COLLEGE OF OSTEOPATHIC PHYSICIANS
AND SURGEONS · LOS ANGELES, CALIFORNIA

A MANUAL OF SURGICAL TREATMENT

CHEYNE AND BURGHARD'S
MANUAL OF SURGICAL TREATMENT.

CONTENTS OF THE VOLUMES.

VOLUME I.

The Treatment of General Surgical Diseases, including Inflammation, Suppuration, Ulceration, Gangrene, Wounds and their Complications, Infective Diseases and Tumours, Deformities.

With an Appendix upon the Administration of Anæsthetics by Dr. Silk, and the Examination of the Blood by Dr. W. D'Este Emery.

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The Treatment of the Surgical Affections of the Skin and Subcutaneous Tissues, the Nails, the Lymphatic Vessels and Glands, the Bursæ, the Muscles, the Tendons and Tendon Sheaths, the Nerves, the Blood Vessels and the Bones: Amputations.

VOLUME III.

The Treatment of the Surgical Affections of the Joints, the Spine, the Head and the Face.

VOLUME IV.

The Treatment of the Surgical Affections of the Tongue, the Mouth, the Pharynx and Œsophagus, the Stomach, the Intestines, the Rectum and Anus.

VOLUME V.

The Treatment of the Surgical Affections of the Pancreas, Liver and Spleen, the Genito-Urinary Organs, the Larynx and Neck, the Thorax and the Breast.

A Manual of Surgical Treatment

BY

SIR W. WATSON CHEYNE, BART., C.B.
D.Sc., LL.D., F.R.C.S., F.R.S.
Hon. Surgeon in Ordinary to H.M. the King; Senior Surgeon to King's College Hospital

AND

F. F. BURGHARD
M.S. (Lond.), F.R.C.S.
Surgeon to King's College Hospital, and Senior Surgeon to The Children's Hospital, Paddington Green

NEW EDITION

ENTIRELY REVISED AND LARGELY REWRITTEN WITH THE ASSISTANCE OF

T. P. LEGG
M.S. (Lond.), F.R.C.S.
Surgeon to the Royal Free Hospital; Assistant Surgeon to King's College Hospital

AND

ARTHUR EDMUNDS
M.S. (Lond.), F.R.C.S.
Surgeon to the Great Northern Central Hospital; Surgeon to Out-patients, The Children's Hospital, Paddington Green

In Five Volumes

VOL. III.

The Treatment of the Surgical Affections of the Joints, the Spine, the Head, and the Face

LEA & FEBIGER
PHILADELPHIA AND NEW YORK
1912

TO

THE RIGHT HON.

LORD LISTER, O.M., LL.D., F.R.S.

THE FOUNDER OF MODERN SURGERY
WITHOUT WHOSE WORK MUCH OF THIS BOOK
COULD NOT HAVE BEEN WRITTEN.

PREFACE

TO

REVISED EDITION.

SINCE the first edition of this work was published many changes have naturally occurred in the field of Surgical Treatment. Attempts have been made from time to time to incorporate the most essential of these in successive impressions, but it is always difficult to interpolate new matter of this kind satisfactorily without extensive revision of the entire work. It has therefore seemed best to revise the matter throughout and to alter in it whatsoever was necessary to bring it up to date. The original scheme of the work has been adhered to; to depart from it would have been to abandon the fundamental idea upon which it was based. Every part of the book, however, has been thoroughly revised, and a considerable part has been re-written.

The pressure of other work rendered it impossible for the original authors to undertake a task of such magnitude with any hope of being able to complete it within a reasonable time. In Messrs. T. P. Legg and Arthur Edmunds they have been fortunate in securing collaborators who have rendered their task possible, and to them they are under a great obligation. To their colleagues Dr. Silk, Dr. D'Este Emery, Dr. Arthur Whitfield and Mr. A. D. Reid, they are also much indebted for help in the several departments of treatment with which these gentlemen are specially concerned. Mr. Arthur Edmunds, in addition to his share in the revision, has provided a number of the new illustrations; Messrs. F. Butterworth and S. A. Sewell have drawn the remainder.

Messrs. Down Bros., Allen & Hanburys, Barth, and others have kindly allowed the reproduction of many instrument blocks from their catalogues. Other figures have been reproduced by permission of their authors or publishers, and the source from which they are derived will be found duly acknowledged in the text.

LONDON, 1912.

AUTHORS' PREFACE

TO

THE FIRST EDITION.

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 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.

LONDON, *April*, 1899.

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TO

THE THIRD VOLUME.

DIVISION I.

THE SURGICAL AFFECTIONS OF JOINTS.

SECTION I.—INJURIES OF JOINTS.

CHAPTER I.

DISLOCATIONS: GENERAL CONSIDERATIONS.

DEFINITION.—In a dislocation there is partial or complete displacement of the ends of the bones which constitute the joint, so that the articular surfaces no longer maintain their relative positions.

In a *complete dislocation* the normal positions of the articular surfaces are altered so that the end of one bone overrides the other; this is most common in the ball-and-socket joints, but it may occur in almost any joint in the body. In a *partial dislocation*, on the other hand, there is only an incomplete displacement—usually lateral—without any overriding; this is most common in hinge-joints—such as the elbow or the knee.

CLASSIFICATION.—Dislocations may be classified, according to their cause, into the three following groups:—

Traumatic dislocations, in which a healthy joint is dislocated as the result of violence. Under this heading will also come *recurring dislocations*, which are commonest in the shoulder and thumb. They are due to extensive injury to the capsule of the joint, followed by imperfect repair, and also, in the case of the shoulder-joint, to an imperfectly formed head of the humerus which does not fit the glenoid cavity.

Pathological dislocations, or those resulting from disease. The chief factor in the production of this form is disease in the joint capsule and ligaments, which give way and allow displacement of the ends of the

bones; examples of this are seen in tuberculous disease, osteo-arthritis, Charcot's disease, and arthritis after specific fevers—such as typhoid.

Congenital dislocations, which are due either to malformation, to displacement *in utero*, or to violence at or immediately before birth.

We shall here deal only with traumatic dislocations; the others are discussed elsewhere.

CAUSES.—Exciting.—A dislocation may be caused by (*a*) *indirect violence*, as when a fall upon the hand results in dislocation of the humerus; (*b*) *direct violence*, as when a blow on the point of the shoulder dislocates the clavicle; (*c*) *traction*, as when the head of the radius is dislocated in lifting a child by the hand; or (*d*) *muscular contraction*, as in dislocation of the humerus in throwing a ball or playing single-stick.

Predisposing.—In addition there are various predisposing causes. For example: (*a*) *The nature of the joint.* Joints such as the shoulder, in which the articular surfaces are held in apposition mainly by muscular action, the ligaments being lax, are, from their anatomical conformation, more liable to dislocation than well-fitting joints like the elbow. (*b*) *The age of the patient.* Dislocation is most common in the young adult. In children, a joint injury is most likely to cause a separation of the epiphysis, while in the old, the bones are more brittle, and fracture is more common than dislocation. (*c*) *The condition of the muscles which surround the joint.* If these be wasted from disuse or disease, or if they be taken by surprise, dislocation may be caused by a force that would otherwise do no injury either to bone or joint.

TREATMENT.—The treatment of a dislocation may be considered according as it is simple, compound, or of long standing. Any dislocation may be complicated by a fracture in its immediate vicinity or at some distance from it, by severe damage to vessels or nerves near the joint, by pressure on nerves, leading to paralysis, and, in long-standing cases, by adhesion of vessels, nerves, and other tissues to the dislocated articular surfaces. The treatment of these complications will also need consideration.

TREATMENT OF SIMPLE TRAUMATIC DISLOCATIONS.

The treatment of a simple dislocation must fulfil three requirements: (1) restoration of the displaced articular surfaces to their normal positions; (2) prevention of recurrence of the dislocation; and (3) preservation of the functions of the joint.

REDUCTION OF THE DISLOCATION.—The chief obstacles to reduction of a dislocation are:—

(*a*) *Muscular contraction.* The muscles around the joint are usually spasmodically contracted as a result of the laceration of the ligaments and the presence of the articular ends of the bones in a new position. It is most important to overcome this spasmodic contraction and this may be effected either by giving a general anæsthetic, or by overcoming

the resistance of the muscles by steady traction. We strongly recommend the administration of an anæsthetic, if possible, in all cases of dislocation. Without an anæsthetic it is very difficult to overcome the contraction of the muscles if the patient be powerful, while excessive pain may be caused, and fresh and unnecessary laceration of the tissues may result. An anæsthetic should never be withheld unless there is some constitutional affection contra-indicating its use, or unless, from the situation of the dislocation, interference with breathing would be likely to result during its administration, or unless the dislocation is only partial and can be readily reduced without it.

(*b*) *Entanglement of one of the articular ends with some of the structures in the vicinity of the joint.* The articular end may be gripped by the edges of the lacerated capsule through which it protrudes, or by some of the muscles, tendons or ligaments in the neighbourhood, or it may become firmly hitched against some bony prominence.

In these cases appropriate manipulations will be necessary to get the articular surfaces into position. The manipulations are designed to disengage the articular end from any structure with which it may have become involved, and will therefore vary according to the joint affected. They will be described in connection with individual dislocations; their chief object is to bring the head of the bone opposite the rent in the capsule through which it has escaped, and then to cause it to pass back through that rent into position.

(*c*) *The interposition of neighbouring structures—especially tendons—between the articular surfaces.* The best example of this occurs in dislocations of the ankle. In joints, such as the temporo-maxillary, which possess an inter-articular fibro-cartilage, this structure may be displaced and interfere with reduction.

When the ends of the bones have been brought into position, the surgeon must make sure that the movements of the joint are perfectly free in all directions. Should there be an obstacle, such as a tendon or ligament caught between the ends of the bones, and should manipulations directed to getting rid of the interposed structure fail, there must be no hesitation in opening the joint and removing the obstruction. The strictest antiseptic precautions are necessary, but a skilled surgeon need have no hesitation in performing it. After clearing out all blood-clot and removing the obstacle to reduction, the surgeon can also stitch up the rent in the capsule—a point of considerable importance in some joints, such as the shoulder—as a preventive against recurrence of the displacement.

PREVENTION OF RECURRENCE OF THE DISLOCATION.—Recurrence of the dislocation is apt to take place when ligaments have been widely torn, or when portions of bone have been broken off. For example, dislocation backwards of the elbow-joint when accompanied by fracture of the coronoid process, is

liable to recur unless means be taken to prevent it by applying suitable retentive apparatus. In some cases no special apparatus is required; a bandage which restrains the movements of the joint may be quite sufficient.

PRESERVATION OF THE MOVEMENTS OF THE JOINT.—After a dislocation, adhesions are certain to form, not only in the joint itself but also in the peri-articular structures, if the limb be kept at rest too long, and the result will be that the surgeon is confronted with the difficult task of restoring movement in a joint that is very stiff: this task may be impossible, especially in elderly persons. In them there is always some amount of traumatic arthritis following these injuries, and this may lead to much impairment of function, especially in the shoulder. The movements of the joint must therefore be maintained from the first by means of massage and passive movements. In the majority of dislocations the tendency to recurrence of the displacement is not so great as to contra-indicate movement and manipulations from the beginning. We therefore advise that massage should be practised daily from the first, and that this should be combined with suitable passive movements until the functions of the joint have been restored completely. The exceptions to this general rule will be indicated later.

TREATMENT OF DISLOCATIONS COMPLICATED BY OTHER INJURIES.

Since the treatment in these cases must necessarily depend essentially upon the particular circumstances of the case, it is dealt with in detail in connection with dislocations of individual joints, and we need only refer here to two points common to all dislocations.

Fracture complicating Dislocation.—Under such circumstances, much depends upon whether the fracture is close to the joint or at some distance from it. In the latter case the portion of bone intervening between the fracture and the dislocated joint may be long enough to serve as a lever by which to manipulate the dislocated end into position. When, however, the fracture is close to the joint, reduction of the dislocation by manipulative methods is often impossible, and the only satisfactory procedure is to operate without delay, replacing the dislocated end of the bone first and then fastening the fractured ends together (see Vol. II. Chap. XIV.).

Injury to Vessels or Nerves.—Large vessels may be torn when dislocation takes place, and serious hæmorrhage may occur into the limb, or a diffuse aneurysm may form. Similarly a nerve may be torn across, or there may be paralysis as a result of direct pressure on the nerve by the displaced end of the bone. These cases must be treated in accordance with the principles laid down for injuries of vessels and nerves (see Vol. II.).

TREATMENT OF COMPOUND DISLOCATIONS.

Wounds of joints, unless they can be kept aseptic, are among the most serious injuries that we are called upon to treat, since acute suppuration in a joint often leads to complete disorganisation of the articulation and also involves a great risk of septicæmia and pyæmia.

In recent cases, therefore, a most energetic attempt must be made as soon as possible to get rid of any septic material that may have entered the joint. The skin must be shaved for a considerable distance around the wound and thoroughly disinfected (see Vol. I.). All recesses in the tissues about the joint must be freely exposed, and the soft parts should be well washed with 'strong mixture'; [1] if they are very dirty, it will be advisable to swab them over with undiluted carbolic acid. The joint cavity and the articular ends of the bone should be douched thoroughly with sterile normal saline solution. If there be gross soiling of these structures, they must also be well washed with the 'strong mixture' and then freely douched with the saline solution; otherwise the strong antiseptic should be kept from contact with the articular structures. Some surgeons who have great faith in tincture of iodine mop the soiled surface of the wound with it, but it is doubtful whether it is so useful as carbolic acid. After the wound has been thoroughly cleansed, the dislocation is reduced, and drainage-tubes are introduced into the joint at suitable points. The edges of the wound should then be brought together, except where the tubes emerge, or where there is severe bruising of the tissues and skin.

If there be no sign of sepsis in the wound, the tubes may be taken out on the third day and the case treated like an aseptic wound of a joint (see Chap. XI.). The joint should be kept on a splint until the drainage-tube is removed, when passive movements may be begun and the case treated as if it were a simple dislocation.

When some days have elapsed since the injury and sepsis is already established, the condition is most serious. To reduce the dislocation under such circumstances would be to confine the pus between the ends of the bones and interfere with its free escape, and therefore, if for some reason no operative procedure is deemed desirable at once, the displacement may be left for a time and free drainage established. In some cases in which the infection is not severe and has not spread to the medulla of the bone, it may be worth while to continue this treatment in the hope that the wound will heal. If it does heal it may then be possible to perform an excision or some arthroplastic operation with the view of restoring the function of the joint (see Murphy's method of dealing with anchylosed joints, p. 153).

[1] The 'strong mixture' is a 1 in 20 watery solution of carbolic acid, in which is dissolved one five-hundredth part of corrosive sublimate.

In the majority of these cases, however, it is safest to amputate the limb or excise the joint at an early period. When the patient is old or when the septic symptoms are violent, amputation will be the better practice ; but in mild cases in young subjects removal of the articular ends of the dislocated bones may be justifiable, although it is a dangerous proceeding on account of the risk of infecting the cut surfaces of the bones. If excision is performed, the ends of the bones should be swabbed over with undiluted carbolic acid at the end of the operation so as to seal them temporarily against infection, and very free drainage must be provided.

TREATMENT OF UNREDUCED DISLOCATIONS.

Attempts to reduce a dislocation that has remained unreduced for any length of time are likely to fail for various reasons. Under such circumstances the displaced ends of the bones contract adhesions to surrounding structures, and these become so firm that attempts at reduction may fail, even though considerable force be used. Further, the bone is apt to become adherent to vessels or nerves, and when this has happened, even mild attempts at reduction may tear these structures, and give rise to disastrous consequences. Again, the capsule of the joint in an unreduced dislocation becomes shrunken and altered in shape, and so adherent to the structures around that, even if the articular end of the bone is brought into position, it cannot be pushed into the joint cavity. Lastly, changes in the articular ends of the bones take place with such rapidity, that very soon the bony surfaces no longer fit each other, and therefore, even though the dislocation be reduced, displacement is prone to recur. It is well before deciding on the treatment to obtain a stereoscopic radiogram of the joint. This will show the exact position of the dislocated bones, the changes in the contour of the joint surfaces, and the extent to which the formation of a new joint has taken place.

The treatment must therefore vary with the time that has elapsed since the dislocation occurred, and the changes which have taken place. Speaking broadly, we may say that it is seldom that a dislocation can be reduced by simple manipulation when more than three or four weeks have elapsed since the injury, and it is hardly safe to attempt reduction after a period of six weeks. We shall refer to this point again when dealing with the unreduced dislocations of individual joints.

When too long a time has elapsed to make an attempt at reduction advisable, or when such an attempt has failed, there are three courses open to the surgeon—viz. to leave matters alone, to attempt reduction by an open operation, or to excise the joint.

In the first place matters may be left alone. As time goes on the displaced ends of the bones tend to form a fresh joint in the new position,

and this may prove quite as good as anything that could be obtained for the patient by other measures. The conditions which would lead one to adopt this course are that there are no pressure symptoms and that the functional result is likely to be good.

When the displaced bone presses upon nerves and causes pain, and when the movements of the joint are greatly limited, the surgeon may adopt the second course and cut down upon the displaced ends and attempt to replace them in position, thus re-establishing the joint. This is sometimes possible, even when a long time has elapsed since the accident. Before, however, the ends of the bones can be got into place, it is usually necessary to divide a number of structures—particularly muscles—surrounding the joint, and it may be advisable also to restore the original contour of the joint surfaces, so as to prevent recurrence of the dislocation. A good estimate of the chances of success from this procedure can often be made by inspection of a stereoscopic radiogram before operation, but actual possibilities can, however, only be ascertained by direct inspection of the parts. If it is possible to replace the articular ends of the bones without extensive division of important structures and to suture the capsule, a satisfactory result is likely to be obtained, although even here there is always a liability to traumatic arthritis in elderly subjects.

The third course which, however, should only be adopted when neither of the foregoing is practicable, is excision of one or both of the articular surfaces of the affected joint. It generally suffices to excise one articular surface, and the raw surface of bone left should be covered with soft tissue to prevent anchylosis (see p. 153). In some joints—such as the elbow—this may lead to an excellent result ; in others, as the hip or shoulder, it may not be advisable. This question will be discussed in connection with dislocation of the individual joints.

OTHER FORMS OF DISLOCATION.

So far, we have been speaking of traumatic dislocations ; of the other forms referred to on p. 1 the majority are described elsewhere. Recurring dislocations will be referred to under dislocations of the shoulder-joint, in which they are most common (see p. 34) ; and congenital dislocation of the hip has already been dealt with in Vol. II.

As regards pathological dislocations occurring in the course of acute febrile diseases, their pathology and anatomy are quite different from that of traumatic dislocations. The capsule, instead of being ruptured, is softened and stretched, and the bone simply slips out of its socket. The treatment is to pull the bone back into place, if possible, as soon as the condition is discovered, and to retain it there by apparatus and extension until the softening process has passed off. Attempts must then be made to restore the function by massage and movements.

CHAPTER II.

DISLOCATIONS OF THE CLAVICLE.

EITHER end of the clavicle may be dislocated; the acromial is the one more frequently affected.

DISLOCATION OF THE ACROMIAL END.

This is really a dislocation of the scapula from the clavicle, and, although more frequent than dislocation of the sternal end, it is far from common. It is usually caused by falls or blows upon the back or outer side of the shoulder, which push the scapula forwards. Falls or blows upon the point of the shoulder generally produce fracture.

DISPLACEMENT.—The acromial end of the clavicle almost invariably projects above the acromion process of the scapula, which is displaced forwards and downwards; there is generally dropping of the shoulder. Cases have, however, been met with in which the clavicle was displaced below the acromion; it has even been found below the coracoid process.

TREATMENT. — **Of Dislocation upwards.** — Reduction is effected easily by carrying the shoulder forcibly backwards and upwards, pushing up the elbow and pressing down the acromial end of the clavicle. This brings the articular surfaces into good position, but the difficulty is to maintain the reduction. Some deformity is certain to recur, and will be permanent. Fortunately, however, it rarely interferes with the usefulness of the limb, and heavy manual labour can often be performed as well as ever in spite of considerable deformity; occasionally, however, the patient's work may be much interfered with.

