outer side just above the origin of the anastomotic branch. The after-treatment is that already described for the other ligatures of this vessel.

**(b) Of the Popliteal Artery.**—As the anastomotica magna is one of the main factors in carrying on the collateral circulation, it is a better plan to

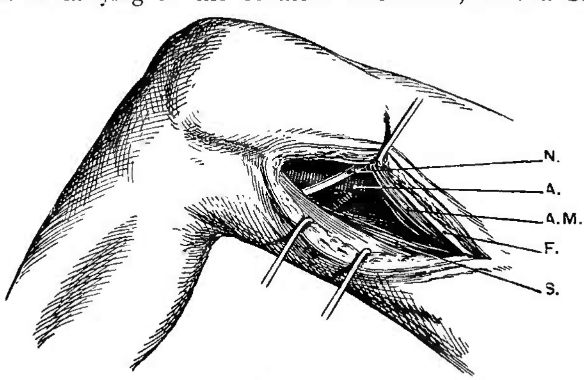



FIG. 133.—LIGATURE OF THE FIRST PART OF THE LEFT POPLITEAL.—
**A.M.** Adductor magnus tendon. **A.** Popliteal artery.
**S.** Sartorius muscle. **N.** Long saphenous nerve. **F.** Fascia lata.

tie the artery below the origin of that vessel wherever it is possible. This means that when the aneurysm is situated at the lower part of the popliteal space the popliteal artery should be tied above its centre. The best way to reach the upper part of the popliteal is to dissect down upon it from the inner side of the thigh. The limb is placed in the same position as for ligature of the femoral, and the surgeon feels for the adductor tubercle and the tendon of the adductor magnus which is attached to it. He then makes an incision about four inches in length from the adductor tubercle upwards, parallel with the tendon of the adductor magnus, and slightly behind it. After the fascia is divided the sartorius will be found running downwards on the inner side of the thigh, and overlapping the tendon of the adductor. When this is pulled inwards and backwards, the tendon of the adductor will be evident, with the hamstring tendons lying behind it. The space between the tendon of the adductor and the hamstrings must be opened, the latter pulled inwards and backwards, whilst the tendon of the adductor is pulled outwards towards the bone. The finger introduced along the posterior surface of the adductor magnus will feel the popliteal artery as it passes through the opening in the muscle (see Fig. 133). The vessel then comes into view with the vein lying to its outer side, the popliteal nerve being separated from it by some distance. The sheath of the vessel is opened and the needle is passed from without inwards. The operation is a very simple one, and has the advantage we have already mentioned, that it gives a better collateral circulation than is the case when the artery is tied higher up, and the risk of gangrene is therefore to a considerable extent diminished.

It occasionally happens, especially after proximal ligature at some distance above the sac, that after a few days pulsation returns and the aneurysm continues to increase. It used to be recommended under such circumstances that amputation should be performed, but now that suppuration in the deep tissues can be readily avoided the best procedure is to perform the old operation (see below). Similarly, should the aneurysm become inflamed and threaten to suppurate, or should suppuration actually occur around the aneurysm, or should the latter threaten to burst through the skin, the old operation should always be performed in preference to amputation.

(c) **The Old Operation.**—The old operation as applied to popliteal aneurysm is somewhat difficult of performance, chiefly on account of the relation of the popliteal vein and the internal popliteal nerve to the artery, and the adhesions which are apt to occur between these structures and the sac. The former are often very considerably displaced by the enlargement of the sac, so that their exact position is difficult to gauge; hence the old operation for this affection is generally restricted to those cases in which the aneurysm has become diffuse. To perform it, a tourniquet is applied around the thigh, and after the skin has been disinfected, the limb is abducted and rotated outwards with the knee flexed upon a suitable sandbag; a free incision is then made over the centre of the popliteal space behind and the internal popliteal nerve is looked for and pulled aside (see Fig. 134).

The next structure which should be identified is the popliteal vein, which should also be displaced to one side; should it be difficult to clearly define the vein, an opening should be made into the sac wall towards the inner side, so as to avoid it if possible. The sac is then freely incised, the clots turned out, and the artery tied above and below. This can readily be done if a bougie be introduced through the orifice of the vessel so as to distend it; it can then be easily felt, and there is less likelihood of injury to the vein. A full-sized bougie, about No. 12, fits the lumen of the artery fairly well, and it should be pushed up through the opening in the sac until it is felt in the vessel above it, which is then cleared and tied; the bougie is next introduced into the distal portion of the vessel, which is similarly treated. When this has been done the vein is easily identified above and below, and with a little care it can be peeled off the sac, after which the whole of the latter should be removed *en bloc*. Some of the articular branches of the knee will probably open into the sac, and if these can be recognized they should be tied before the tourniquet is removed, as otherwise the collateral circulation through them may be very free, and considerable bleeding will occur.