Splints.—However well the arm be fixed immediately after the dislocation has been reduced, there is a constant tendency for it to drop, when the end of the clavicle immediately projects upwards. This is practically unavoidable, but when it is important to reduce the resulting deformity to a minimum, the best plan is to support the arm in a large

elbow-sling, place a thick pad in the axilla, another over the outer end of the clavicle, and a third over the front of the forearm close to the elbow. A broad leather strap is then carried over the pad upon the clavicle, around the elbow, and then over the pad upon the forearm (see Fig. 1). This presses down the outer end of the clavicle, and pushes the elbow upwards and backwards. The chief trouble with this apparatus is that the strap slips off the point of the shoulder, and it is necessary, therefore, to fix straps or bandages to it opposite the anterior and posterior folds of the axilla, and to fasten them together beneath the opposite axilla. The arm should be bound to the side with the elbow somewhat pushed forward. This apparatus may be kept on for three weeks, the strap being tightened when it gets loose; after it is left off, the arm should be supported in a large elbow-sling for another two or three weeks.

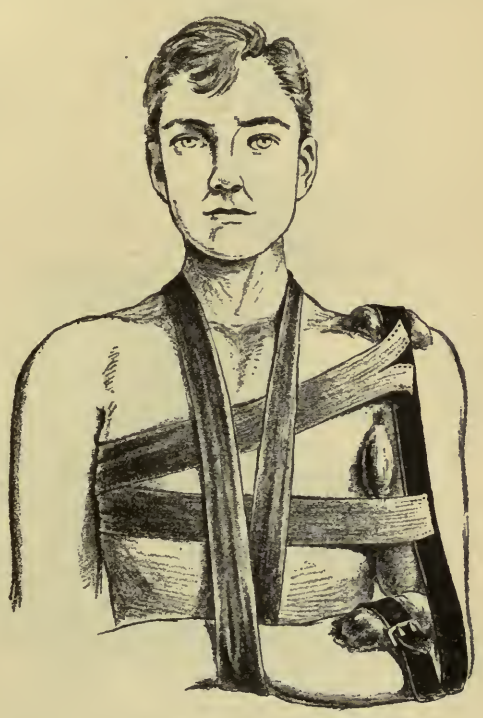


Fig. 1.—Apparatus for Dislocation of the Acromial End of the Clavicle. The strap—kept from slipping by the two bands passing beneath the opposite axilla—is seen passing over the point of the shoulder and around the elbow, where the two turns are often fastened together to keep them from slipping. A wrist-sling only is shown in the figure for the sake of clearness; it should be a large elbow-sling, and the arm should be bound to the side.

A more efficacious but somewhat more complicated apparatus is shown in Fig. 2, and is made by applying a shoulder-cap, between which and the acromial end of the clavicle a firm pad is inserted, and supporting the elbow in a moulded elbow-sling. The sling and the shoulder-cap can then be braced firmly together by straps or elastic tubing, and the humerus is thus pushed forcibly upwards.

Wiring.—When there is marked inability to raise the arm from the side, operative interference will have to be considered. Operation has the disadvantage that it may abolish the movements between the clavicle and the scapula, which are important for the proper performance of the antero-posterior movement of the latter. Nevertheless, if the disability persists after a thorough trial of massage and exercises, the best plan is to expose the joint through a curved incision with its convexity

forwards. The flap is dissected back, and the joint exposed. The dislocated surfaces can then be seen and the articular ends are drilled obliquely and a wire (No. 5 French gauge) passed and twisted up so as to retain them in good position. When the wound has healed passive movements may be begun, and if necessary, the wire may be removed some months later.

Should it be impossible to get the articular surfaces into apposition—as may be the case in injuries of long standing and with much displacement—there will be no alternative but to remove the joint surfaces with a chisel and then to wire the ends of the bones together.

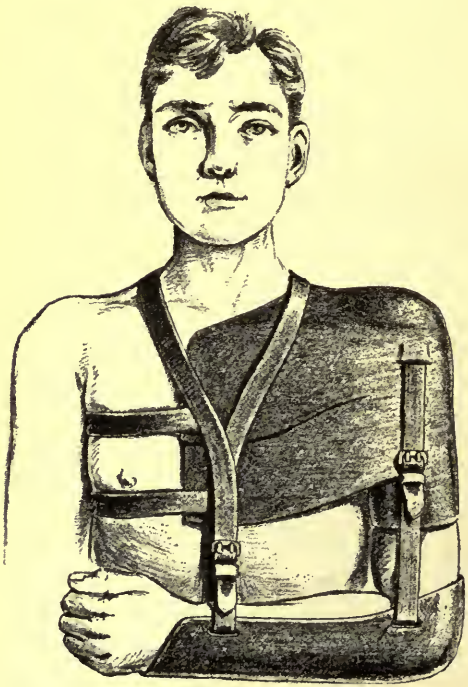


FIG. 2.—SHOULDER-CAP APPLIED FOR DISLOCATION OF THE ACROMIAL END OF THE CLAVICLE. There is a pad over the acromial end of the clavicle beneath the shoulder-cap which is firmly buckled to the elbow-sling.

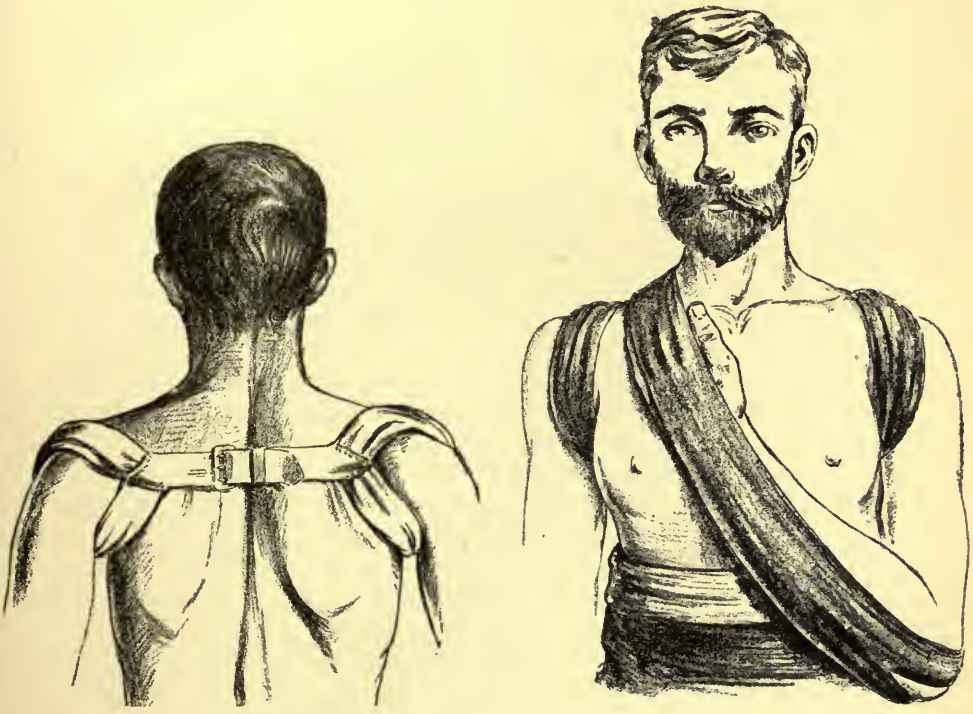
Of Dislocation downwards.—When the end of the clavicle is wedged beneath the acromion or the coracoid process, it will generally be easy to disentangle the bone under an anæsthetic by carrying the shoulder forcibly backwards and outwards. There is little tendency to upward displacement after reduction and no likelihood of the downward displacement recurring, as the weight of the limb is sufficient to prevent that. The arm should be fixed to the side, and the elbow supported in a large elbow-sling for a few days, during which time massage and passive movements are employed.

DISLOCATION OF THE STERNAL END.

Owing to the great strength of the rhomboid ligament, dislocation of the sternal end only occurs as the result of extreme violence ; this accident is therefore rare and usually accompanied by other serious injuries. The commonest displacement is forwards, in front of the sternum, but the sternal end may be driven backwards behind that bone, or directly inwards, so that it lies in the supra-sternal notch. The dislocation generally results from violence applied to the point of the shoulder, and its exact

nature depends to some extent on the direction in which the shoulder is carried by the injury. If this be pushed forwards, the sternal end may be displaced backwards, if backwards the sternal end will be displaced forwards, while, if it be depressed, the sternal end will be displaced upwards. When the sternal end is displaced directly upwards, the rhomboid ligament is torn as well as those of the joint proper.

As a result of these dislocations there is considerable interference with



A *B*

FIG. 3.—APPARATUS FOR DISLOCATION OF THE STERNAL END OF THE CLAVICLE. The shoulders are first drawn well back by the handkerchiefs braced together, as shown in *A*. Then the forearm is flexed across the chest and the elbow supported by the oblique band of strapping seen in *B*.

the movement of the upper extremity, and when there is backward displacement severe dyspnœa or even dysphagia from pressure upon the trachea or œsophagus may be present.

TREATMENT.—It is often very difficult to keep the ends of the bones in position after reduction. It is generally best to carry the shoulder backwards and outwards under an anæsthetic, when the sternal end of the bone can usually be replaced. When dyspnœa is present, an anæsthetic must be avoided; the patient should sit upon a chair while the surgeon, standing behind him with the foot upon the same chair, places

his knee against the spine and, grasping one shoulder in each hand, pulls them forcibly backwards. This disengages the sternal end of the bone, which either slips into place or can be pushed forwards by the fingers.

The best plan to prevent the deformity recurring is to brace the shoulders back with handkerchiefs, applied as for fractured clavicle (see Fig. 3, *A*). The elbow on the injured side should be supported and brought well forward over the chest (see Fig. 3, *B*).

Unreduced Dislocation.—In long-standing cases, and in some recent ones in which the end of the bone is displaced backwards and presses on the trachea, and cannot be brought into place by manipulation, it may be necessary to remove the sternal end. This is exposed by means of a curved incision with its convexity upwards. The periosteum is incised parallel to the long axis of the bone, and stripped off both surfaces of the bone with a rugine. A Gigli's wire saw is then passed around the bone immediately beneath the periosteum by means of a special introducer (see Fig. 18) and the sternal end is divided, after which it is seized with bone forceps and carefully removed, any structures retaining it being peeled off with a rugine assisted by a few touches of the point of the knife kept in close contact with the bone. Extreme care is required at this stage of the operation because adhesions may have occurred between the end of the bone and the innominate vein, but the risk of damage to the latter structure is comparatively slight if the periosteum be peeled off completely before the end of the bone is removed.

The wound is sewn up without a drainage-tube, the shoulder is drawn back, and the arm is kept in a large elbow-sling until healing is complete, when the sling may be left off and the patient allowed to use the limb.

CHAPTER III.

DISLOCATIONS OF THE SHOULDER.

THESE accidents usually occur in middle-life, and are rarely met with in early childhood or in old age. After escaping from the capsule, the head of the bone may pass forwards, backwards, or downwards—the particular form of the dislocation being determined mainly by the direction of the force and the position of the arm at the time of the injury. The primary displacement may also be modified subsequently by muscular action or by further violence ; this especially applies to the downward dislocation. The violence which generally produces the injury is a fall or blow upon the hand or the elbow, with the arm abducted and rotated outwards. The result is that the head of the bone is thrust violently against the anterior inferior part of the capsule which gives way, and allows the head of the bone to pass downwards below the glenoid cavity.

VARIETIES.—In all the forms of dislocation the primary displacement is *sub-glenoid*. As the head of the bone passes downwards it comes into contact with the anterior edge of the long head of the triceps, and, unless the direction of the force be such as to drive the head backwards, the result of contact with this structure is displacement forwards ; the head then lies below the coracoid process—the so-called *sub-caracoid dislocation*—which is the most common dislocation of the shoulder.

When the violence is more severe, the head of the bone may be thrust beyond the coracoid process until it lies beneath the clavicle—the form spoken of as *sub-clavicular dislocation* Still more rarely the head of the bone travels backwards ; this is the result either of a fall with the hand fully outstretched, or of direct violence applied to the front of the shoulder. Here also the lower part of the capsule is torn, but generally somewhat more posteriorly than in the former instances, and the head of the bone is carried backwards and lodges in the infra-spinous fossa—the *sub-spinous dislocation.*

Among the rarer forms are the *sub-acromial dislocation,* in which the head of the bone passes upwards into contact with the acromion, and

the *supra-acromial dislocation*, in which it lodges actually above it. These two forms are excessively rare, and, as the treatment is practically the same as for the other varieties, we need not refer to them further.

DISPLACEMENT.—*Sub-coracoid Dislocation.*—The upper arm is directed somewhat backwards and outwards so that the elbow is away from the side. The forearm is supinated, there is marked flattening of the shoulder, and the head of the bone can be made out in its new situation.

Sub-clavicular Dislocation.—The signs of this variety are usually those of the preceding one in an exaggerated degree; not uncommonly the coracoid process is fractured by the head of the humerus as it passes upwards towards the clavicle.

Sub-glenoid Dislocation.—Here there is generally much pain from the pressure of the head of the bone upon the nerves; the elbow projects markedly from the side, the arm is slightly elongated, and the head of the bone can be felt in the axilla. There may be absence of pulse at the wrist from pressure on the axillary artery, or a rapid œdema of the hand from pressure on the vein.

Sub-spinous Dislocation.—The arm is generally rotated inwards, is nearer to the side than in the other forms, and the long axis of the humerus is directed slightly forwards.

TREATMENT OF SIMPLE DISLOCATIONS.

Immediate reduction should be effected, and means must then be taken to retain the head of the humerus in the glenoid cavity.

REDUCTION.—Reduction may be effected either *by manipulations*, having for their object relaxation of the capsule and the muscles and the re-introduction of the head of the bone through the rent in the capsule by which it left the joint; or *by traction*, which brings the head of the bone down to the rent in the capsule.

The patient should be placed under a general anæsthetic. The pain of a dislocation is generally very severe, and the powerful muscles around the joint are kept in a state of such violent contraction that they offer great resistance to reduction; when, however, the patient is anæsthetised, manipulations often suffice to replace the head of the bone with the greatest ease. Indeed, in the ordinary sub-coracoid cases, it is not at all uncommon to find that, by the time the patient is fully anæsthetised, the dislocation has reduced itself. When, however, no anæsthetic is at hand, the pain that the patient suffers may be so severe as to demand immediate reduction without waiting. The best method of reduction for dislocation downwards or forwards is by the manipulations introduced by Kocher and usually called by his name. It is performed as follows:—

Kocher's Method.—When the patient is not under an anæsthetic he sits bolt upright in a chair, and an assistant steadies the trunk and fixes

the scapula. It is essential that the entire trunk should be steadied during the manipulations, as otherwise the patient may defeat them entirely by swaying the body about. A good plan is to fasten the trunk to the back of a strong chair by means of a stout jack-towel. The surgeon stands or kneels a little in front of the patient on the affected side, and first flexes the forearm to a right angle and then steadily approximates the elbow to the side (see Fig. 4). This stretches the upper part of the

FIG. 4.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *First Stage.* The trunk is fixed by a stout towel passed round the back of a chair and held by an assistant. The elbow is then flexed to a right angle and approximated to the chest-wall.

capsule and causes the head of the bone to hitch against the edge of the glenoid cavity (see Fig. 9). The arm is then rotated outwards until the rotation can be carried no farther (see Fig. 5). This carries the head of the bone outwards from the coracoid process to beneath the acromion, and relaxes the outer and posterior portion of the capsule, which has been unduly on the stretch (see Fig. 10). The whole arm is now brought forwards and upwards, full outward rotation of the humerus being still maintained, until the limb is almost at a right angle to the body (see Fig. 6). This relaxes the front and upper part of the capsule so that the gap in it

is freely open, while at the same time the head of the bone comes down almost to its normal position (see Fig. 10). The last step in the manipulations is to rotate the arm inwards, and carry the elbow forwards across the front of the chest, making the fingers touch the opposite shoulder (see Fig. 7). This brings the head of the bone back through the rent in the capsule (see Fig 11); and at this point it generally slips into position almost imperceptibly. The arm is finally brought down to

FIG. 5.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Second Stage.* The forearm is rotated outwards as far as it will go while the elbow is kept at a right angle and firmly pressed to the side.

the side (see Fig. 8) to which it is fastened after being supported in a large elbow-sling. Although these manipulations have been described in stages for the sake of clearness, the process is continuous in practice and should be carried out rapidly and forcibly.

In some cases the re-position of the bone is not noticeable, and it is not until after the manipulation has been completed that an examination of the shoulder shows that it has been successful; in other cases there is a distinct jerk when it slips in. There should be no difficulty in ascertaining whether the dislocation has been reduced. The

roundness of the shoulder, due to the prominence of the greater tuberosity in its proper place beneath the deltoid, at once denotes success. Moreover the hand can be brought to the opposite shoulder, and a ruler laid flat upon the outer aspect of the arm can no longer be made to touch both the external condyle and the acromion as it did when dislocation was present.

Traction Methods.—In muscular subjects without an anæsthetic

FIG. 6.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Third Stage.* While full outward rotation is maintained, the arm is carried upwards parallel to the antero-posterior plane of the body until it is almost horizontal.

Kocher's method is not always successful; should it fail, some form of traction must be resorted to.

Outward Traction.—The method that seems to combine the most satisfactory results with the least pain to the patient and bruising of the parts is the following: The patient is laid flat upon the back on the ground or on a low couch, and the surgeon sits or kneels beside him; the forearm is flexed to a right angle, and the arm is drawn gradually from the side until it is at right angles to the trunk. An assistant, if available,

makes counter-extension by means of a jack-towel passed transversely around the upper part of the chest, while the surgeon keeps up steady traction at right angles to the body (see Fig. 12). If no assistant be present, the surgeon sits upon the floor at right angles to his patient and places his unbooted foot against the axillary border of the scapula so as to fix it while he makes the traction and tires out the muscles. Sometimes the head of the bone slips in with a jerk; but commonly it

FIG. 7.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Fourth Stage.* When the horizontal position is reached, the arm is rotated inwards, the forearm being carried through rather more than a right angle from left to right.

does so gradually, so that the surgeon finds when the arm is brought to the side that the dislocation has been reduced. If plenty of assistance is at hand, the extension and counter-extension can be entrusted to assistants, while the surgeon manipulates the head of the bone into place.

Downward Traction.—The older method was to reduce the dislocation by means of the heel in the axilla. This is very effectual and is also probably the easiest method for those who have but slight experience. The patient lies upon his back on a couch or on the ground, and the

surgeon sits facing him on the affected side, and after removing his boot, places his foot in the axilla. The pressure of the foot should be somewhat outwards towards the arm, the object being partly to fix the scapula and partly to provide a fulcrum which will force the head of the bone outwards into position as traction is made. If the pressure be made too much inwards, the vessels and nerves may be bruised, or indeed the ribs may be fractured. The forearm is seized above the

FIG. 8.—KOCHER'S METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *Final Stage.* The elbow is now brought down to the side.

wrist and steady traction is made downwards and somewhat outwards, the surgeon leaning a little away from the patient for the purpose (see Fig. 13). After the traction has been continued long enough to tire out the muscles, the limb is approximated to the side by carrying the forearm nearly to the middle line of the trunk, with the result that the head of the bone is felt to slip into position (see Fig. 14).

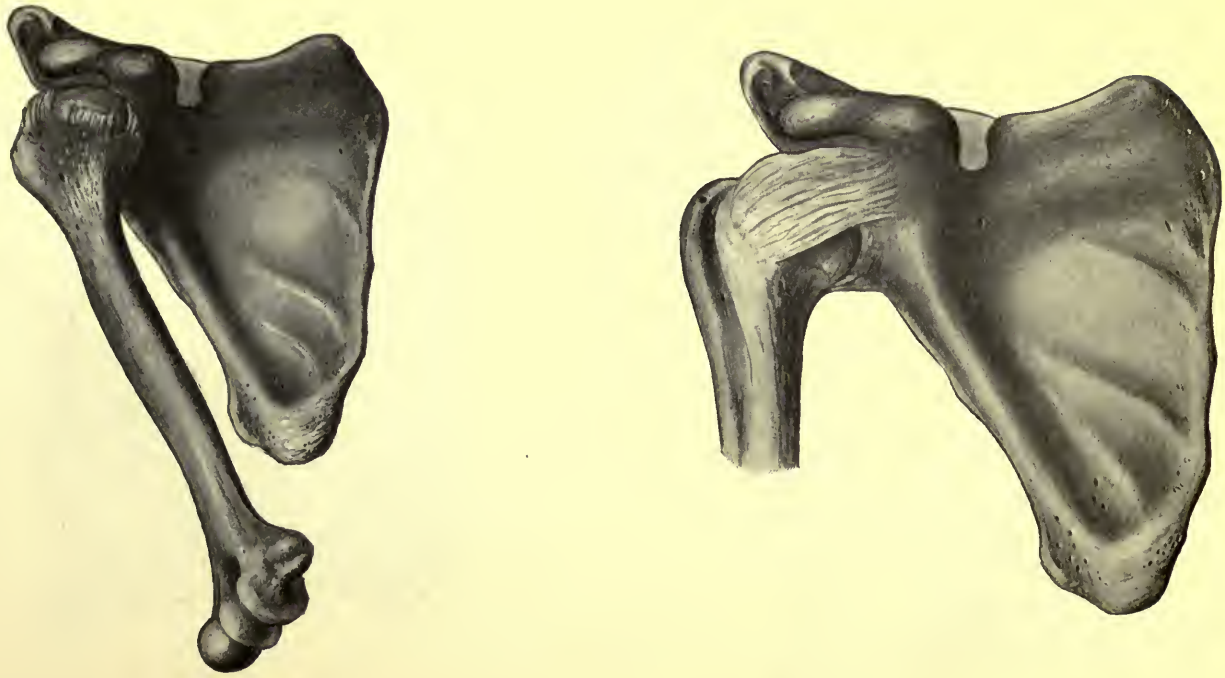
In sub-glenoid dislocations, traction, either transversely to the trunk or with the heel in the axilla, readily brings the head of the bone into

A *B*

Fig. 9.—Reduction of a Dislocation of the Shoulder by Kocher's Method. *A* shows the head of the humerus beneath the coracoid process and the humerus itself directed away from the side of the chest. *B* shows how approximating the elbow to the side brings the head of the humerus down clear of the coracoid and hitches it against the edge of the glenoid cavity.

C D

FIG. 10.—REDUCTION OF A DISLOCATION OF THE SHOULDER BY KOCHER'S METHOD. *C* shows the position of the head of the humerus during full outward rotation; *D* its position while the arm is elevated and rotated outwards. The head of the bone is seen passing back through the opening in the capsule.



E *F*

FIG. 11.—REDUCTION OF A DISLOCATION OF THE SHOULDER BY KOCHER'S METHOD. In *E* the head of the bone is seen in the position it occupies just before the final inward rotation of the limb, by means of which—as shown in *F*—the head returns into place.

position. *In the sub-spinous and the sub-acromial forms*, an anæsthetic should always be used if possible; reduction, by traction downwards and

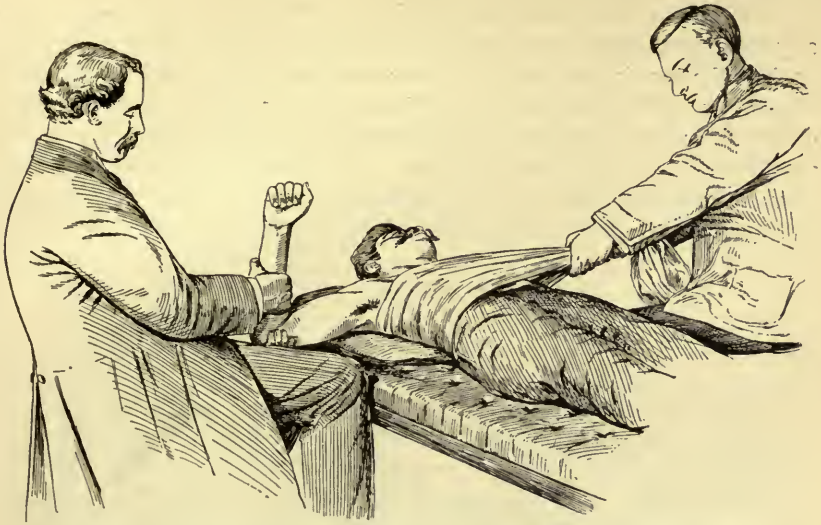


FIG. 12.—THE RIGHT-ANGLED TRACTION METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. If no assistant be available the surgeon may exert counter-extension by his unbooted foot against the axillary border of the scapula.

FIG. 13.—THE HEEL-IN-AXILLA METHOD OF REDUCING DISLOCATIONS OF THE SHOULDER. *First Stage.* Steady traction is made downwards and as much outwards as the surgeon can manage by leaning over away from the patient.

forwards, is then easy. The arm should be slightly rotated inwards, so as to disengage the lesser tuberosity from the edge of the glenoid cavity,

and, after the traction has been continued for some time, the arm should be rotated outwards and carried forwards across the chest ; the scapula must be firmly fixed by an assistant.

After-treatment.—Recurrence of the dislocation is likely to result from any movement such as free abduction which thrusts the head of the bone against the rent in the capsule. The movements of the joint should be restricted during the night by binding the arm to the side with a handkerchief or bandage ; during the day it usually suffices to keep the limb supported in an elbow-sling. After the first week this may be replaced by a strap around the trunk connected with another round the arm in such a way as to allow the patient to move the limb in all directions without carrying

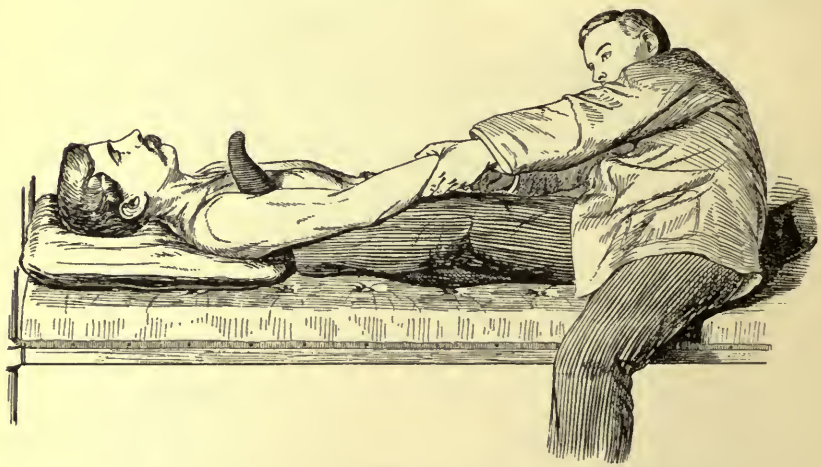


Fig. 14.—The Heel-in-Axilla Method of Reducing Dislocations of the Shoulder. *Final Stage.* When full extension has been made, the limb is swung across the middle line and the head of the bone should slip into place.

it far from the thorax. This should not be left off for at least a month, and must be worn for two or three months if the patient wishes to hunt.

Strict immobilisation of the joint must be avoided, because adhesions in the joint are likely to result from the accident. Passive movements and massage should therefore be commenced by the surgeon the day after the injury. In performing movement, the arm must be well rotated inwards when the limb is abducted, and, moreover, abduction should only be practised to a very limited extent for the first fortnight after the occurrence of the dislocation. We would especially warn the practitioner against keeping the arm at rest too long, as the results of doing so, especially in elderly subjects, are most disastrous. The shoulder-joint becomes practically useless, and no treatment, however vigorous, has any marked effect upon it. It is well to bear in mind also that persons over the age of thirty-five who suffer from a dislocation are apt to become the subject of a traumatic chronic arthritis which is often very intractable.

TREATMENT OF THE COMPLICATIONS OF DISLOCATION OF THE SHOULDER.

Bruising of the muscles inserted into the tuberosities of the humerus is practically constant, but is generally recovered from without trouble.

Fracture of the humerus may complicate the dislocation; the fracture may occur either in the shaft or the neck of the bone.

Injury to vessels or nerves—particularly the axillary artery, the brachial plexus, or the circumflex nerve—may be met with, especially in subglenoid or sub-coracoid dislocations. The injury may vary from simple bruising to complete rupture; in the majority of dislocations of the shoulder these structures are bruised to some extent.

DISLOCATION COMPLICATED BY FRACTURE.—This accident is not at all uncommon, and the condition is readily shown in a stereoscopic radiogram. Treatment must be immediate and thorough in order to preserve the usefulness of the limb.

Treatment.—*When the fracture is in the shaft.*—Should the fracture occur low down in the shaft of the bone, it may be possible to reduce the dislocation first, and then put up the fracture in the ordinary manner. The principal importance of this injury is that stiffness of the shoulder-joint is apt to follow, and special measures have to be taken to prevent this. When the fracture is quite low down in the shaft, the fracture should be surrounded with well-moulded splints, which will permit of free passive movements of the joint with but very slight disturbance of the fracture. It is highly important not to keep the arm fixed to the side until consolidation has occurred; if this be done, a hopelessly stiff shoulder will certainly result. When the fracture is in the upper third of the shaft, however, and in all cases of combined fracture and dislocation in elderly subjects in whom operation is not contra-indicated, the proper practice is to expose the seat of the fracture without delay, reduce the dislocation, and secure the fragments together by the most appropriate methods of fixation (see Vol. II. p. 305). The reduction of the dislocation should be accomplished, if possible, before the fractured ends are fastened together, as there is then less risk of undue strain being thrown upon the plates or wires used; but should this be impossible, the fracture is fixed in the first place, and then the leverage obtained will allow of reduction being accomplished.

When the fracture is in the neck.—When, however, the fracture is situated in the neighbourhood of the surgical or the anatomical neck, the small size of the upper fragment renders it difficult, if not impossible, to reduce the dislocation. Formerly, the fractured ends were brought into position and allowed to consolidate in the first instance, and afterwards an attempt was made to reduce the dislocation. For reasons already mentioned when speaking of unreduced dislocation (see p. 6) this practice should not be followed. It has also been suggested that when the

dislocation cannot be reduced, passive movements should be commenced at once without attempting to immobilise the fracture, so as to obtain a false joint between the fractured surfaces, and thus maintain the usefulness of the arm, but this is not good practice. A third course is to attempt, with the aid of a general anæsthetic and the X-ray screen, both to reduce the dislocation and set the fracture, but even if this were successful, the after-treatment would offer almost insuperable difficulties. In order to avoid stiffness in the joint, passive movements would have to be resorted to early and used freely, and it would be impossible to keep the fracture immobilised while this was being done.

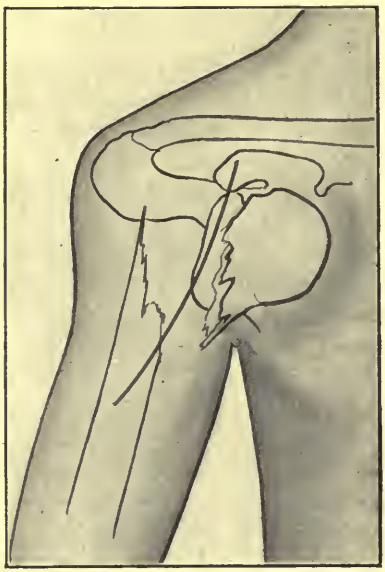


Fig. 15.—Dislocation of the Shoulder combined with Fracture of the Surgical Neck. The continuous line denotes the most suitable incision for operating upon this condition.

In our opinion immediate operation should be advised unless there is something in the patient's condition to contra-indicate operative interference. An operation of this sort involves both a compound fracture and a wound into a joint, and should not be attempted unless the surgeon is absolutely confident of his power to prevent sepsis. The method aims at attaining perfectly free access to the joint, ascertaining and removing any cause of obstruction, replacing the head of the bone in position, sewing up the rent in the capsule, and subsequently fixing the fractured surfaces in position.

The best method of exposing the joint is through an incision commencing just external to the tip of the coracoid process, and running downwards and slightly outwards for four or five inches along the anterior border of the deltoid (see Fig. 15). The margin of the muscle is pulled outwards, the fascia beneath it is divided, and the deeper parts exposed. Should more room be necessary, it may be obtained by curving the incision outwards below so as to divide a portion of the insertion of the deltoid into the humerus; the muscle is then turned outwards as a sort of flap, and it is easy to stitch the detached portion into position again at the end of the operation. After the wound has been well retracted, the structures about the shoulder-joint are easily identified, the rent in the capsule is visible, and the situation of the fracture is obvious. Traction should be exerted upon the arm downwards and slightly outwards, so as to get the lower fragment of the humerus out of the way, and then it is generally easy to grasp the head

of the bone directly, and to make it re-enter the joint through the rent in the capsule, which can then be sewn up with fine catgut.

The chief obstacle to the return of the head is the subscapularis tendon, but it is usually possible to hook this aside when the parts have been exposed. After the reduction has been effected, the rent in the capsule closed, and any torn structures sutured, the fracture of the humerus should be secured by some mechanical means (see Vol. II. p. 305). The wound is then stitched up without a drainage-tube, after suture of the deep fascia, and the arm is put up as for fracture of the upper end of the humerus (see Vol. II. p. 321).

As soon as the wound has healed, passive motion must be begun, so as to prevent adhesions in the joint. There is not much fear of disturbing the fracture, and a good result should be obtained when the fracture is through the surgical neck. Weakness of the deltoid may persist for some time without definite evidence of injury to the circumflex ; in these cases the nerve may have been bruised, or possibly it may be a reflex trophic disturbance, but power is usually recovered within three months provided that the nerve has not been divided.

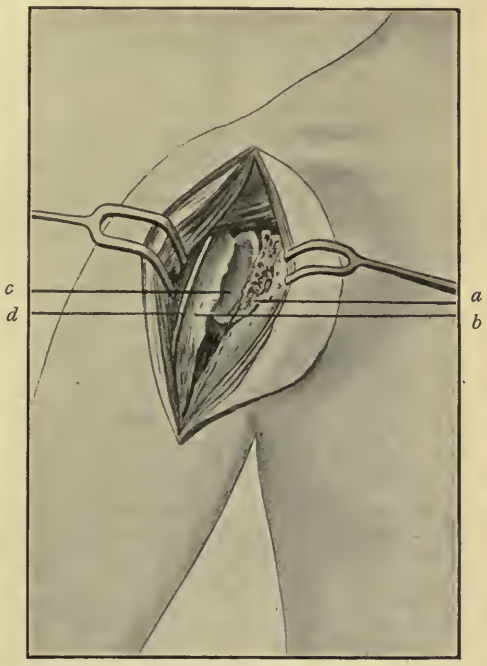


Fig. 16.—Dislocation of the Shoulder Combined with Fracture of the Greater Tuberosity. The parts have been exposed by the incision shown in the previous figure. *a*, Fractured surface of head of humerus; *b*, fractured surface of greater tuberosity; *c*, glenoid surface of scapula; *d*, long head of the biceps.

When, however, the anatomical neck is the seat of the fracture, the prospects of a satisfactory result are not so good. The rounded head of the bone may be detached, and will probably not unite to the shaft, even though it be fastened to it. The best result will often be obtained by removing the loose portion and smoothing off any rough surface left, and in that case it is well to interpose some soft tissues between the end of the humerus and the glenoid cavity (see p. 153). The arm is brought into position, the rent in the capsule closed, and the wound sutured. Passive movement should be carried out from the first, as there is now no fracture to be considered, the only object being to obtain free mobility of the joint: in fact, the

case is one of partial excision of the joint without division of any muscles.

Removal of the head of the bone is also advisable in the rarer cases in which the head is comminuted. If this be not done, so much new bone may be thrown out as to fix the joint more or less completely.

Injury to the Axillary Vessels and Nerves.—The axillary artery is the vessel usually affected; in sub-glenoid dislocation especially, it is often stretched over the head of the bone and there is a temporary arrest in the circulation through it, which passes off as soon as the displacement is remedied. In the more severe cases there may be extensive bruising of the vessel, followed by thrombosis. The artery may be torn across either partially or completely. One of two things will then happen: either the ruptured artery is so twisted or the head of the bone so presses upon it that there is no free escape of blood; or, more commonly, profuse hæmorrhage takes place and the axilla becomes distended with blood. If the rent is large the patient may bleed to death in a very short time, but if it is small the hæmorrhage may ultimately become partially arrested and a large diffuse axillary aneurysm will be formed. Rupture of the artery is easily recognised; the swelling in the axilla is marked and may increase visibly, while the patient becomes faint from loss of blood and may die before assistance can be procured. The accident, however, is extremely rare in recent cases; it more often occurs during attempts to reduce a dislocation of several weeks' standing.

Treatment of Rupture of the Artery.—As soon as the condition is recognised, the subclavian artery should be compressed against the first rib (see Vol. II. p. 495) while arrangements are being made to secure the injured vessel. As soon as possible an incision should be made as for ligature of the third part of the axillary artery (see Vol. II. p. 216), but somewhat freer. The subclavian being fully controlled by an assistant, the clots are turned out and the torn ends of the vessel tied. If the extravasation be widespread, and particularly if there be any difficulty in securing efficient compression of the subclavian, an incision through the skin and deep fascia should first be made above the clavicle, as for ligature of the third part of the subclavian (see Vol. II. p. 196); through this an assistant can introduce his thumb and compress the vessel directly against the rib whilst the incision is being made into the axilla. The surgeon is thus enabled to turn out all the clots and to search for the divided ends of the vessel, which will be difficult to find until the clots have been evacuated. After the vessel has been ligatured above and below the rent, a large drainage-tube should be inserted into the axilla.

Treatment of Injury to the Nerves.—It is not uncommon for the head of the bone to press upon one of the axillary nerves and produce paralysis or anæsthesia. If due simply to pressure, this will pass off soon after the pressure is relieved; if permanent, it is the result either of bruising or of actual rupture of the nerve.

When there is no complication calling for an incision, the dislocation should be reduced and the case watched to see if the nerve recovers its functions. If there is only bruising or slight extravasation of blood, recovery will take place readily, and within a fortnight or three weeks there should be definite signs of improvement.

As regards electricity, the faradaic current should be used unless it fails to cause contraction, when the galvanic current should be substituted for it. The current should not be allowed to flow continuously, since it is only at the 'make' and 'break' that the muscle is stimulated. The current may be made and broken by a key or by repeatedly lifting the electrode which is over the muscle. The negative pole should be applied over the paralysed muscle, the positive being over the spine, and a current sufficiently strong to cause definite but not painful contractions should be passed for about ten minutes daily.

If no sign of recovery be evident in two or three weeks, it may be assumed that the nerve is seriously damaged, and operative interference is necessary. The nerve must be cut down upon and examined, and the ends, if torn, accurately sutured. If there is compression by blood or cicatricial tissue, the blood must be turned out or the cicatricial tissue removed; if the nerve structure has been destroyed by bruising without solution of continuity, excision of the damaged part followed by immediate union of the divided ends will be indicated. These operations are fully described in Vol. II. Chap. X.

TREATMENT OF COMPOUND DISLOCATIONS.

This rare complication usually occurs as part of an extensive injury; there is generally such damage to the surrounding parts that amputation is not uncommonly required. Should the condition of affairs justify an attempt to save the limb, however, the surgeon must enlarge the wound, disinfect it and the skin around (see p. 85), and must then replace the head of the bone, insert a drainage-tube at the most convenient spot, suture the bulk of the rent in the capsule if possible, and treat the case on ordinary lines. If there are no signs of sepsis, passive movement must be begun in four or five days, otherwise there will be great danger of firm adhesions.

Should the attempt at disinfection fail, or should the patient not be seen until suppuration has been established, the treatment will be that for a suppurating joint (see Chap. XII.). The articulation must be opened up freely, every facility provided for the escape of pus, and irrigation of the joint employed. If the condition be grave, the question of amputation will arise, and will be determined by the rules laid down for the treatment of septic wounds of joints (see Chap. XI.).