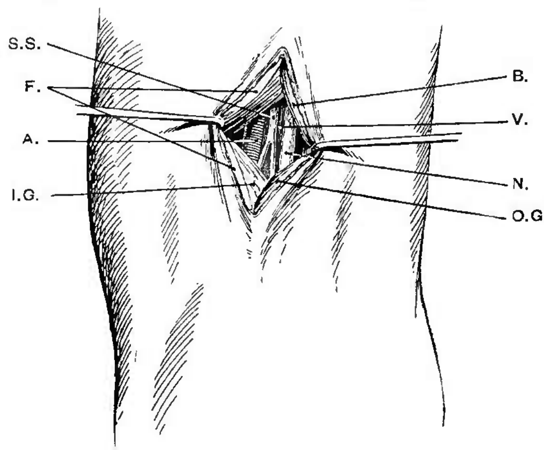



FIG. 134.—LIGATURE OF THE RIGHT POPLITEAL THROUGH THE HAM.—
I.G. Inner head of gastrocnemius. B. Tendon of Biceps. V. Popliteal vein.
O.G. Outer head of gastrocnemius. S.S. Short saphena vein. N. Internal popliteal nerve.
A. Popliteal artery. F. Fascia lata.

After the tourniquet is taken off, five to ten minutes should be allowed to elapse before the wound is closed, so as to make sure that there is no bleeding from any of these branches. The clots must also be turned out of the tissues around; sometimes it may be necessary to clear them out of the knee joint should the aneurysm have ruptured into it. Even in these cases amputation is not necessary, because if the operation be performed aseptically the articulation will probably recover perfectly. A drainage tube must be inserted into the popliteal space and left in for about ten days on account of the free oozing which often occurs. The leg should be put on a straight back splint and somewhat elevated, and the same precautions should be taken with the lower extremity as are requisite after ligature of the common femoral (see p. 356).

*Results.*—Gangrene is not nearly so likely to occur after the old operation for popliteal aneurysm as after ligature of the femoral artery high up, because the anastomosis is as a rule better. The anastomotica magna artery remains intact and serves to carry a large volume of blood to the articular arteries and the recurrent branches of the tibial.

## GLUTEAL ANEURYSM.

This is not of common occurrence, and may be either spontaneous or traumatic—generally the latter.

**TREATMENT.**—The treatment will vary according to the position of the sac in reference to the pelvis. When the aneurysm is entirely outside the pelvis the old operation is the one to be recommended, and the artery should if possible be ligatured before the aneurysmal sac is opened. Should the aneurysm be inside the pelvis, or partly inside and partly outside it, the best treatment is ligature of the internal iliac vessel. It is very important before deciding upon the precise operation to make an examination *per rectum* or *per vaginam* in order to ascertain the exact position of the aneurysmal sac.

**Ligature of the Gluteal Artery.**—This vessel emerges from the pelvis through the upper part of the great sacro-sciatic notch above the

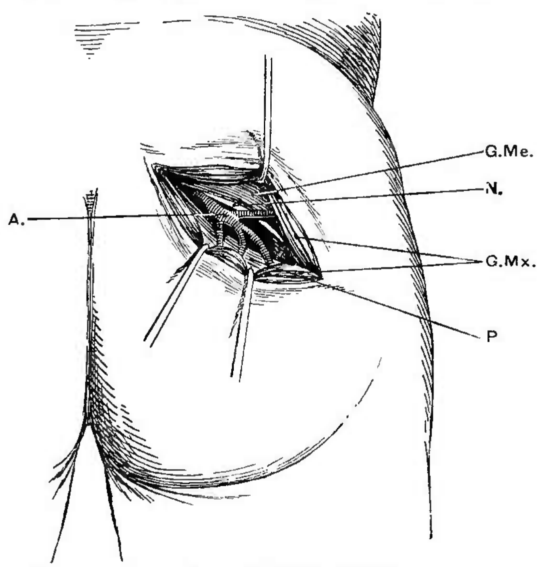



FIG. 135.—LIGATURE OF THE RIGHT GLUTEAL ARTERY.—
G.Mx. Gluteus maximus. G.Me. Gluteus medius.
P. Pyriformis. A. Obturator artery.
N. Superior Gluteal nerve.

pyriformis muscle, its point of exit corresponding very closely to the junction of the upper and middle thirds of a line drawn from the posterior superior iliac spine to the tip of the great trochanter when the thigh is slightly flexed and rotated inwards.