TREATMENT OF UNREDUCED DISLOCATIONS.

An unreduced dislocation of the shoulder may be due to the injury not having been recognised at the time, to the patient not having sought advice, to the surgeon having been under the impression that he has reduced the dislocation while in reality he has failed to do so, or to the dislocation having recurred after reduction. In any case the condition is serious, because the head of the bone soon contracts adhesions to the surrounding structures in its new position. In sub-glenoid and sub-coracoid dislocations especially, adhesions are extremely likely to form between the head of the bone and the vessels and nerves.

The chief troubles in attempting to reduce a long-standing dislocation of this kind without operation are three in number. The first is the shortening of the muscles and tendons attached to the tuberosities; the second is the adhesion of important structures—such as the vessels and nerves—to the head of the bone; and the third is the difficulty of replacing the head in position after these obstacles have been overcome, owing to the distortion of the capsule and the filling up of the glenoid cavity. All these changes occur very rapidly.

It is difficult to lay down an exact rule as to the length of time after a dislocation of the shoulder has occurred within which it is safe to attempt reduction. Reduction has been successfully accomplished as long as two months or more after the injury. On the other hand, rupture of the axillary artery has resulted from attempts to reduce a dislocation of four weeks' standing. We should say that it is not advisable to attempt reduction of a sub-coracoid or sub-glenoid dislocation after six weeks have elapsed from the time of the injury, and that it is practically unjustifiable to attempt it after nine weeks.

Within the periods mentioned, attempts at reduction must be carried out with extreme care, on the following lines. The patient is fully anæsthetised and then the limb is moved freely in all directions, so as to break down adhesions. This is done very cautiously at first, the limb being gradually made to move through a wider range. Then an attempt should be made to get the head of the bone back into position by Kocher's method (see p. 14). This may not succeed, but it does good by loosening various adherent structures that oppose reduction; if it fails it should be followed up by traction at right angles to the trunk (see p. 17). Should this fail, an attempt may be made with the heel in the axilla (see p. 18).

If, after a fair trial of these methods, the head of the bone will not go into place, the question arises whether the patient should be left alone or whether anything further should be done. In elderly subjects the surgeon may be justified in leaving matters alone if the arm has regained so much usefulness that the patient does not suffer serious inconvenience; this is most likely to occur in sub-spinous dislocations.

Operative methods.—On the other hand, in sub-glenoid and sub-coracoid dislocations the patient may have a useless arm, or he may suffer so much pain that life is intolerable. As these accidents not infrequently occur in young adults, operation is often absolutely necessary to obtain a useful arm.

Cases have been operated upon as long as eight months after the dislocation, and the head of the bone has been replaced in position with most satisfactory results; in the more recent cases, these results are better than those obtained by excising the head of the bone. Therefore in all cases of intense pain, and in all those in young and healthy patients, the aim of the surgeon should be to see whether he cannot *replace the head of the bone by operation*, and he should only proceed to the alternative of excising the head of the bone when he finds that this is impossible.

The joint may be exposed by the incision recommended on p. 26, and the flap containing the deltoid is pulled outwards and the pectoralis major inwards. If there are many adhesions and fuller exposure of the joint is required, a second incision may be added to this a finger's breadth below and parallel to the acromion and the clavicle dividing the clavicular fibres of the pectoralis major. The circumflex nerve must be preserved from injury. The fibrous structures about the anatomical neck are carefully detached from the head and neck all round by a periosteum detacher, taking care to keep close to the bone. If the vessels and nerves are adherent, they will be detached along with these structures, and thus the risk of their being torn is reduced to a minimum. After the head and neck of the bone have been fully cleared, extension is applied to the humerus, which will cause any resistant bands to be put on the stretch, so that they can be localised by the finger and divided. The capsule is nearly always so distorted and adherent as to be of no use, and the glenoid cavity itself will probably be filled up with soft tissue. The cavity should be cleared out, so as to restore it to its normal depth, and any remains of the capsule that obstructs the re-position of the head dissected away. Any osteophytic outgrowths around the head of the bone should be trimmed off with a gouge. As a rule the head of the bone can now be replaced, but in very long-standing cases it may be necessary to divide some of the muscles attached to the tuberosities, especially the supra- and infra-spinatus. The sub-scapularis should not be interfered with if it be possible to get the head of the bone into position by pulling its tendon down, but sometimes it may be necessary to divide it. Division of the muscles should be practised gradually so as to see the effect that successive divisions produce, as, if even only a portion of the insertions of the muscles into the tuberosities be left intact, satisfactory union will take place in the remainder without any necessity for suturing them at the end of the operation. If, however, complete separation of all the muscles attached to the great tuberosity should be necessary, it

will be better to chisel off that process along with the muscles attached to it, and then to fasten it in position again at the end of the operation by means of a screw or tin-tacks.

If there is sufficient capsule left, the aperture in it may be sutured, so as to help to retain the head of the bone in position. This is a

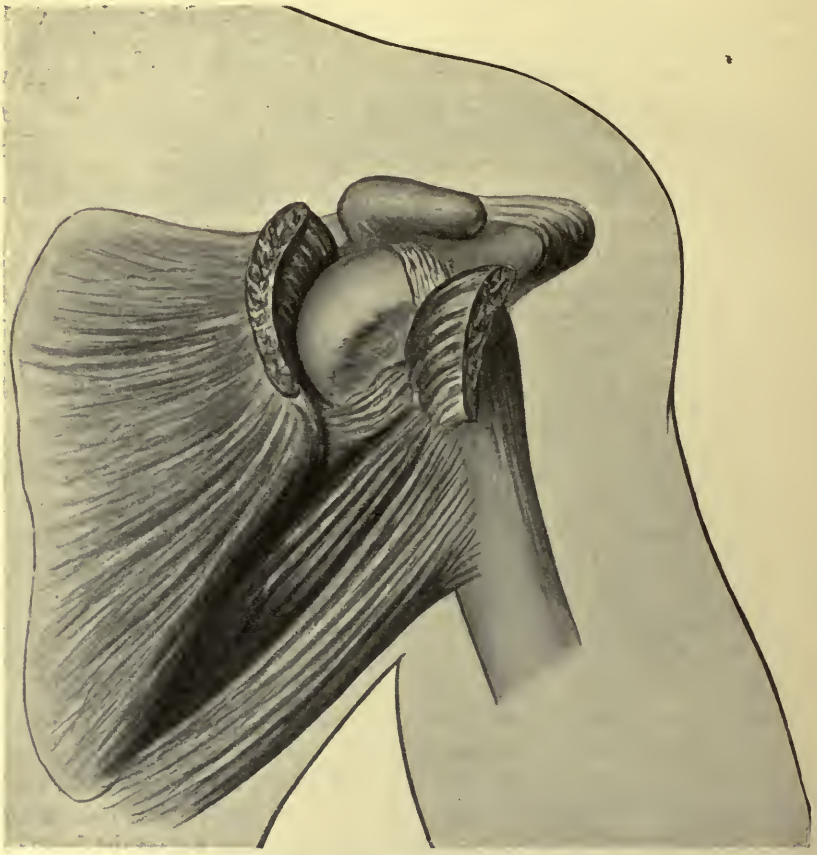


FIG. 17.—SUB-CORACOID DISLOCATION IN RELATION TO THE SUB-SCAPULARIS TENDON. The tendon has been cut and turned back to show how this structure may interfere with reduction.

considerable help, as there is a great tendency for the head to slip forward again owing to the shallowness of the glenoid cavity and the alterations which have taken place in it. The wound is now stitched up; a drainage-tube is unnecessary. A large pad of wool should be placed in the axilla outside the dressings, and the elbow brought to the side and pushed somewhat forwards, the forearm being carried obliquely across the chest. The arm is bandaged to the trunk and a special large pad of

wool should be placed over the front of the head of the humerus so as to resist any tendency to displacement forwards.

Passive movements should be begun in a week; for the first few days an anæsthetic is generally necessary. The elbow is grasped in one hand and the shoulder-joint in the other, and the movements carried out without removing the dressing. They should be continued daily for three weeks, and then twice a day. Passive movement is most important, as there is a constant tendency to the formation of adhesions, which, if unchecked, might entirely neutralise the results obtained by the operation.

Excision of the head of the bone should only be performed when an examination of the condition of the parts through the incision recommended above, convinces the surgeon that it is impossible to get the head of the bone into position. It is readily done after the detachment of the soft tissues described above (see p. 31), the bone being divided with a saw or a chisel, and the soft parts on the opposite side protected by a broad copper spatula; a Gigli's saw passed round the head of the bone by a special introducer (see Fig. 16) answers very well. A considerable amount of the bone must be taken away if a good result is to be looked for; unless this is done, the movements will be imperfect, as the long axis of the humerus will be in a wrong position. It will generally be advisable to cover over the divided end of the bone with a flap of soft tissues, as recommended by Murphy,

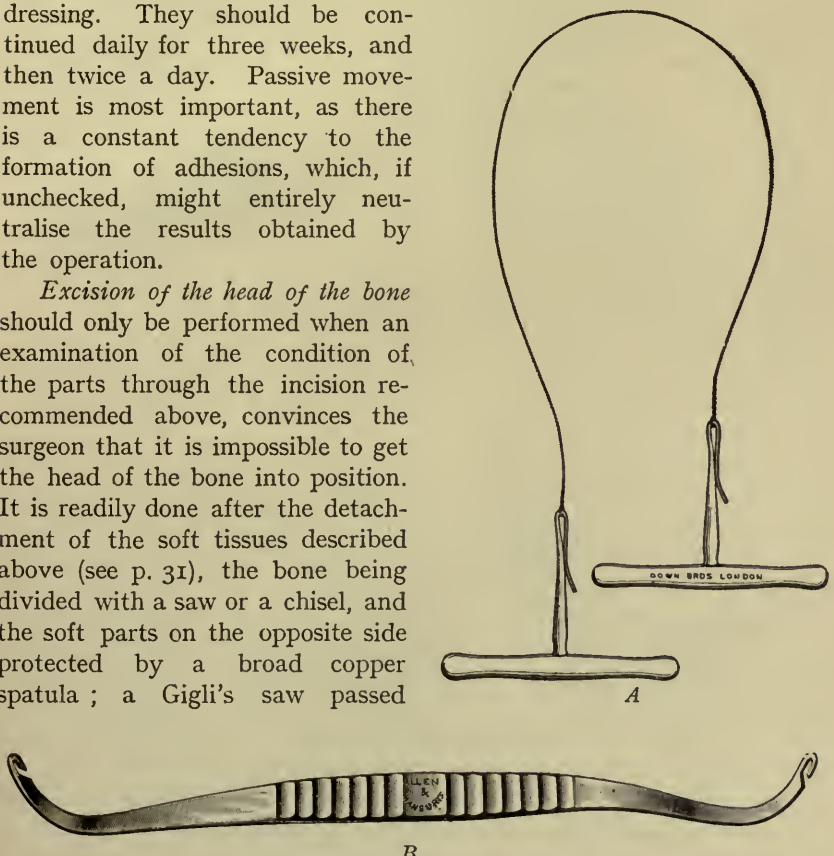


Fig. 18.—Gigli's Saw and Stiles's Introducer. The saw, *A*, is a finely tempered wire with a low screw-thread cut on it. It is introduced by hooking it into the eye of the introducer, *B*, which is passed round the bone like an aneurysm needle and then withdrawn carrying the saw. The handles are then hooked on to the saw which can then be made to divide the bone very rapidly.

in order to improve the chance of obtaining free movement subsequently. The details of this method are given fully in connection with Anchylosis (see p. 153).

RECURRING DISLOCATION OF THE SHOULDER-JOINT.

Cases are not infrequently met with in which a dislocation of the shoulder-joint frequently recurs on very slight injury, sometimes only on raising the arm. On examining radiograms of the joint in these cases, it is generally found that the head of the humerus is not normal, but is narrow and misshapen. As there is no sign of disease about it, it is probably a congenital condition; and, while the head remains in position so long as the capsule is intact, it tends to slip out of place on very slight provocation when the capsule has been stretched and weakened by the primary dislocation. The result may be very serious disability.

In considering the treatment it is obvious that no advantage will be gained by interfering with the head of the humerus, and that the only thing to do is to repair the weak part of the capsule, or, if there is no specially weak spot, to tighten up the lax capsule. We have performed the following operation for diminishing the size of the capsule in several cases with considerable benefit.

An incision is made from just below the coracoid process downwards and slightly outwards for about four inches between the deltoid and pectoralis major muscles (see Fig. 15). The deltoid is pulled outwards and the coraco-brachialis and biceps are then seen and also pulled outwards. The tendon of the pectoralis major now comes into view, running to its insertion into the humerus, and when the clavicular attachment of the muscle is pulled inwards while the deltoid and other muscles are pulled outwards, a space is seen above the upper border of the tendon of the pectoralis major, at the bottom of which are the head of the bone and the capsule. If the upper border of the tendon of the pectoralis be well pulled down and the arm moderately abducted, the lower part of the capsule, which is the part to which access is desired, may be brought into view. Generally, however, it is necessary to divide the upper part of the attachment of the pectoralis to the humerus before good access is obtained. After the lower part of the capsule has been exposed, some fibres of the sub-scapularis will be seen attached to it, and must be peeled off by a blunt dissector, so as to leave the capsule cleanly exposed. A somewhat curved incision (see Fig. 19, *A*), with the convexity upwards, is now made in the lower part of the capsule, extending from the glenoid cavity to the neck of the humerus, and the joint is freely opened. The lower margin of this cut is seized in forceps and pulled forwards and upwards over the anterior part of the capsule till the cavity of the joint has been sufficiently narrowed. From the edge of the upper portion of the capsule catgut stitches are passed through the overlapping portion

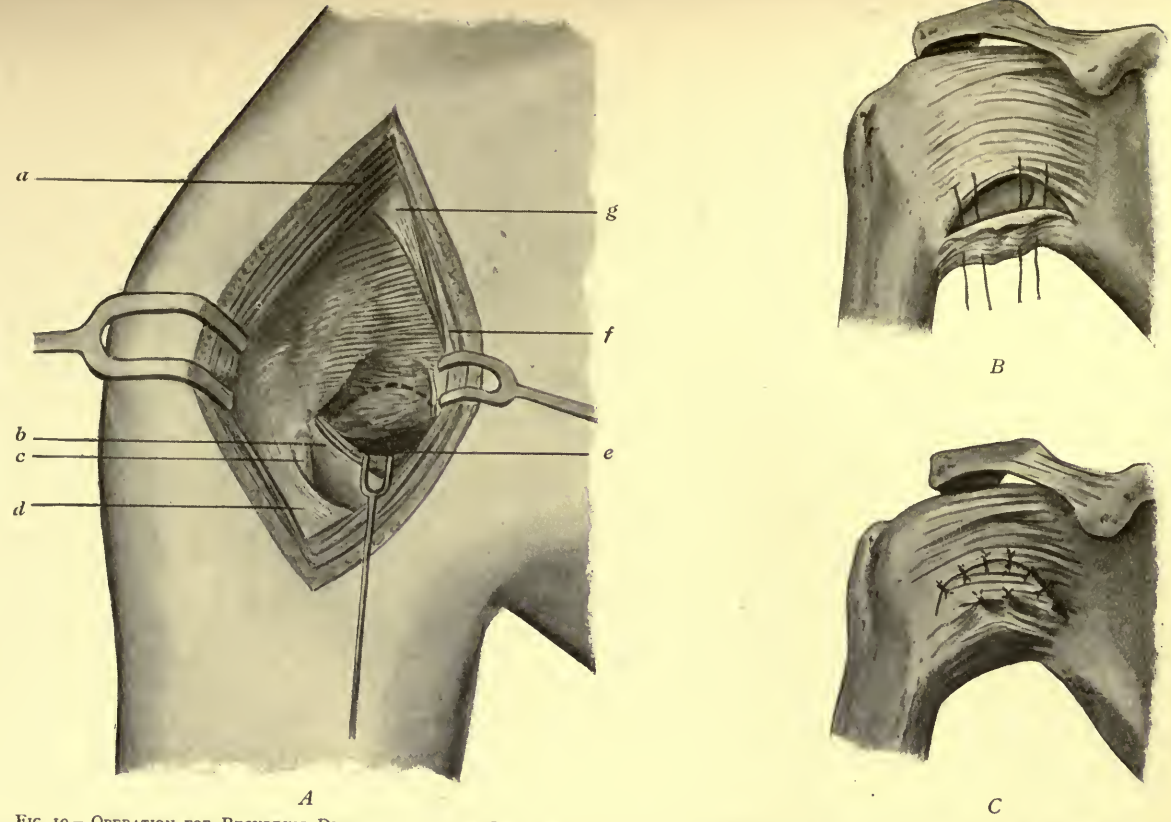


FIG. 19.—OPERATION FOR RECURRING DISLOCATION OF THE SHOULDER-JOINT. In *A* the capsule of the joint is exposed and the dotted line on it indicates the incision made into it for the purpose of narrowing it. *B* and *C* show the way in which the sutures are inserted for this purpose. The two mattress sutures inserted in *B* are shown tied in *C* and reinforced by the semi-circle of sutures above them. *a*, Divided fibres of Deltoid; *b*, Latissimus dorsi; *c*, tendon of Biceps; *d*, tendon of Pectoralis major; *e*, Teres major; *f*, fibres of Pectoralis major; *g*, short head of Biceps and Coraco-brachialis.

of the capsule and tied (see Fig. 19, *B*). The free upper margin of the lower portion of the capsule is now sewn to the underlying part, and in this way no portion is left free in the joint and a double thickness of capsule is obtained at the union (see Fig. 19, *C*).

After-treatment.—The patient should be kept in bed on his back for about a week, gentle passive movements of the arm being carried out by the surgeon every day. After that the amount of movement may be gradually increased and active movements carried out as well; massage may be necessary if there is swelling about the shoulder. For several months the patient must avoid extreme abduction of the arm.

CHAPTER IV.

DISLOCATIONS OF THE ELBOW.

The elbow-joint is frequently dislocated, and the accident commonly occurs before the age of sixteen. Dislocation may take place backwards, forwards, inwards, or outwards, and besides these typical forms, the bones of the forearm may also be displaced obliquely, the most frequent forms being dislocation backwards and inwards and dislocation backwards and outwards. Either bone of the forearm may also be dislocated separately; in this case the radius, if dislocated alone, may pass either backwards, outwards, or forwards; whilst if the ulna alone be displaced, it is dislocated backwards.

DISLOCATION OF BOTH BONES OF THE FOREARM.

In the majority of cases both bones are dislocated directly backwards, but in some cases an inward or an outward displacement may be combined with this. All the other forms of displacement, *i.e.* directly inwards, directly outwards or forwards, are very rare.

DISLOCATION OF BOTH BONES BACKWARDS.

As a rule this injury is caused by a fall upon the outstretched hand with the elbow fully extended. The result is that the anterior and lateral ligaments are ruptured and the coronoid process slips back over the lower end of the humerus. In some cases, however, fracture of the coronoid process occurs in addition. The head of the radius passes backwards along with the ulna, the radio-ulnar articulation being uninjured.

The extent to which the bones are displaced backwards depends upon the damage done to the internal lateral ligament, the tendon of the brachialis anticus, or the coronoid process. Should these structures remain intact, the displacement is comparatively slight, as the coronoid process usually hitches against the lower end of the articular surface of

the humerus, whereas, if the soft parts be torn through, the coronoid process may pass backwards until it lodges in the olecranon fossa. The essential factor that determines whether the displacement shall be simply backwards or to one side as well is the direction of the force producing the injury. If the arm be driven inwards or outwards as the ligaments give way, the dislocation will be both backwards and to one side.

Dislocation of the elbow may be complicated with a fracture of some

FIG. 20.—METHOD OF REDUCING A DISLOCATION OF BOTH BONES OF THE FOREARM BACKWARDS. The knee fixes the lower end of the humerus. Traction is made with the limb as nearly extended as possible, and then the joint is flexed across the knee.

part of the articular surfaces or with injury to vessels or nerves in the neighbourhood. The dislocation may also be compound.