In order to ligature the vessel the parts are rendered aseptic, the patient rolled over upon the unaffected side and a free incision from three to four inches in length, with its centre corresponding to the point of emergence of the artery is made along the line of the vessel. This incision will run more or less parallel to the fibres of the gluteus maximus, which must be separated and pulled apart with retractors. The interval between the pyriformis muscle below and the gluteus medius above is sought for, and these muscles are separated and held apart. The finger then seeks for the upper edge of the sacro-sciatic notch, upon which the gluteal artery will be found beating (see Fig. 135). The vessel is isolated and a ligature applied; care should be taken to tie it as far back as possible, because the artery divides into two main branches very soon after its exit from the pelvis. After the vessel has been ligatured the aneurysmal sac should be opened, the clots turned out, and the wall dissected away as completely as possible.

**The Old Operation.**—Sometimes, however, when the aneurysm is situated outside the pelvis, there is no room to get proper access to the artery in order to tie it, and in those cases an incision should be first made into the aneurysm sufficiently large to admit one finger. As the knife is withdrawn the finger is rapidly introduced through the opening so as to plug the hole, and gradually pushed on through the clots until it identifies the communication with the artery. This can generally be recognized by feeling the warm stream of blood impinging upon the finger or by actually feeling the ragged orifice of the vessel. The tip of the finger is pressed over this opening so as to command the circulation, and the sac is then slit upwards and downwards from the finger by a probe-pointed knife. The clots are turned out and the vessel tied above and below, the sac being subsequently dissected away.

**Ligature of the Internal Iliac.**—When the aneurysm encroaches upon the pelvis, ligature of the internal iliac artery must be employed. This can be done either by a trans-peritoneal incision or by *Abernethy's extra-peritoneal operation.* The steps of these operations are the same as those described (see p. 344) for ligature of the external or common iliac trunk. In either case the ureter must be carefully avoided and the needle passed from above downwards so as to avoid the internal iliac vein which lies behind and to the inner side of the artery. In the *trans-peritoneal operation* special care must be taken in passing the ligature to avoid including the ureter, which crosses the vessel in front, but which is, however, usually turned forwards with the peritoneum. The internal iliac vein is on the inner side of and behind the artery and the external iliac vein on its outer side. A good light is essential for success as the separation of the artery from the large internal iliac vein has to be very carefully done.

The operations for ligature of the two following arteries are much less frequently called for.

**Ligature of the Internal Pudic Artery in the Buttock.**—This artery emerges from the abdomen through the lower part of the great sacro-sciatic notch, winds around the spine of the ischium and passes to the front of the innominate bone through the lesser sacro-sciatic notch. The artery is tied as it lies on the posterior surface of the spine of the ischium, and this point corresponds to the junction of the lower with the middle third of a line drawn from the posterior superior iliac spine to the ischial tuberosity.

An incision is made somewhat obliquely to this line parallel to the fibres of the gluteus maximus and with its centre corresponding to the ischial spine. After the skin and fascia are divided the fibres of the gluteus maximus are separated and held apart. This shows the lower border of the pyriformis muscle with the tendon of the obturator internus below it. The vessel will be found as it passes around the spine with the nerve lying to its inner side.