TREATMENT.—(a) Of Simple Dislocation.—An anæsthetic is generally desirable, and as a rule the bones will slip into place on making extension.

Reduction without an anæsthetic may be effected as follows: The surgeon stands sideways in front of the patient (who sits in a chair), puts his foot upon the seat of the chair and inserts the bent knee into the

bend of the affected elbow (see Fig. 20). The end of the humerus rests against the surgeon's patella; the forearm is then grasped firmly with one hand, and the upper arm steadied with the other, whilst steady and prolonged traction is made in the semi-flexed position of the arm until the muscles are tired out. The joint is then rapidly flexed around the knee, when the ends of the bones slip into place. The preliminary extension is designed to disengage the edge of the coronoid process from the lower end of the humerus, and the flexion around the knee causes this process to slip forward over the lower end of the humerus, which is steadied against the surgeon's patella. It is always easy to tell when reduction has been accomplished, as the bones spring into position with a sharp snap, and the movements of the joint are at once restored.

After-treatment.—There is no danger of recurrence of the dislocation unless the coronoid process is broken off. Should recurrence take place soon after reduction, it is strong presumptive evidence that the coronoid process has been fractured. When the coronoid process is intact the after-treatment consists in employing an elbow-sling and applying evaporating lotions (see Vol. I. p. 9) to diminish the synovial effusion. Massage may be commenced on the day following the injury, and in four days passive movements should be practised. The patient may also be encouraged to move the elbow for himself inside the sling, which may be left off after a fortnight, when the functions of the joint should be perfectly restored.

(b) Of Complications.—1. *Fracture of the Coronoid process.*—In these cases there is a constant tendency for the displacement to recur, and therefore it is necessary to fix the elbow. The best way of preventing recurrence of the displacement is to put the elbow up in the fully flexed position as for fracture of the lower end of the humerus (see Vol. II. p. 333), and this applies also to those cases in which the coronoid process is not completely detached. Should this not suffice, it may be necessary to cut down upon the process and fasten it in position (see Vol. II. p. 345).

Massage is practised from the first, and slight passive movement, carried out by the surgeon himself, may be begun at the end of the first week. The passive movement must be gentle and great care must be taken to prevent recurrence of the dislocation, while the full movements of the joint should not be carried out till two or three weeks have elapsed and then very carefully. In a good many cases after dislocation without fracture of the coronoid there is a growth of bone into the lower end of the coraco-brachialis which subsequently prevents flexion. In these cases there has probably been a partial detachment of a scale of bone from the raw surface of which bone cells have escaped and spread into the tendon. It may be necessary to remove this piece of new bone.

2. *Detachment of the internal Epicondyle.*—In young subjects the internal epicondyle is often torn off. The injury is of slight importance and has been dealt with in Vol. II. (see p. 336).

3. *Fracture of the articular surface of the Humerus.*—This requires to be treated upon the lines laid down for that particular form of fracture (see Vol. II. p. 334) after the dislocation has been reduced. It will sometimes be advisable to cut down upon the fracture.

4. *Injuries to Vessels and Nerves.*—Severe damage to these structures is a rare complication. There is a certain amount of pressure exerted both upon the vessels and nerves by the projecting lower end of the humerus when the bones of the forearm are displaced backwards, but, owing to the intervention of the soft structures, the pressure is not severe, and the interference with the circulation and innervation is usually temporary, and disappears when the dislocation is reduced.

Should the brachial artery or the median nerve be torn across, however, the treatment must be similar to that for the corresponding injuries connected with dislocations of the shoulder (see p. 28). The indications for operative interference already laid down there apply equally here.

(c) **Of Compound Dislocation.**—A compound dislocation of the elbow backwards is not common. Sometimes, however, the olecranon or the lower end of the humerus is forced through the skin. The treatment should be on the lines laid down for compound dislocation in general (see p. 5). *Drainage-tubes* should always be inserted on either side, one rather behind the external condyle, to drain the back and outer side of the joint, and one in front of the internal condyle to drain the anterior part. The elbow is put up at right angles.

Should the wound remain aseptic, the drainage-tubes are taken out in three days, and at the end of a week passive movement is carried out daily. The splint should be discontinued as soon as the wound has healed, and massage and movements practised for about four weeks longer.

It is not always wise to treat a case by simple disinfection and drainage. When there is considerable soiling of the joint, and particularly when the lower end of the humerus is comminuted, *immediate excision* will probably give the best result. An attempt to save the joint by disinfection and drainage would require a long time for healing, while extensive adhesions would certainly result, and lead to a stiff joint; whereas the functions of the articulation are well preserved after excision, and the period of convalescence is comparatively short.

The excision must be preceded by the most careful disinfection (*vide supra*), and the amount of bone removed will depend largely upon the extent of the fracture; generally, the mistake made is in taking away too little. When the lower end of the humerus is broken up, the surgeon is often tempted to remove only the comminuted portion. There is a great likelihood of stiffness subsequently when the ulna is left untouched, and in most cases it is well to excise the usual amount of the bones of the forearm (see Chap. XXIII.).

When the dislocation is accompanied by widespread damage to important structures in the neighbourhood as well as to the bones, it may

be necessary to have recourse to amputation. In determining this question, the surgeon will be guided by the same considerations as have already been discussed in connection with fractures (see Vol. II. p. 287).

(d) **Of Unreduced Dislocation.**—It may be possible to effect reduction in the case of the elbow-joint as long as six weeks after the injury without damaging important structures. The patient is fully anæsthetised, and as many adhesions as possible are broken down before reduction is commenced. An attempt must then be made by forcible traction in the semi-flexed position to bring down the forearm sufficiently, and then the elbow is flexed and the bones of the forearm brought forward over the lower end of the humerus. The X-ray screen is most useful here.

Operative procedures.—If reduction cannot be effected, some operative procedure will be required. It is seldom justifiable to leave the patient with an unreduced dislocation, because a more useful joint can be obtained by excision than from attempts by means of massage and movements to form a fresh joint with the bones in the wrong position. The difficult point to decide is, whether an attempt should be made to replace the bones in position by operation, or whether the surgeon should proceed at once to excise the joint. In a number of cases the bones have been replaced in position, and when there is no marked alteration in the joint surfaces—as may be the case if only a short time has elapsed since the injury—the result may be very satisfactory.

In operating with the view of reducing the dislocation, the joint is exposed by two vertical incisions, each about four inches long, one over the external, and the other over the internal condyle. Care must be taken not to damage the ulnar nerve at the upper end of the inner incision, whilst in the outer one, the posterior interosseous nerve must be avoided below. The soft parts in front and behind are detached with a rugine, until the joint has been cleared and the surgeon can feel what structures are tense ; these should be divided if they do not contain important structures and the bones may then be brought into position. The structures requiring division are the remains of the anterior part of the capsule and the external lateral ligament and the adhesions which have formed in their neighbourhood ; the bones will come into position when these structures have been divided, unless the triceps is unusually contracted.

When re-position has been affected, the wounds are stitched up, the usual dressings applied, and the limb placed on an internal rectangular splint with the forearm supinated ; pronation and supination are carried out from the first, and flexion and extension are added at the end of a week. These movements cause considerable pain at first, and it may be advisable to move the arm under an anæsthetic once or twice a week, so as to insure that it moves throughout its full range. If the patient

persevere with the massage and movements the result is often extremely satisfactory.

When it is evident that the bones cannot be replaced, or when the articular surfaces have undergone considerable alteration, excision is the best practice (see Chap. XXIII.). Before proceeding to remove any bone, the soft parts should be detached freely, traction made on the forearm, and any tendons or ligamentous structures divided which prevent the arm from coming down. Unless this be done, more bone than is desirable will have to be removed in order to obtain satisfactory movement, and an unduly loose joint may result.

COMBINED BACKWARD AND LATERAL DISLOCATION.

When reducing a combined lateral and backward dislocation, the surgeon brings the bones of the forearm downwards and inwards or outwards as the case may be. When operating for long-standing dislocations of this kind, it is advisable to make the lateral incision first upon the side towards which the forearm is dislocated, because in this situation the adhesions are more numerous and firmer than on the other.

DISLOCATION OF BOTH BONES LATERALLY.

Both bones of the forearm may be dislocated outwards or—much more rarely—inwards, without any dislocation backwards. The dislocation may be partial or complete.

Dislocation of both bones outwards occurs from falls upon the hand when the elbow is partially flexed, the force being applied in such a direction that it drives the bones outwards. Generally, the radius passes sufficiently outwards to be quite free of the humerus, and it is usually also displaced forwards from the lesser sigmoid cavity. The ulna, on the other hand, rests upon the capitellum. In the incomplete variety the radius remains in contact with the articular surface of the humerus.

Treatment.—The dislocation is reduced under an anæsthetic by slight extension combined with pressure inwards, the bones slipping into position readily. When no anæsthetic is used the patient should sit upon a chair, while the surgeon grasps the limb, extends it, and brings it across his knee, as described for dislocations backwards (see p. 38) ; the articular surfaces slip into position readily. The after-treatment is similar to that for dislocation backwards.

Dislocation of both bones inwards.—This is very rare, on account of the downward projection of the inner condyle of the humerus, and considerable force is required to produce it.

Treatment.—This is similar to that just described, except that the forearm is pressed outwards instead of inwards during reduction.

DISLOCATION OF BOTH BONES FORWARDS.

This accident is the result of a severe blow upon the back of the flexed elbow, or of forcible traction—as when the arm is caught in machinery. Both bones are displaced forwards, and the olecranon lies in front of the articular surface of the humerus. So severe an injury is necessary for the production of the dislocation that all the ligaments of the joint are usually ruptured and the dislocation is very likely to be compound.

Treatment.—Reduction is effected under an anæsthetic by fixing the upper arm and then flexing the elbow to its utmost limit and at the same time pushing the forearm downwards and backwards. As soon as the olecranon reaches the lower part of the articular surface of the humerus it clears its edge and the bones slip readily into position. The after-treatment is similar to that for dislocation of both bones backwards (see p. 39).

DISLOCATION OF EITHER BONE ALONE.

The radius is dislocated alone much more frequently than is the ulna.

DISLOCATION OF THE ULNA ALONE.

This is such a rare injury that doubts have been thrown upon its occurrence, and more exact information—which is only to be obtained by radiography—is required before much can be said about it. The dislocation is backwards; the orbicular ligament is ruptured, but the head of the radius remains in its normal position with regard to the lower end of the humerus.

Treatment.—The treatment will be similar to that for dislocation of both bones backwards (see p. 38).

DISLOCATION OF THE RADIUS ALONE.

It is not uncommon for the head of the radius to be dislocated forwards whilst the ulna retains its normal position. The accident usually occurs in children, and generally results either from falls upon the outstretched hand or from the common practice of lifting children by the hands. A severe strain is thus thrown upon the orbicular ligament, which may rupture, or the head of the bone may escape upwards in front of the outer condyle of the humerus. The accident may also be caused by a direct blow upon the upper end of the radius, such as would occur in falls upon the outer side and back of the elbow. The dislocation renders flexion beyond a right angle mechanically impossible on account of the apposition of the head of the radius to the front of the articular surface of the humerus. The forearm is usually in a position midway between pronation and supination.

Treatment.—There is often much difficulty in replacing the head of

the bone, owing to the obstacle offered by the orbicular ligament, which may fall into and fill up the lesser sigmoid cavity of the ulna. Moreover, after successful reduction, the head of the bone is apt to slip out of place again owing to the pull of the biceps.

A general anæsthetic is required for reduction, because it may be necessary to employ manipulations for a considerable time in order to get the remains of the orbicular ligament out of the lesser sigmoid cavity, and greater nicety of manipulation is required than is possible without its aid. The elbow is bent to a right angle and traction is made upon the forearm, whilst the head of the radius is pressed backwards into position with the thumb of the hand that fixes the arm. It is easy to get the head of the bone nearly into place, but the reduction is not satisfactory unless the bone remains in position with the aid of very slight pressure from the thumb, and pronation and supination are free. If the divided ends of the orbicular ligament curl up between the head of the radius and the ulna, these movements will be hampered, and the head of the bone will betray a constant tendency to slip out of position, particularly when full pronation is performed.

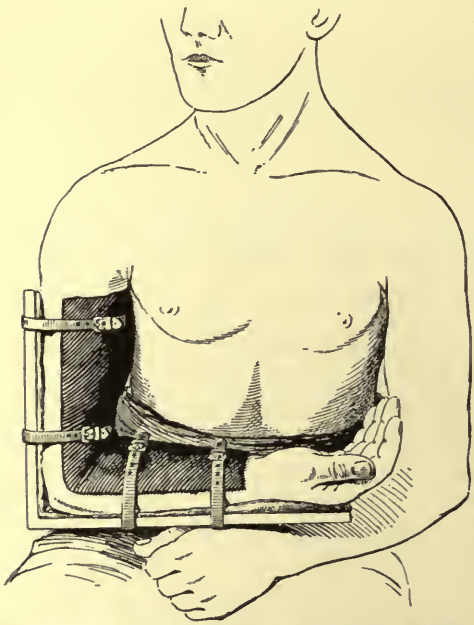


FIG. 21.—APPARATUS FOR USE AFTER DISLOCATION OF THE HEAD OF THE RADIUS FORWARDS. The posterior rectangular splint is of wood; the anterior splint is a moulded one, and has a pad between it and the front of the head of the radius.

After-treatment. — When reduction is complete, the elbow is put up upon a posterior rectangular splint with the forearm fully supinated; a moulded anterior splint of guttapercha or poroplastic material with a pad between it and the front of the head of the radius should be employed to press the latter back (see Fig. 21).

It is important to practise pronation and supination daily within a week from the time of the accident, as otherwise troublesome adhesions may form. The movements should always be carried out by the surgeon himself, and displacement of the head of the radius should be guarded against by applying pressure over it by the thumb. The splint and pad should be kept on for the first three weeks; after that time the patient may discard the splint, but should keep the arm in a sling for another two

weeks. The patient should not carry heavy weights or attempt any forcible movements for at least another fortnight.

Operative measures.—If it is evident that reduction is not satisfactory, it will be necessary to expose the articulation and remove the remains of the orbicular ligament; otherwise the dislocation will recur and will lead to disability which may require for its cure an operation under less favourable circumstances.

The head of the radius is readily exposed by the angular incision recommended by Kocher for excision of the elbow. The joint is flexed to an angle of 150°, and an incision is commenced one inch above the external condyle and carried down along the external supra-condyloid ridge to the head of the radius, and thence to the subcutaneous border of the ulna three inches below the tip of the olecranon (see Fig. 22). This incision runs between the supinator longus and the triceps above, and between the extensor carpi ulnaris and the anconeus below, and exposes the radio-humeral joint without damaging any important structure.

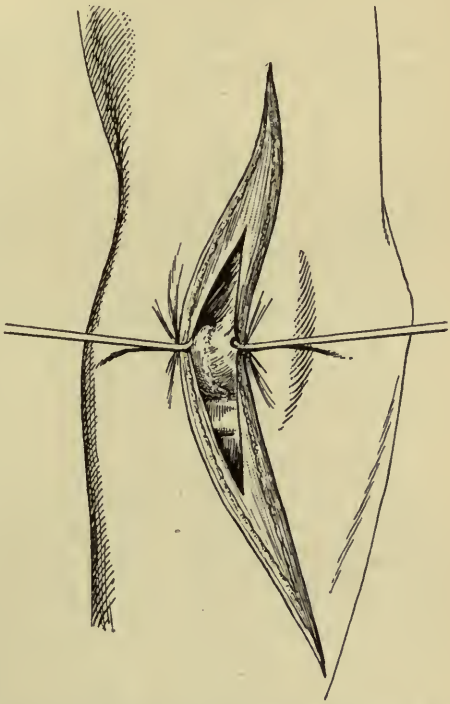


Fig. 22.—Incision to Expose the Head of the Radius. The deep fascia and the capsule of the joint have been incised directly over the head of the bone.

The capsule of the joint is now incised at its posterior aspect, and the head of the radius will then be seen. The orbicular ligament is defined and the torn ends held aside, after which it is easy to press the head of the bone into position. The torn ends of the orbicular ligament are then stitched together if possible, but, should the ligament be torn close to its insertion into the ulna, it may be very difficult to repair the injury; as a rule, however, the difficulty may be overcome by passing two or three catgut sutures through the end of the torn ligament, and then through the periosteum or the insertion of the ligament close to the bone, before the dislocation is reduced. These stitches are left loose and are tied when the head of the radius has been brought into position. The wound is closed without a drainage-tube. The after-treatment is similar to that for dislocation reduced by manipulation.

Dislocation of the head of the radius **backwards** or **outwards** is very rare, and the treatment resembles that of the form just described.

UNREDUCED DISLOCATION.—The trouble in these cases is that flexion cannot be carried out even up to a right angle, whilst the movements of pronation and supination are interfered with.

Treatment.—When the dislocation is of long-standing, it is obviously impossible to obtain satisfactory reduction by mere manipulation, as the alterations in the radio-ulnar joint entirely preclude this. We have, however, obtained satisfactory results by cutting down upon the articulation in the manner just described, and removing the head of the bone (see p. 43). The sigmoid cavity is then cleared of fibrous tissue, and the upper end of the bone is pressed back into position. If enough bone be removed to enable full flexion to be carried out, the result is satisfactory. It is well to introduce some soft tissues between the upper end of the radius and the humerus and ulna so as to prevent bony union between the radius and the ulna (see p. 153). A flap of fascia may be obtained from the outer side of the upper part of the forearm, the base of the flap being over the ulna.

The wound is sewn up without a drainage-tube, and no splint is employed; a mass of dressing is put on to immobilise the joint, and the arm is carried in a sling. The passive movements of pronation and supination are practised from the day following the operation, and as soon as the wound has healed, the patient is encouraged to move the arm.

'PULLED ARM.'—Before leaving the question of dislocation of the head of the radius, it is necessary to refer to those cases, so frequently met with in children, in which severe pain is felt in the neighbourhood of the superior radio-ulnar articulation accompanied by loss of pronation and supination, as the result of lifting the child up suddenly or swinging him round by the forearms. The child screams on any attempt to rotate the radius and the limb is powerless, and in a position midway between pronation and supination. Several explanations of this condition are put forward, the most probable being that the head of the radius has been partially withdrawn from the orbicular ligament, and that, as a result, folds of the synovial membrane covering the ligament lie over the head of the radius and are nipped between it and the articular surface of the humerus.

Treatment.—That this explanation is the most probable one seems proved by the fact that the condition is easily remedied under anæsthesia by fixing the elbow-joint, firmly grasping the wrist, and then suddenly pronating and supinating the arm fully, if necessary deflecting the whole of the forearm somewhat outwards. As a rule the head of the bone slips into position at once, and the movements of the joint become free and painless.

CHAPTER V.

DISLOCATIONS OF THE WRIST AND FINGERS.

DISLOCATIONS OF THE WRIST.

Dislocation of the carpus from the radio-ulnar arch is of rare occurrence, and usually results from heavy falls or violent blows upon the outstretched palm, the hand being bent backwards and the wrist-joint over-extended. The displacement may be either forwards or backwards, the latter being the more common form. The condition is difficult to diagnose from Colles's fracture, with which it is often confounded; the points of diagnostic importance are the maintenance of the normal relative positions of the styloid processes and the absence of any displacement of the hand to the radial side in dislocation.

TREATMENT.—This can be carried out without an anæsthetic. The dislocation is readily reduced by traction, which brings the articular surfaces into contact, and there is little tendency to recurrence of the deformity. It is well to lay the hand upon an anterior splint for a few days and to employ the ordinary evaporating lotions (see Vol. I. p. 9), as there is often considerable effusion into the joint and the tendon sheaths around it. Massage should be practised from the first.

The splint may be left off in a week and the arm kept in a sling for two or three weeks longer, whilst massage and passive movement are persevered with. The result is usually satisfactory.

DISLOCATIONS OF THE CARPAL BONES.

Dislocation of one carpal bone from another, is not nearly so rare as was at one time supposed; it usually occurs in connection with crushes of the hand or run-over injuries. Some 'sprains' of the wrist are examples of this injury, and it is always advisable in doubtful cases to obtain a stereoscopic radiogram of the joint. In most cases it is best to remove the displaced bone. We have had a considerable number of

these cases, the bones most commonly dislocated being the scaphoid or the semilunar. The dislocation is sometimes accompanied by fracture, especially in the case of the scaphoid bone.

TREATMENT.—An attempt should be made to replace the dislocated bone by manipulations and pressure on the bone; an anæsthetic should be employed. If, however, a stereoscopic radiogram shows that the displaced bone has also become rotated, excision of that bone will be required (see Vol. II. p. 359).

DISLOCATION OF THE METACARPAL BONES.

Dislocation of the metacarpal from the carpal bones is of extreme rarity; when it does occur the metacarpal bones are usually displaced backwards.

TREATMENT.—The dislocation should be reduced by traction and pressure under an anæsthetic. After the bones have been brought into position, the hand should be placed upon a splint for a week and evaporating lotions employed. Massage and passive movements of the fingers and wrist should be begun from the first, as there is great tendency to stiffness after these accidents, especially in elderly subjects.

DISLOCATION OF THE PHALANGES.

The phalanges may be dislocated either from the metacarpal bones or from one another.

DISLOCATION AT THE INTER-PHALANGEAL JOINTS.

This injury results from falls or blows upon the oustretched finger. The displacement is generally lateral, although it may be backwards; it is not infrequently incomplete.

FIG. 23.—TIN FINGER-SPLINT. The oval portion lies in the palm, while the finger is received into the trough.

TREATMENT.—Reduction is effected by exerting traction upon the tip of the finger and bringing the phalanx into its proper line. After reduction, the digit should be put on a finger-splint (see Fig. 23) and evaporating lotions employed to reduce the swelling. Passive movement should be begun from the first and regularly practised, so as to prevent stiffness.

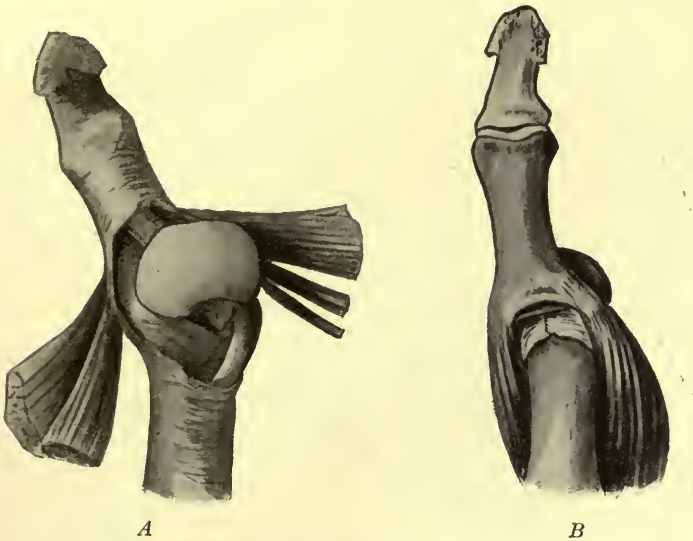
DISLOCATION AT THE METACARPO-PHALANGEAL JOINTS.

This accident is rare except in the thumb and the little finger—in the former of which it is not at all uncommon. As there are special difficulties in connection with reduction of dislocations of the thumb we shall describe this somewhat more fully.

DISLOCATION OF THE THUMB.—Dislocation of the first

metacarpo-phalangeal joint usually occurs from blows or falls upon the abducted thumb. The extremity of the thumb is driven backwards, so that the anterior ligament is overstretched and ruptured; the base of the first phalanx passes backwards, and the head of the metacarpal bone projects forwards through the rent in the anterior part of the capsule, the two sesamoid bones near the insertion of the flexor brevis pollicis also embracing the neck of the bone, one on either side. The ruptured glenoid ligament is carried backwards on to posterior surface of the neck of the metacarpal, and forms another obstacle to reduction (see Fig. 24).

Treatment.—In a recent case, reduction is attempted by trying to



A *B*

FIG. 24.—DISLOCATION OF THE THUMB. *A* is a view from the palmar surface showing the head of the metacarpal bone projecting between the heads of the flexor brevis pollicis. *B* is a view from the dorsal surface showing how the remains of the glenoid ligament is carried on to the dorsal surface of the metacarpal. The dotted line shows where it is divided.

disengage the head of the metacarpal bone from the flexor brevis which embraces it and also to pass it back through the rent in the capsule. The metacarpal bone of the thumb is flexed into the palm and firmly fixed by one hand, whilst the thumb is grasped with the other and hyper-extended almost to a right angle, strong traction being also exerted (see Fig. 25). The object is to disengage the anterior edge of the base of the phalanx from the posterior aspect of the head of the metacarpal. It is often difficult to apply sufficient traction with the unaided fingers, but considerable help may be got either by a clove-hitch around the thumb or by special forceps invented for the purpose (see Fig. 27). When sufficient traction has been applied in the hyper-extended position, the

base of the phalanx is firmly pushed forwards and the thumb is rapidly flexed into the palm (see Fig. 26). By adducting the thumb, the flexor brevis pollicis is relaxed, and by the extension applied to the phalanx the orifice in the capsule through which the head of the metacarpal bone has passed is brought opposite to the head of the bone; by continuing the extension and suddenly flexing the joint, the head of the metacarpal bone is made to pass back through the opening in the capsule.

FIG. 25.—METHOD OF REDUCING A DISLOCATION OF THE THUMB. *First Stage.* The metacarpal bone is pressed well down into the palm with the left hand while firm downward pressure is exerted by the thumb against the base of the phalanx which is hyper-extended by the right hand.

Frequently, however, it is impossible to reduce these dislocations in this manner, and, when that is the case, subcutaneous or open operation is called for; in our opinion the latter method is the best. A median incision is made over the palmar surface of the articulation, and the protruding head of the matacarpal bone is at once exposed. It is then easy to define the encircling tendons of the flexor brevis pollicis, and also the rent in the glenoid ligament. The tendons of the flexor brevis are hooked aside and the torn portion of the glenoid ligament is pulled

out of the way. The head of the bone can then be pressed into position, extension being employed at the same time.

The rent in the capsule is closed by catgut sutures, the wound sewn up, and a moulded splint of block tin or guttapercha (see Fig. 23) applied on the anterior surface of the thumb. The splint consists of a trough in which the thumb lies, embracing about half the circumference of the digit

FIG. 26.—METHOD OF REDUCING A DISLOCATION OF THE THUMB. *Final Stage.* The thumb is firmly and fully flexed into the palm while the base of the phalanx is kept well pushed down.

and having a broad extension over the palm of the hand. Passive movements may be begun at the end of the first week.

Some surgeons divide the resisting structure subcutaneously. The chief structure to be divided is the glenoid ligament, and this is done as it lies on the posterior aspect of the neck of the metacarpal bone (see Fig. 24, *B*). The knife is introduced from the dorsal surface of the thumb, just above and to one side of the centre of the base of the phalanx, avoiding the extensor tendon, which can usually be felt; its

point should be carried upwards along the neck of the metacarpal bone. After the ligament has been divided, the manipulations described above will generally reduce the dislocation. It is however difficult to carry out the subcutaneous incision effectually, and it cannot be recommended in preference to the open method.

When the dislocation has remained unreduced for a long time, it will

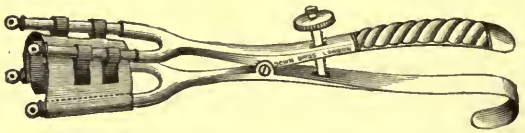


Fig. 27.—Forceps for reducing Dislocations of the Thumb. The traction is made by these forceps in an exactly similar manner to that shown in the preceding figures.

be necessary to remove the head of the metacarpal bone. This is a simple operation, and, if sufficient bone be taken away, the raw end of the bone covered by a flap of soft parts according to Murphy's method (see p. 153), and passive movement properly carried out, a satisfactory result will be obtained. It is seldom necessary to remove any portion of the phalanx.

Similar procedures may be required for dislocations at other metacarpo-phalangeal joints.

CHAPTER VI.

DISLOCATIONS OF THE HIP.

TRAUMATIC dislocation of the hip usually occurs in healthy adult males as the result of severe violence applied to the lower extremity while the hip-joint is flexed and abducted; similar violence applied to the fully extended limb is more likely to give rise to a fracture of the neck of the femur than to a dislocation. The spontaneous and congenital forms of dislocation are dealt with elsewhere in connection with diseases of joints and deformities respectively.

VARIETIES. — The traumatic dislocations are divided into (1) the *regular* dislocations of the hip, which comprise the posterior and the anterior dislocations; and (2) the *irregular* dislocations, in which there is coexisting injury to structures which remain intact in the regular forms.

The points that have to be remembered in connection with these dislocations are: that the acetabulum is shallowest at its lower part—where it is also somewhat defective—and that a very strong ligament, called from its shape the Y-ligament, extends from the region of the anterior inferior spine of the ilium downwards across the front of the joint and ends in two bands, one of which passes vertically downwards to the base of the lesser trochanter, whilst the other runs horizontally outwards to be inserted into the outer and upper end of the anterior inter-trochanteric line. This ligament is very strong, and great violence is required to rupture it. The Y-ligament is the principal factor that determines the particular form of the displacement; in the regular dislocations it is always intact. It is, moreover, one of the chief agents in aiding reduction.

Another structure that plays an important part in dislocations of the hip is the tendon of the obturator internus muscle. This muscle arises from the inner surface of the obturator foramen and the fascia covering it, passes out of the pelvis through the lesser sacro-sciatic notch, where it is joined by the two gemelli, and with them is inserted into the digital fossa at the back of the femur. The tendon acts as a powerful reinforcement

to the posterior part of the capsule of the joint, and determines the particular form of dislocation when the head of the bone is dislocated backwards; when the head of the bone lies below the tendon, the displacement is known as a sciatic dislocation, and when it lies above it, as a dorsal dislocation.

The regular dislocations are all primarily sub-cotyloid, as the head of the bone always escapes from the acetabulum at its lower part, the inferior portion of the capsule being torn. The sub-cotyloid position is, however, one of unstable equilibrium, and a further displacement invariably occurs, the head always passing either backwards or forwards, the direction that it takes being mainly determined by the direction of the force producing the injury, and the position of the limb at the time of the accident.

The Regular Dislocations.—The regular dislocations of the hip—namely, those in which the Y-ligament and the margin of the acetabulum remain intact—are divided into four groups, in two of which the head of the bone passes backwards, while in the remaining two it is found in front of the acetabulum. These dislocations are classified as follows :—

1. The most common are the backward dislocations, and of these the true *dorsal dislocation* is the more frequent. The head of the bone, after leaving the acetabulum, passes backwards and upwards around its posterior margin, and finally rests upon the dorsum ilii, above the tendon of the obturator internus.

2. Instead of passing above the obturator tendon, the head of the bone may rest below it, and is thereby guided backwards until it reaches the sciatic notch; this is termed the *sciatic dislocation.*

3. After leaving the acetabulum, the head of the bone may pass obliquely inwards and forwards until it rests over the obturator foramen—the *thyroid dislocation.*

4. In other cases, the head of the bone does not remain over the thyroid foramen, but travels upwards and inwards, and is then found in the neighbourhood of the spine of the pubes—the *pubic dislocation.*

Two other regular forms of dislocation are described, namely, the *supra-spinous*, in which the head of the bone lies above the anterior inferior iliac spine; and the *everted dorsal* form, in which the head of the bone lies upon the dorsum ilii, but is directed forwards instead of backwards. In both of these rare dislocations the outer limb of the Y-ligament is torn.

The Irregular Dislocations.—These are always accompanied by rupture of the Y-ligament or fracture of the acetabulum; hence the head of the bone, instead of passing out through the lower part of the capsule and then travelling either forwards or backwards, may leave the acetabulum anywhere, and generally passes upwards. Many of the signs characteristic of the regular dislocations are therefore absent.

TREATMENT OF THE REGULAR FORMS OF DISLOCATION.

In all the regular dislocations, manipulations designed to cause the head of the femur to pass back into position along the path that it followed as it escaped from the joint should be tried. Reduction may be effected in this way, without the necessity for pulling on the exceedingly powerful muscles which surround the joint. A general anæsthetic should always be employed, although the bone may sometimes be replaced without one.

FIG. 28.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY BIGELOW'S METHOD. *First Stage.* The assistant steadies the pelvis and the surgeon flexes the affected limb to its utmost limit, and at the same time slightly adducts it and rotates it inwards so as to disengage the head of the bone.

OF DISLOCATIONS BACKWARDS.—(a) **Dislocation upon the Dorsum ilii.**—When possible, the method of reduction by manipulation—called after Bigelow, who introduced it—should be attempted.

Bigelow's Method.—The patient is laid flat on his back upon the floor or a low couch, and the surgeon, standing on the affected side, raises the thigh, and flexes it fully upon the abdomen, whilst an assistant fixes the pelvis (see Fig. 28). The knee should also be flexed to a right angle, and is useful in the later stages as a lever for rotating the

limb. As the full flexion of the thigh is carried out, the femur should be rotated somewhat inwards and slightly adducted; by doing this the Y-ligament is relaxed, and the head of the bone is disentangled. When flexion has been carried to its fullest limit, downward pressure should be made upon the knee, so as to depress the head of the bone, and at the same time the limb should be strongly rotated outwards. Abduction is next carried out to its fullest limit (see Fig. 29), the result being that the head of the bone passes downwards behind the acetabulum, and then forwards to a point opposite the rent in the capsule. The limb is finally

FIG. 29.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY BIGELOW'S METHOD. *Second Stage.* The fully flexed limb is now abducted and rotated outwards to its utmost limit.

circumducted outwards, and brought down parallel to its fellow (see Fig. 30); the head of the bone is thus made to enter the rent and slip into the acetabulum. The success of these manœuvres depends upon the integrity of the Y-ligament, which forms a fixed point around which the head of the bone rotates.

Reduction by Traction.—Should reduction by manipulation fail, either because the opening in the capsule is too small, or because the Y-ligament has been injured, attempts should be made to reduce the dislocation by traction. The patient should be anæsthetised and laid upon his back, while an assistant fixes the pelvis. The surgeon flexes the hip

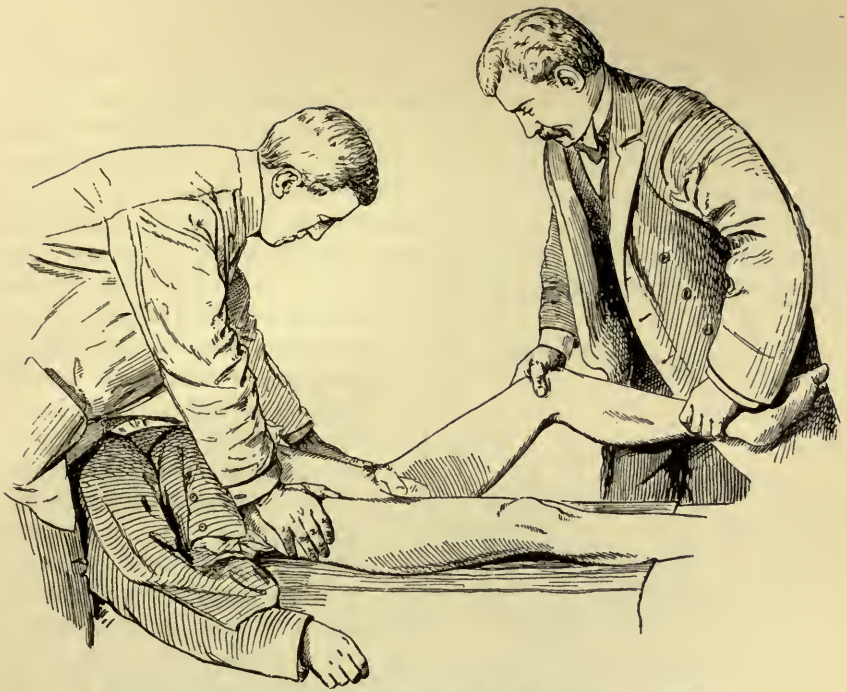


FIG. 30.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY BIGELOW'S METHOD. *Final Stage.* The limb is circumducted outwards and brought down to the middle line parallel with its fellow.

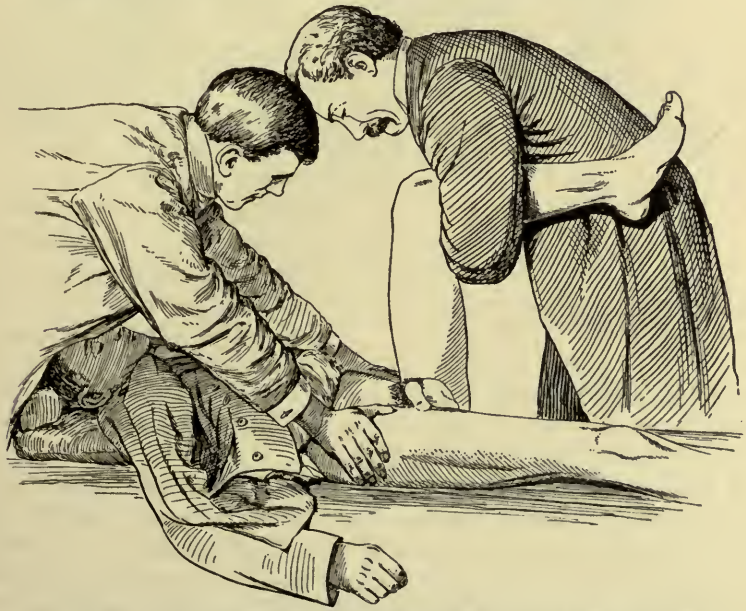


FIG. 31.—REDUCTION OF A DORSAL DISLOCATION OF THE HIP BY TRACTION. The pelvis is steadied by an assistant and the surgeon makes traction at right angles to the pelvis by grasping the limb as shown above.

joint to a right angle, and at the same time adducts and rotates the thigh inwards so as to disentangle the head of the bone (see Fig. 31). Firm vertical extension is then made upon the thigh, at first quite steadily and later on in a series of jerks; after a time, the head of the bone may slip into the acetabulum with a distinct snap. Should no assistant be available to steady the pelvis, this may be done by the surgeon's unbooted foot pressing directly downwards upon the anterior superior iliac spine of the same side. If the traction were exerted in the long axis of the body with the limb fully extended it would be ineffectual, as the Y-ligament would prevent the descent of the head of the bone, and is strong enough to bear without rupture more traction than the surgeon can employ. On the other hand, when the thigh is flexed to a right angle, the Y-ligament is relaxed and the head of the bone is allowed to pass back into place through the rent in the capsule (see Fig. 32).

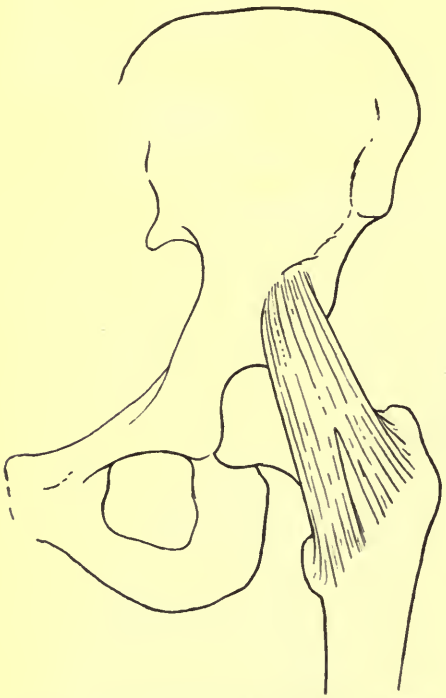


FIG. 32.—DIAGRAM OF THE ARRANGEMENT OF THE Y-LIGAMENT OF THE HIP.