**Ligature of the Obturator Artery.**—This vessel may require ligature as it passes out of the abdomen at the upper and outer part of the obturator foramen. The obturator nerve lies above the artery. A vertical incision is made from a point a finger's breadth internal to the centre of Poupart's ligament downwards for about four inches. The

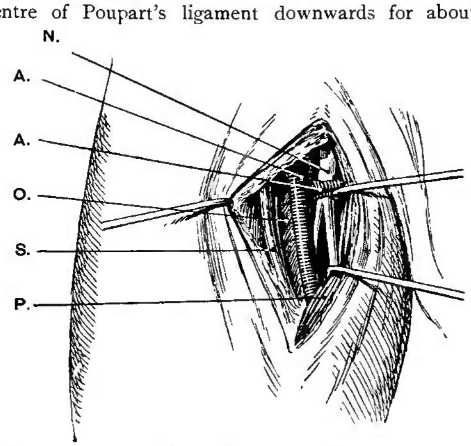



Fig. 136.—Ligature of the Right Obturator Artery.—
P. Pectineus. A. Obturator artery. N. Obturator nerve.
O. Obturator externus. S. Internal saphena vein.
The branches of the vessel are drawn much too large.

skin, superficial and deep fascia are divided, the internal saphena vein drawn outwards, and the pectineal fascia divided just internal to the femoral vein. The outer border of the pectineus muscle is defined and drawn inwards, the fascia over the obturator externus is divided, and the under surface of the horizontal ramus of the pubis is felt for with the finger. At the upper border of the obturator externus muscle the artery will be found passing through the obturator foramen with the obturator nerve above it (see Fig. 136).

## ANEURYSMS OF THE LEG AND FOOT.

These, although not at all common, do occasionally occur. They are generally situated on the posterior tibial artery, but sometimes they may be met with on the peroneal or the anterior tibial. In the foot, it is true, aneurysms are exceedingly rare, and when they do occur they are generally traumatic, the most common situation being on the dorsalis pedis.

The treatment of these aneurysms is as a rule the old operation; the methods of exposing the arteries concerned are given below.

**Ligature of the Anterior Tibial Artery.**—This vessel may be tied at any part of its course. The operation is most frequently done in the upper or the lower third. The line of the artery is from a point midway between the crest of the tibia and the head of the fibula to another on the front of the ankle midway between the two malleoli. Before the operation is performed it is well to rotate the leg somewhat inwards, and flex and extend the foot so as to trace out the lines of the tendons and muscles.

(*a*) **In Upper Third.**—When the vessel requires ligature in the upper third, an incision from three to four inches in length should be made over the line of the artery, commencing about an inch helow the external tuberosity of the tihia. After division of the skin and

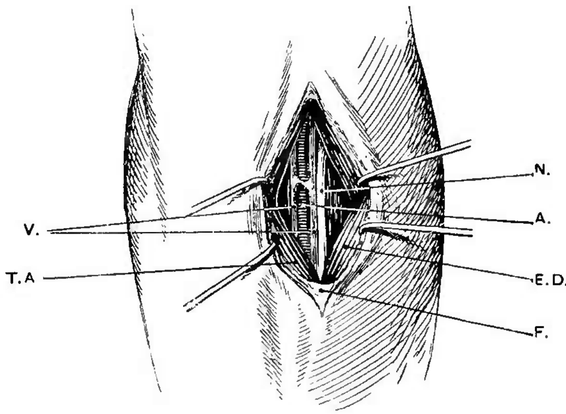



FIG. 137.—LIGATURE OF THE LEFT ANTERIOR TIBIAL IN THE UPPER THIRD.—
T.A. Tibialis anticus. A. Anterior tibial artery. V. Venæ comites.
E.D. Extensor longus digitorum. N. Ant. tibial nerve. F. Fascia lata.

fascia the outer edge of the tibialis anticus, as it arises from the external tuberosity, is seen, and the inter-muscular septum between this muscle and the extensor longus digitorum is opened up. While this is being done it is well to flex the foot so as to relieve the tension upon the muscles, and to enable them to be separated more easily. The artery

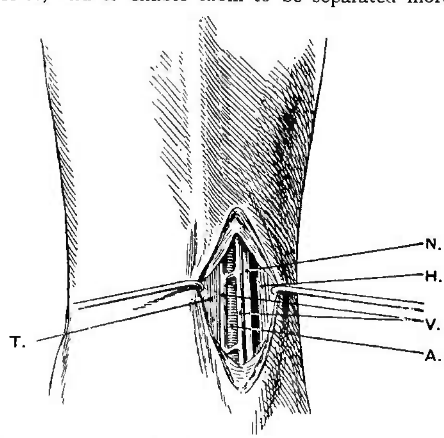



FIG. 138.—LIGATURE OF THE LEFT ANTERIOR TIBIAL IN THE LOWER THIRD.—
T. Tibialis anticus tendon. A. Ant. tibial artery. V. Venæ comites.
D. Ext. longus digitorum tendon. N. Ant. tibial nerve.

will be found lying upon the inter-osseous membrane at the bottom of this space immediately after it has passed to the front of the leg. The anterior tibial nerve is not always seen in the operation, as it may reach the outer side of the artery somewhat lower down (see Fig. 137).