After-treatment. — The tendency to recurrence of this dislocation is very slight. The patient should be put to bed and the lower extremities may be tied together, whilst evaporating lotions, or an ice-bag (see Vol. I. p. 9) are applied to reduce any swelling that may occur. Passive movement may be carried out after three days, and within a week the patient may walk. For some weeks, however, he should avoid too great flexion or abduction of the limb, because these movements might reproduce the dislocation as long as the rent in the capsule remains unhealed.

(b) **Dislocation into the Sciatic notch.**—In this case reduction is effected in a similar manner to that described above, except that the hip joint must be flexed as far as possible in the first instance so as to disengage the head of the femur from beneath the tendon of the obturator internus.

OF DISLOCATIONS FORWARDS.—The manipulations for the reduction of these dislocations must be the reverse of those just described.

(a) **Dislocation into the Thyroid foramen.**—*Bigelow's Method.*—The patient is anæsthetised and placed flat upon his back, whilst the pelvis is fixed and the thigh is flexed and abducted sufficiently to disengage the head of the bone from the obturator foramen. The limb is next rotated inwards, strongly adducted and then brought down parallel to its fellow, whilst the inward rotation is kept up (see Fig. 33). This has the effect of fixing the trochanter through the agency of the Y-ligament and the obturator internus tendon, whilst the head of the bone is forced upwards and outwards into the acetabulum.

Reduction by Traction.—Should manipulations fail, the patient should

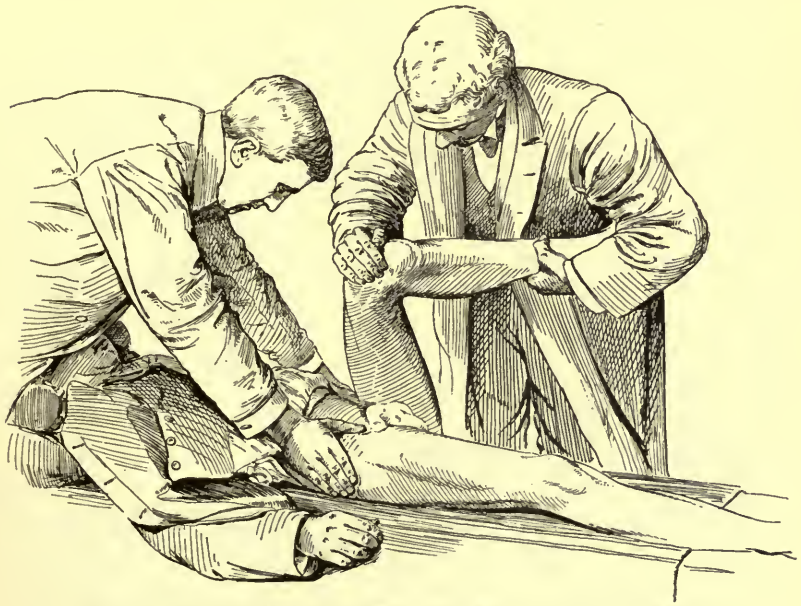


FIG. 33.—REDUCTION OF A THYROID DISLOCATION OF THE HIP BY BIGELOW'S METHOD. The limb is fully flexed, adducted and rotated inwards, and is finally brought down to the middle line by circumducting it inwards.

be placed upon the floor or a low couch, and the thigh flexed to a right angle, and slightly abducted so as to disengage the head of the bone. A strong jack-towel is passed transversely around the upper part of the thigh, and whilst an assistant fixes the pelvis, the surgeon makes extension vertically upwards with the limb rotated somewhat inwards, a second assistant pulling upon the towel so as to drag the head of the bone directly outwards (see Fig. 34). The combined traction should cause the head of the bone to pass into the acetabulum.

Should the surgeon fail with both the methods just described, the best thing is to convert the dislocation into one upon the dorsum ilii. This can generally be done by flexing the limb and then forcibly

circumducting it inwards. Indeed, it commonly happens during the attempts to reduce the dislocation that the head of the bone slips past the lower margin of the acetabulum and travels round upon the dorsum of the ilium. When a dorsal dislocation has thus been produced, reduction can be effected by the manipulations described on p. 55.

(b) **Pubic dislocation.**—In this form manipulations should be combined with traction, as there is generally difficulty in flexing the thigh to its full extent owing to the neck of the bone hitching against the brim of the pelvis. The patient is anæsthetised, and the thigh flexed as far as possible and abducted so as to disengage the head of the bone from the

FIG. 34.—REDUCTION OF A THYROID DISLOCATION BY TRACTION. This closely resembles the traction method for the dorsal dislocations, except that a second assistant makes traction outwards at right angles to the long axis of the femur with a towel passed round the limb, so as to pull the head of the bone outwards from the thyroid foramen.

brim of the pelvis. Outward traction is then applied by means of a jack-towel passed transversely around the upper third of the thigh so as to pull the head of the bone downwards and outwards and disengage it from the pubes. The limb can then be more fully flexed, and it should be further abducted and rotated inwards, which completes the disengagement of the head. The lateral traction may now be relaxed, and the dislocation can be reduced by rotating and circumducting the limb inwards, and finally bringing it down parallel to the sound limb as for reduction of thyroid dislocations. This plan of combining manipulation and traction aims at converting the pubic dislocation into the thyroid form by disengaging the head of the bone from the brim of the pelvis.

TREATMENT OF THE IRREGULAR FORMS OF DISLOCATION.

Manipulations are of no avail in the irregular dislocations, because the Y-ligament is torn and there is therefore no fixed point around which the head of the bone can be made to rotate. Traction downwards and forwards with the thigh somewhat flexed is the only procedure that is of use; while it is being carried out, the surgeon should alternately rotate the limb inwards or outwards, and also adduct or abduct it, according to the position that the head of the bone occupies with regard to the acetabulum; this will generally succeed in reducing the dislocation.

When the Y-ligament only has been torn, there is usually no difficulty in retaining the head of the bone in position after reduction, but it is expedient to keep the joint at rest for some weeks before the patient is allowed to stand, so as to facilitate the repair of this structure. The best splint to employ is a long Liston (see Vol. II. p. 371), but this must be taken off daily for passive movement.

When the margin of the acetabulum has been broken off, the after-treatment is much more difficult, as there is a constant tendency to recurrence of the displacement. It is imperative, therefore, to keep up extension in the fully abducted position—which is best done by weight and pulley (see Vol. II. p. 365)—until union of the fractured surfaces is complete. In the meantime careful passive movement must be carried out by the surgeon.

TREATMENT OF UNREDUCED DISLOCATION.

When a dislocation of the hip has remained unreduced for some time, marked changes take place in the joint. The head of the femur becomes broader than normal, whilst the acetabulum becomes shallower and may be filled up with fibrous tissue, which in parts may undergo ossification. The ruptured capsule becomes shortened and adherent, so that reduction of the dislocation is a matter of absolute impossibility after the lapse of a few weeks. It is impossible to reduce the dislocation if more than six weeks have elapsed from the time of the accident, and if reduction is deemed desirable operative measures will be necessary. In some cases, however, when the bones are fixed, and also when a long time has elapsed since the injury, an operation may not be necessary or desirable.

Operative Measures.—Immediately prior to operating for the relief of unreduced dislocation, the limb should be freely moved in all directions, and all movements should be carried to their fullest limit.

An incision is commenced just below the anterior superior iliac spine and carried downwards and forwards for about four inches in the interval between the tensor fasciæ femoris and the sartorius. The deep fascia of the thigh is divided, the muscles above mentioned are pulled apart,

and the region of the neck and head of the bone is exposed (see Fig. 35). In order to obtain satisfactory access to the acetabulum, it will generally be found necessary to detach the tensor fasciæ femoris and the anterior part of the gluteus minimus from the ilium, as they will be shortened, and will not only oppose retraction of the wound, but also interfere

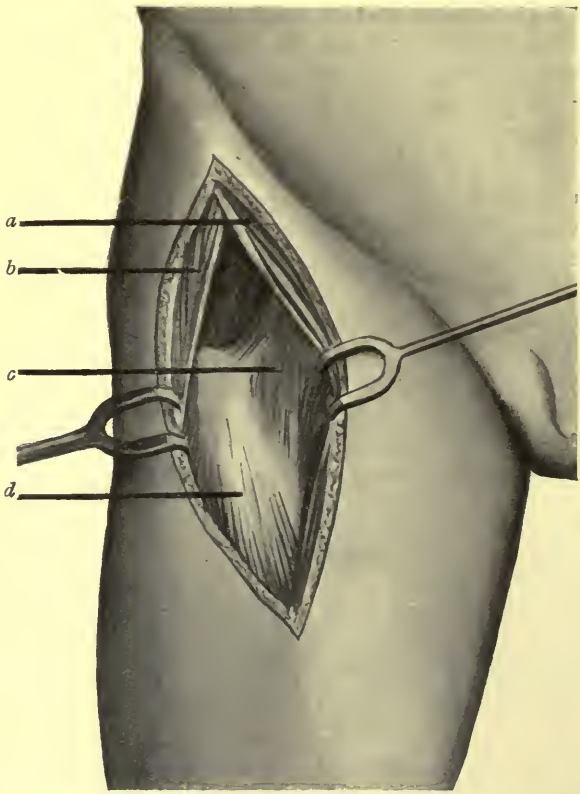


FIG. 35.—INCISION FOR EXPOSURE OF THE NECK OF THE FEMUR. *a*, Sartorius; *b*, Tensor fasciæ femoris; *c*, capsule of the hip-joint; *d*, Quadriceps.

with the extension of the limb necessary to bring the head of the bone into position.

The capsule is incised near its insertion into the neck of the femur and the Y-ligament defined and divided at that spot. The capsule is then pulled aside so as to expose the acetabulum, out of which any soft tissues must be cleared in order that it may receive the head of the femur. Traction is then effected by an assistant or by pulleys, and any resisting structures are divided; not infrequently the tendon of the obturator internus must be cut. The head of the bone can then usually be brought into the

acetabulum. The wound is sewn up without a drainage-tube, and the limb fixed upon a long Liston splint; if there is much shortening of the muscles, weight extension of seven pounds or more may be employed for the first three weeks, after which time the splint and extension may be discontinued, and massage and passive movements carried out. After six weeks the patient may get about with a crutch or stick, but he must not bear much weight upon the limb, and must not abduct or flex it to any great degree for at least another six weeks.

When, however, division of the resisting structures does not allow the head of the bone to come into position, better access to the deep parts may be obtained by enlarging the wound and sawing off the great trochanter obliquely and turning it aside along with the attached muscles. One can then get much better access to the head and acetabulum and can more easily replace the head of the bone in the acetabulum. After reduction has been effected, the trochanter is fixed to the femur by plates, the muscles attached to it being partially divided if they are much shortened.

When replacement of the head of the bone is not possible the following procedures may be considered:—

In bad cases with much pain from pressure on the sciatic nerve, excision of the head of the bone has been suggested. The functional result, however, is bad and excision should be avoided if possible.

If the pressure can be taken off the nerve, the best thing to do is to form a new acetabulum upon the iliac bone, in the position that the head of the bone occupies. To do this, a posterior incision is made and a portion of the pelvis is gouged away opposite the head of the bone, until a shallow bed is formed in which the head can lie. Instead of removing the portions of bone so raised, it is well to leave them attached at the upper end and then bend them up at right angles to the pelvis, so that they form a sort of buttress preventing the head of the bone being pulled farther up. In the course of a few weeks considerable callus is thrown out around the detached portions of bone, and thus an important obstacle to the further displacement of the head upwards is obtained. It is well to turn in a portion of fascia over the raw surface so as to prevent bony union (see p. 153).

The after-treatment consists mainly in the employment of extension for some weeks with the limb in the abducted position, so as to prevent the head of the bone being thrust up forcibly against the buttress, until the latter has undergone solidification. Passive movement should be carried out from the first.

When the unreduced dislocation of the femur is accompanied by fracture of the acetabulum, the condition is more difficult to treat. There can be no possibility of restoring the limb to its normal condition, but if the head of the femur slides up and down on the side of the pelvis an attempt

may be made to refresh the detached fragments of the acetabulum if they are sufficiently large, and to fix them to the pelvis, or if this is not feasible to scoop out the acetabulum and turn the fragments of bone up as before, so as to provide a buttress for retaining the head of the bone in position. Unfortunately the results are not satisfactory in either case.

CHAPTER VII.

DISLOCATIONS OF THE PATELLA.

THE accident may occur either from sudden violent contraction of the quadriceps or from a direct blow upon one edge of the bone. This dislocation is often associated with a lax condition of the ligaments, resulting from previous chronic synovitis with effusion, and is most common when genu valgum is present.

VARIETIES.—The patella may be dislocated outwards or inwards, or it may be rotated vertically upon its long axis. Of these, dislocation outwards is far the most common, no doubt owing to the fact that the patella lies more over the external condyle than over the internal. This is still more marked when any degree of genu valgum is present; indeed, when the knock-knee is excessive, the patella is displaced outwards whenever the knee is fully flexed.

DISLOCATION OF THE PATELLA OUTWARDS.

In this dislocation the capsule is torn over the inner condyle and the patella slips over the external condyle, and therefore lies upon the outer side of the knee. The accident may occur whether the knee is flexed or extended; when due to muscular action, it generally occurs with the knee bent.

TREATMENT.—Reduction may generally be accomplished without employing an anæsthetic. The knee-joint is fully extended and the thigh flexed upon the pelvis, so as to relax the extensors of the thigh, and then comparatively slight manipulation will cause the bone to slip into position.

After-treatment.—There is considerable synovial effusion as a result of the accident, and there may be some bleeding into the joint. The limb should be placed on a back splint, and cold—either in the form of an ice-bag or Leiter's tubes (see Vol. I. p. 10)—should be applied immediately after reduction. When the effusion has become stationary, its absorption may be aided by massage, and firm support should be afforded by a bandage applied outside a mass of cotton-wool.

The rent in the capsule takes some time to heal, and the patient must be careful in moving the knee. Passive movements must be employed from the first, and daily massage of the extensors of the leg should be begun as soon as hæmorrhage into the joint has ceased. The patient should not walk for at least three weeks and then it is well that he should wear either an elastic bandage around the knee or some form of elastic knee-cap for about three months to diminish the risk of recurrence. If knock-knee is present it should be treated (see Vol. I. p. 376).

DISLOCATION OF THE PATELLA INWARDS.

This rare condition generally results from a direct blow upon the upper and outer aspects of the bone. The treatment is similar to that of the variety just described; an anæsthetic may be necessary.

VERTICAL DISLOCATION OF THE PATELLA.

In vertical dislocation of the patella, the bone is turned upon itself through an angle of nearly 90° so that one edge is caught in the groove between the condyles of the femur whilst the other points directly forwards. The bone is usually twisted so that the anterior surface is directed outwards, while the articular surface looks inwards. It is almost always due to direct violence applied from the front and one side. The capsule is torn, usually over the internal condyle.

TREATMENT.—Reduction is readily accomplished if the patient be placed under an anæsthetic. When the quadriceps is relaxed, pressure should be applied to the anterior edge of the patella, so as to rotate the bone into position. If this be unsuccessful, it is probably because the upper part of the bone is engaged in the inter-condyloid notch, and downward pressure must be applied to overcome this. Should this fail, the knee may be flexed somewhat and the bone thus disengaged, when pressure upon the edge of the bone will cause it to slip into position.

Should the surgeon fail to effect reduction under an anæsthetic—which, however, is very unlikely—it may be necessary to make a small incision through the capsule on one side of the patella, and to introduce an elevator beneath the lower edge of the bone so as to lever it upwards while pressure is made upon the upper edge. The after-treatment in these cases is precisely similar to that for dislocation outwards.

UNREDUCED DISLOCATION OF THE PATELLA.

A dislocation of the patella may either be unrecognised, or reduction may have failed, and the patient may apply for relief weeks and even months after the occurrence of the injury. In such cases operation may give satisfactory results.

Two free vertical incisions are made through the capsule, one on

either side of the patella; from the one on the inner side an elliptical portion of the cicatricial tissue which represents the capsule is excised (see Fig. 36). Reduction is then quite easy. The important points are to divide the capsule on the outer side freely enough to allow the patella to come into place, and to excise through the inner incision enough of the capsule and the cicatricial tissue to keep the patella in position

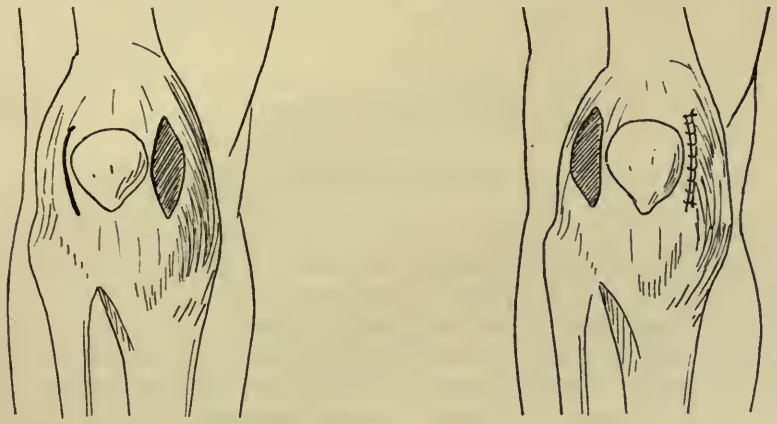


FIG. 36.—DIAGRAMMATIC REPRESENTATION OF THE OPERATION FOR UNREDUCED DISLOCATION OF THE PATELLA. *A, The first stage of the operation.*—A free vertical incision is made on the side of the patella towards which it is dislocated, while the cicatricial tissue formed about the rent in the capsule on the opposite side is excised by means of an elliptical incision. *B, The final stage.*—When the patella is pulled into position, the gap on the inner side is sutured, and the incision on the outer side becomes an oval aperture.

when the edges of the gap in the capsule are stitched together (see Fig. 36).

The limb is put on a back splint in the semi-flexed position, and, when the wound has healed, the treatment is similar to that of outward dislocation of the patella (see p. 65). Spontaneous movement, however, should not be allowed until five weeks after the operation, when the patient may be allowed to walk, wearing an elastic bandage.

CHAPTER VIII.

DISLOCATIONS OF THE KNEE AND ITS CARTILAGES.

DISLOCATIONS OF THE KNEE.

TRAUMATIC dislocation of the knee-joint is very rare, as might be expected from a consideration of the size of the joint and the strength of the ligaments concerned. Severe violence is required to produce dislocation, and hence these injuries are usually either compound or complicated by fracture of the bones in the immediate neighbourhood.

VARIETIES.—The knee may be dislocated forwards, backwards, or to one side, and the dislocation may be complete or incomplete; usually it is incomplete.

Dislocation of the Tibia forwards.—This may occur from direct violence, such as a severe blow upon the front of the femoral condyles when the limb is fully extended; the lower end of the femur is driven directly backwards. Generally, however, the accident occurs from indirect violence, as when the foot becomes caught in a hole and fixed, whilst the weight of the body carries the upper end of the femur forward, and thrusts the lower end forcibly backwards against the posterior ligament of the knee-joint, which gives way. The other ligaments of the joint are also ruptured to some extent. The popliteal vessels and nerves generally lie in the inter-condyloid notch of the femur and are pressed upon; should the artery be atheromatous it may be torn across. This is the most common form of dislocation.

Dislocation of the Tibia backwards, although common as a result of disease, is rarely of traumatic origin. It may result from violence applied either to the head of the tibia in front or to the lower end of the femur behind, the knee being in a flexed position at the time the injury is received.

Lateral dislocations of the knee are still rarer, outward dislocation being perhaps more frequent than the inward form. They are almost always incomplete.

TREATMENT.—As these dislocations are generally partial, reduction, as a rule, is readily carried out. The patient is anæsthetised, and the lower end of the femur is fixed by an assistant, whilst the surgeon makes traction on the leg and employs the movements necessary for the reduction of the dislocation. Thus, in dislocation of the tibia forwards, reduction is effected by traction followed by flexion of the knee. When the tibia is dislocated backwards, traction is also employed, and the head of the bone is pushed forwards into position. In lateral dislocations, traction alone may suffice, but if necessary lateral pressure may be made upon the tibia.