The only difficulty in the operation is to choose the right inter-muscular septum (viz. the innermost), and not to separate the one between the extensor longus digitorum and the peroneus longus.

(*b*) **In the Lower Third.**—In the lower third the artery is reached by an incision along the outer edge of the tendon of the tibialis anticus muscle, which is the first prominent tendon external to the anterior border of the tibia. The skin and fascia are divided and this tendon is drawn inwards, whilst the next, that of the extensor longus hallucis, is drawn outwards; the artery will then be seen with the anterior tibial nerve to its outer side and rather in front of it (see Fig. 138).

**Ligature of the Dorsalis Pedis Artery.**—The dorsalis pedis may be tied either at the ankle joint or further down in its course. In the ordinary operation on the dorsum of the foot the latter is extended and an incision is made along a line midway between the two malleoli to the upper end of the first inter-osseous space. After division of the skin and fascia the tendon of the extensor longus hallucis will be seen internally with the innermost tendon of the extensor brevis digitorum running forwards and inwards on its outer side. The artery lies in the angle formed by these two tendons, and by pulling the latter inwards and outwards the artery is at once exposed with the anterior tibial nerve upon its outer side (see Fig. 139).

**Ligature of the Posterior Tibial Artery.**—This vessel is usually tied either in its upper or lower third.

(*a*) **In the Upper Third** it may be exposed either by an incision along the posterior border of the tibia through which the artery is reached from the side, or by a vertical incision through the middle of the calf which separates the two heads of the gastrocnemius muscle. The former is the more usual operation. The limb is laid upon its outer side, with the knee flexed and supported upon a suitable sandbag, and a vertical incision about four inches long is made parallel to the inner border of the tibia and about a finger's breadth behind it. The long saphenous nerve and the internal saphena vein are generally exposed and must be pulled aside. After the deep fascia has been divided the inner border of the gastrocnemius comes into view and is drawn aside with a retractor. The oblique fibres of the soleus arising from the tibia are then seen, and must be divided in the line of the incision until the glistening fascia upon the deep surface of the muscle is exposed. This is carefully divided in the same direction, when the muscular fibres of the flexor longus digitorum with the tibialis posticus to its outer side, and still more externally the flexor longus hallucis, are seen. The soleus is pulled aside, and the artery will be found lying between the flexor longus digitorum and the tibialis posticus, about an inch and a quarter beyond the inner border of the tibia. The posterior tibial nerve is on its outer side (see Fig. 140).

*Difficulties.*—Two mistakes are often made. Either the soleus is divided too far outwards, and the finger passes outside the tibialis posticus muscle, or after dividing the soleus the flexor longus digitorum is separated from the tibia so that the finger passes inside that muscle and away from the artery.

(*b*) **In the Lower Third** the posterior tibial artery lies midway between the tendo Achillis and the posterior border of the tibia and as it curves behind the internal malleolus it keeps about the same distance from the edge of the bone. An incision, which is usually curved, with its concavity forwards, is made in the line of the artery behind the internal malleolus, when, after division of the deep fascia, the vessel is exposed. Between the malleolus and the artery lie the tendons of the tibialis posticus and the flexor longus digitorum, whilst behind the vessel is the posterior tibial nerve, and behind that again the tendon of the flexor longus hallucis (see Fig. 141). The principal mistake made in tying this artery is to get too far back towards the tendo Achillis.

**Ligature of the Peroneal Artery.**—The course of this vessel is sufficiently

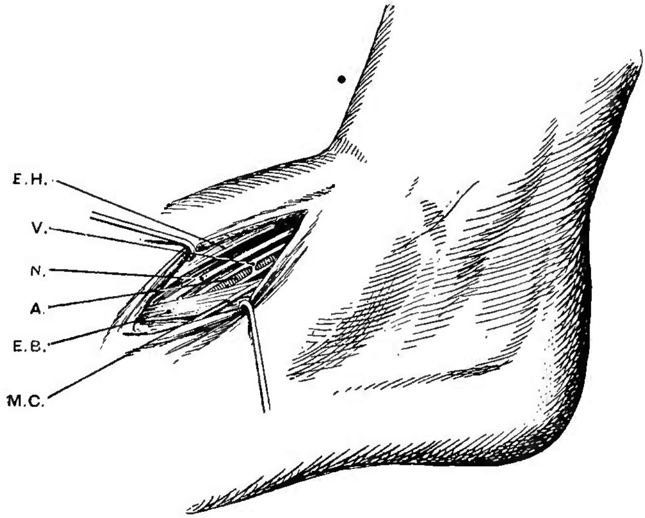



FIG. 139.—LIGATURE OF THE LEFT DORSALIS PEDIS.—

E.H. Ext. long. hallucis tendon.
E.B. Ext. brev. digit., innermost tendon.
M.C. Musculo-cutaneous nerve.
A. Dorsalis pedis.
N. Ant. tibial nerve.
V. Venæ comites.

The ant. tibial nerve usually lies to the outer side of the artery.

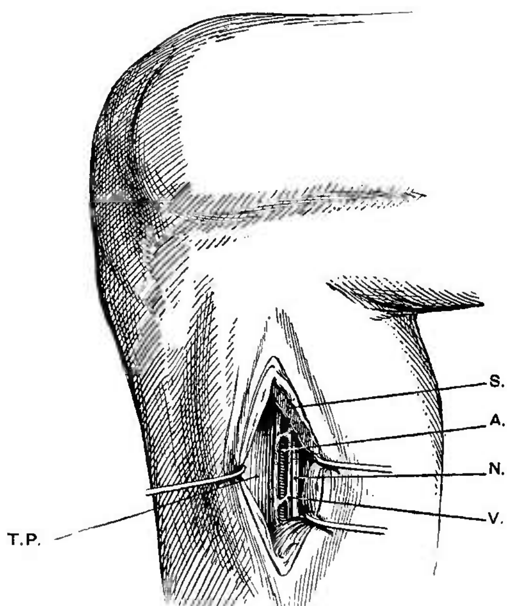



FIG. 140.—LIGATURE OF THE RIGHT POSTERIOR TIBIAL IN UPPER THIRD.—

S. Soleus, showing cut surface.
T.P. Tibialis posticus.
A. Posterior tibial artery.
N. Posterior tibial nerve.
V Venæ comites.

indicated by a line drawn from just above the middle of the calf along the inner border of the posterior surface of the fibula. The line usually given for an incision for tying the vessel is one from the posterior border of the head of the fibula to a point midway

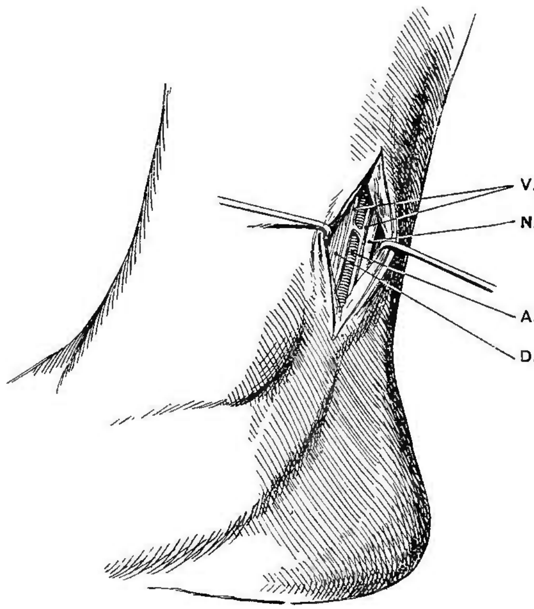



FIG. 141.—LIGATURE OF THE RIGHT POSTERIOR TIBIAL IN LOWER THIRD.—
D. Flexor long. digit. tendon. A. Post. tibial artery.
N. Post. tibial nerve. V. Venæ comites.

between the external malleolus and the tendo Achilles. The artery is generally tied in the lower third, but it can be tied in the upper third near its origin through the incision made for ligature of the posterior tibial in that situation (see p. 367). In ligaturing it in the lower third an incision is made in the line of the vessel, the deep fascia divided and the outer border of the soleus muscle exposed and drawn inwards. Beneath this are seen the fibres of the flexor longus hallucis covered by a tendinous expansion. On separating the flexor longus hallucis from the posterior surface of the fibula the artery is found at the outer border of the tibialis posticus muscle.

# INDEX.

## PART II.