After-treatment.—The principal difficulty lies in the after-effects of the injury. Extensive damage is done to the joint, accompanied by considerable effusion of blood, and this is followed by a sharp attack of synovitis. Union of the ruptured ligaments must be aimed at, otherwise a permanently weak joint will be left. The limb should be put on a straight splint, and an ice-bag or Leiter's tubes (see Vol. I. p. 10) applied to diminish the effusion. Passive movement should be begun during the second week, generally under an anæsthetic at first, as the internal damage is considerable and movement will cause great pain. A firm leather splint may be moulded to the joint three weeks after the accident, and the patient allowed to get about. The splint is removed two or three times a day for movements and massage. As a rule it is necessary to wear a lace-up knee-cap for several months.

DISPLACEMENT OF THE SEMILUNAR CARTILAGES.

Either of the semilunar cartilages of the knee may be injured, generally as the result of some sudden strain, more particularly a twist of the leg on the thigh, such as occurs in playing football, lawn tennis, or any movement in which the leg is firmly fixed on the ground, while the body is twisted violently. The internal cartilage is much more often injured than the external.

The result is that sudden, and often excruciating, pain is felt in the joint, the patient may fall down and is frequently unable to straighten the limb for a time. In some cases a prominence, in others a depression, may be felt in the situation of the semilunar cartilage, and in some cases the patient may not be able to straighten the knee completely for some weeks. The injury is frequently followed by synovitis which may last for some days or even weeks. Not uncommonly the patient has further accidents of the same kind, the fact being that in many cases the injured cartilage does not recover completely, and, being more or less loose, moves in the joint and becomes caught between the tibia and the femur from time to time. It is important to note that the dislocation of the internal semilunar cartilage follows outward rotation of the tibia on the femur, while in the case of the external cartilage, the rotation is inwards.

The lesions in the cartilage are of various kinds; sometimes it is split

more or less longitudinally, in other cases it is divided transversely. In some cases the main portion of the cartilage is torn from its connection with the tibia, but remains attached to the spine of the tibia at both ends. In others, one of the ends attached to the spine of the tibia is torn through and the free part curls up in the inter-condyloid notch and becomes nipped between the ends of the bone. The exact lesion of the cartilage, however, cannot be clearly made out until the joint is opened.

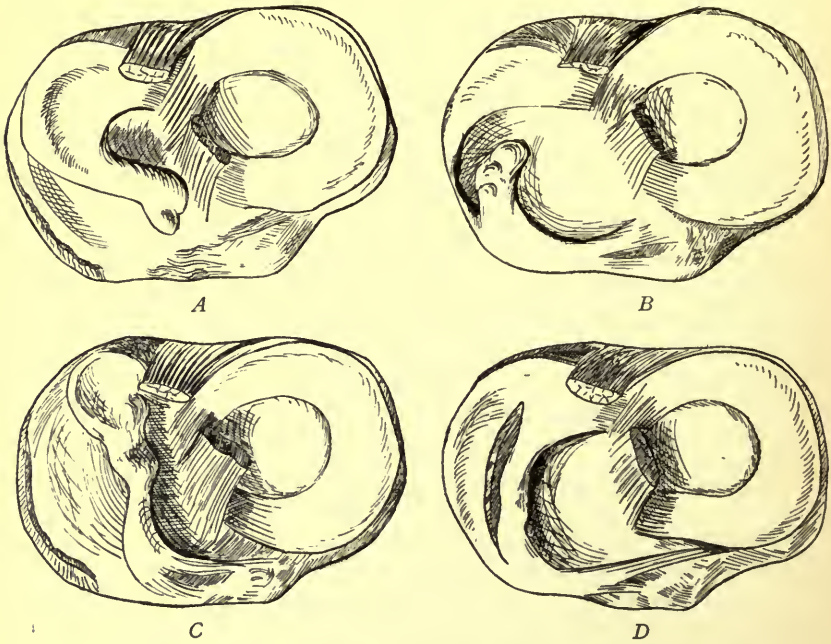


FIG. 37.—INJURIES TO THE SEMILUNAR CARTILAGES. The sketches show the usual types of injury to the semilunar cartilages. In *A* the anterior end is torn away from its attachment; in *B* the cartilage is torn nearly across about its middle; in *C* the periphery is torn loose from the head of the tibia; in *D* there is a longitudinal rent in the cartilage.

TREATMENT.—It is well to consider the treatment under two headings: cases that are seen immediately after the occurrence of the first injury; and cases in which the trouble is constantly recurring.

In cases seen immediately after the injury, the first thing to do is to try to reduce the displaced cartilage. This can be accomplished by flexing the joint completely in order to disengage the cartilage from between the condyles, and then, while keeping up pressure over the side of the articulation, suddenly extending the leg, at the same time rotating the foot inwards (if the internal cartilage has been damaged), or outwards (if it is the external which is at fault). This manipulation should be repeated several times until the joint moves smoothly, and there is no

obstacle to complete extension. After the cartilage has been replaced, it is well to put on a posterior splint for two or three days, and apply cold so as to diminish the effusion into the joint. After that time the splint should be left off and massage and passive movement should be employed daily for about half an hour at a time. After the effusion has disappeared, the massage may be limited to the muscles of the thigh, the object being to keep up the tone of the muscles, and prevent the atrophy which might otherwise occur; it should be continued for about six weeks. As soon as the swelling has disappeared, the patient may be allowed to walk about, but only to a moderate extent, and it is well to strap the joint for a few days.

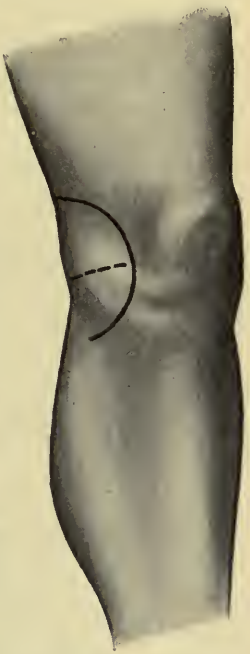


FIG. 38.—INCISION FOR REMOVAL OF THE INTERNAL SEMILUNAR CARTILAGE. The thick line indicates the incision marking out the skin flap, the dotted one, that through the capsule of the joint.

In recurring cases, the displacement often takes place after the most trivial injury. The patient is in constant danger of falling, whilst the usefulness of the limb is much diminished, and there are frequent attacks of synovitis, for which he has to lie up. Under such circumstances there is little chance of curing the trouble in any other way than by operation. If, however, the patient declines to have an operation performed, an attempt must be made to replace the cartilage by the manipulations previously described. He should also be told to keep his knee more or less stiff when walking, and when the internal semilunar cartilage is at fault, he should remember to keep his toes well turned in. Massage to the muscles of the thigh must be employed, while active movements against resistance should be carried out.

The object of the treatment is to strengthen the muscles of the thigh, so that they may hold the limb firmly and prevent the leg being everted. Splints do not seem to be of any particular value, the objections to them being that they are very uncertain as regards keeping the cartilage in its place, and that their use leads to atrophy of the muscles, and so prevents the limb regaining its strength.

Operative measures.—Operation is practically devoid of danger if carried out with careful antiseptic precautions, and the results obtained by it are excellent. It should not be undertaken, however, unless the surgeon is sure of keeping the wound aseptic. In the case of the internal cartilage an incision with its convexity forwards is made over the inner aspect of the knee commencing on the inner side of the joint about half an inch below the articular surface of the tibia and running upwards along the inner side of the patella (see Fig. 38). A flap of skin is

raised and turned backwards, so as to expose the front and inner part of the joint. The capsule is then incised horizontally about a quarter of an inch above the edge of the tibia, combined, if necessary, with a vertical incision at the anterior end. The joint cavity is then freely opened and the cartilage inspected. In all cases it is well to remove the cartilage as completely as possible; attempts to stitch it to the lateral ligament or to close any rents in it, are practically failures. In order to gain good access the knee should be flexed so as to increase the aperture in the capsule; the anterior end of the cartilage should be seized and pulled forwards forcibly while its attachments to the tibia are divided with a few touches of the knife. A tenotomy knife is then introduced as near as possible to the posterior attachment, which is divided and the cartilage removed. In some cases it is very difficult to get quite to the back of the joint, but when the cartilage is firmly attached there, no trouble seems to result from leaving a small portion behind. All bleeding points are now tied, any blood-clots washed out of the joint by sterilised saline solution and the incision in the synovial membrane closed with catgut stitches. It is well to leave a little interval between the stitches, so that any fluid that forms in the joint may escape into the cellular tissue, and thus be more readily absorbed. The fibrous capsule is next sewn up and the wound closed, antiseptic dressings applied, and the limb placed upon a pillow. No splint is necessary and the patient may move the joint in bed from the first. In about a week the stitches may be taken out and active and passive movements should be begun, and gradually increased in range. Massage should also be carried out, especially over the muscles of the thigh, and about ten days after the operation, if there be no marked effusion into the joint, the patient may begin to walk. For the first week or two it is well to support the joint by an elastic bandage applied over a mass of wool in order to prevent synovial effusion.

CHAPTER IX.

DISLOCATIONS OF THE ANKLE AND FOOT.

DISLOCATIONS OF THE ANKLE.

Dislocation of the ankle-joint is not infrequent, but in most cases there is also fracture of one of the bones entering into the articulation; dislocation of the ankle without fracture only occurs in a forward or backward direction, and even in these forms the tip of one or both malleoli may be broken off. The commonest form of dislocation—*i.e.* the dislocation outwards that is met with in connection with fracture of the lower end of the fibula (Pott's fracture) — has already been described (see Vol. II. p. 416).

Fig. 39.—Dislocation of the Foot Backwards. The entire tarsus is carried backwards.

Of the two forms of dislocation uncomplicated by fracture, *dislocation of the foot backwards* is the more common. The tarsus is carried bodily backwards behind the tibio-fibular arch, which therefore lies in front of the astragalus and rests upon the scaphoid and cuboid bones. The accident generally results from severe indirect violence applied when the toes are pointed; the internal malleolus is not infrequently fractured. *Dislocation forwards* also occurs from indirect violence, but generally when the foot is in a position of excessive dorsal flexion.

TREATMENT.—An anæsthetic is administered and an assistant fixes the leg whilst extension is applied to the foot; as downward traction is made, the deformity is increased in order to disentangle the edge

of the astragalus from the tibio-fibular arch against which it is lodged. When sufficient traction has been made, the foot is either flexed or extended according to the nature of the displacement; when the foot is displaced backwards, the plantar-flexion of the foot is increased, the foot is pulled forcibly forwards and downwards, and then rapidly dorsi-flexed. In a dislocation of the foot forwards, movements in the reverse direction are practised; traction is made and the dorsal flexion is increased; then, while traction is maintained, the foot is pushed backwards and is finally plantar-flexed.

Movements should be begun on the day following the accident; the after-treatment will be practically that for fracture of the lower end of the tibia or fibula, as the case may be.

DISLOCATIONS OF THE FOOT.

SUB-ASTRAGALAR DISLOCATION.

In this type of injury the whole of the foot undergoes dislocation with the exception of the astragalus, which remains in position beneath the tibio-fibular arch. The essential lesions are rupture of the connections between the astragalus and the os calcis, on the one hand, and those between the former bone and the scaphoid on the other. The foot usually undergoes a double displacement, being dislocated either forwards or backwards and to one side; the most common displacement is backwards and outwards, and in this form the head of the astragalus rests upon the upper surface of the scaphoid or the internal cuneiform. The posterior articular surface of the astragalus generally lies upon the anterior articular surface of the os calcis, the dislocation at the calcaneo-astragaloid joint being only partial.

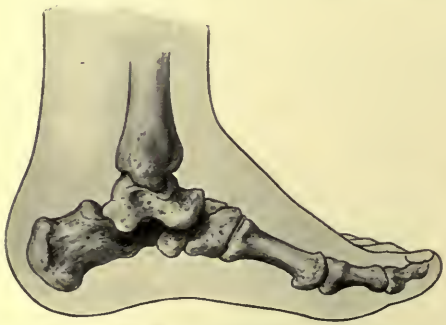


FIG. 40.—SUB-ASTRAGALAR DISLOCATION. In this case the astragalus remains in place beneath the tibio-fibular arch.

The injury is generally produced by indirect violence, such as occurs when a patient alights from a height upon the toes, which are deflected to one side, while the weight of the body forces the ankle and the astragalus forwards and to the other side. The lateral displacement depends upon the particular position of the foot when the violence is applied. In the usual form the foot is extended, and there is a prominence on the instep in the neighbourhood of the scaphoid due to protrusion of the head of the astragalus. The tendo Achillis is widely separated from the back of the tibia and is very tense, whilst the heel is unduly prominent.

TREATMENT.—Reduction is often very difficult owing partly to the tension of the tendo Achillis, and partly also to hitching of the sharp posterior edge of the articular surface of the astragalus in the interosseous groove of the os calcis; in some cases also the tendon of the tibialis anticus may be caught beneath the neck of the astragalus.

Before attempting reduction the patient should be anæsthetised, and an assistant must fix the leg with the knee fully flexed. The surgeon then grasps the foot with one hand over the instep and the other over the heel, and makes firm downward traction in order to disengage the astragalus; at the same time the toes should be depressed. When full extension has been made, the whole foot is pressed forwards by the hand over the heel, when the os calcis may be forced into place, dorsal flexion being employed as the dislocation becomes reduced. These manipulations often have to be repeated several times before they succeed; they may be unsuccessful even after repeated trials.

Should manipulations fail, the dislocation cannot be left unrelieved, on account of the extreme uselessness of the foot which results and the risk of sloughing of the skin; an incision should therefore be made along the inner border of the foot, commencing about an inch above the internal malleolus, and running downwards and forwards over the neck of the astragalus. This exposes the tendon of the tibialis anticus, and allows the nature of the obstacles to reduction to be investigated. Should the main obstacle be the slipping of the tibialis anticus tendon beneath the neck of the astragalus, the head of the bone can be levered up, and the tendon hooked aside whilst the foot is forcibly pushed forwards into place.

Should it still be found impossible to reduce the dislocation, the best treatment is to proceed immediately to *excision of the astragalus*, which can be effected partly through the incision already made, and partly through a somewhat similar one on the outer side. This operation and the after-treatment are described fully in Vol. I. p. 332. In cases in which the dislocation has remained unreduced for some time, excision of the astragalus, with division of any adhesions which prevent the foot coming forward, is the best plan, and gives a satisfactory result.

DISLOCATION OF THE ASTRAGALUS ALONE.

The astragalus may be detached from the bones of the leg above and those of the foot below, and may thus be separated completely from all its connections. It may be displaced in various directions; most commonly it passes directly forwards, or forwards and to one side, but in some cases it may be dislocated backwards. The injury is caused by severe violence, and is frequently complicated by fracture of the bone itself; it may be compound, either as a direct result of the violence, or from sloughing of the skin which is tightly stretched over the prominent head of the bone.

It usually results from violence applied to the foot in the fully plantar-flexed position, as may occur in alighting from a height upon the toes, or in machinery accidents, where the limb is violently pulled and twisted. Dislocation backwards is produced by extreme violence applied whilst the foot is fully dorsi-flexed, but this is a very rare accident.

FIG. 41.—DISLOCATION OF THE ASTRAGALUS FORWARDS AND INWARDS. The toes are pointed and the astragalus projects very markedly on the inner side.

TREATMENT.—The knee should be flexed under full anæsthesia and the leg fixed by an assistant. Traction is exerted upon the foot so as to separate the os calcis as far as possible from the tibio-fibular arch. While this is maintained at its utmost extent, attempts are made to press the astragalus back into position between the os calcis and the tibia. The separation of the bones of the foot from those of the leg may be aided by dividing the tendo Achillis. It is seldom possible to get the bone into place by these means, however, and in that case immediate operation is imperative, otherwise gangrene of the skin over the projecting bone is almost certain to follow. The best plan is to make an incision on each side of the front of the ankle—that on the inner side commencing an inch above the articular surface, just in front of the malleolus, and running downwards and forwards to the internal cuneiform bone; that on the outer, running from just above and in front of the external malleolus downwards and forwards to the cuboid. In deepening the inner incision the tendon of the tibialis anticus should be preserved, and the tissues lying over the astragalus should be separated from the bone so as to enable the condition of the parts to be investigated; it may then be possible to press the astragalus into position by making forcible traction upon the foot. Should the surgeon fail to replace the bone it must be removed. The functional result should be excellent.

OTHER DISLOCATIONS OF THE TARSUS AND METATARSUS.

The remaining dislocations occurring about the foot need no detailed description.

Cases of *dislocation at the transverse tarsal joint* have been recorded; should this form occur, it must be reduced under an anæsthetic by making firm traction upon the front part of the foot.

The metatarsal bones may be dislocated from the tarsus either individually or as a whole. This accident is usually the result of extreme violence, and is generally accompanied by other injuries.

Reduction is effected under anæsthesia by making traction upon the front part of the foot and applying pressure over the prominent bases of the metatarsal bones.

Dislocation at the metatarso-phalangeal joints also occurs. These injuries are very like the corresponding dislocations occurring in the hand (see p. 48), but they are of much greater rarity; the treatment is exactly similar.

CHAPTER X.

SPRAINS OF JOINTS.

By a sprain is understood an injury produced in a joint when its movements are carried beyond their normal physiological limits or when the bones entering into its formation are deflected in some unnatural direction without undergoing actual dislocation. The most common injuries are falls with the limb in an abnormal position, or twists when the lower part of the limb is fixed. Sprains may also be caused by violent muscular action, but this is a much less frequent cause than those already mentioned.

Various conditions predispose to sprains. Amongst the most common are a previous injury of a similar nature which leaves a weak joint behind it, or anything, such as a deformity—for example, knock-knee, or club foot—which places the joint at a mechanical disadvantage and alters the normal line of transmission of the body-weight.

The actual *lesion* which occurs when a joint is sprained varies in different cases and is often difficult to determine. Probably the chief effect of the injury falls on the ligaments of the joint, and they are damaged to a more serious extent than any other structure entering into the articulation. In the mildest forms the ligaments are merely over-stretched. In the more severe cases a portion of the capsule of the joint is ruptured, and some of the ligaments are torn wholly or in part from their attachments to the bones. The amount of damage to the ligaments depends largely upon their form, strength, and structure ; broad, thin, flattened ligaments are more often damaged than comparatively thick and strong ones. Very severe injury is required to tear the latter, and it is more common to find them detached from their insertion into the bone. In joints furnished with an inter-articular fibro-cartilage this structure may be partially or entirely detached—a condition which gives rise to the series of symptoms referred to in connection with displacement of the semilunar cartilages of the knee. In the most serious cases of all, the sprain may be combined with a

fracture, small portions of the bone being detached along with the ligament. Bony injuries varying from a split to actual detachment of a fragment are very common. For example, many so-called 'sprains of the wrist' are really fissured fractures of the radius or one of the carpal bones, especially the scaphoid. These fractures are not very obvious: a radiogram should, therefore, always be taken in so-called sprains. In some of these bad forms of sprain the injury may involve the muscles surrounding and strengthening the joint, and these may be torn from their attachments.

The immediate effect of these injuries is pain, followed by swelling of the joint. Unless efficiently treated, a feeling of weakness and pain in the joint may last for a long time or may even be permanent.

When the ligaments are stretched rather than torn, there is comparatively slight swelling immediately after the accident, but an obstinate synovitis may subsequently occur. In the more severe cases there is effusion of blood at the time of the injury, and this produces immediate swelling of the joint which is increased later on by the occurrence of synovitis. When there is much hæmorrhage, the blood is only slowly absorbed from the articular cavity and it may remain fluid for a long time. When a large area of the joint capsule or a broad flat ligament has been ruptured, the torn portion may project into the joint, and become nipped during movement and thus give rise to serious disability.

The remote effects of sprains are due partly to the synovitis and partly to imperfect union of the torn fibres of the capsule. The latter condition is especially troublesome and gives rise to that feeling of weakness which is so common a result of neglected sprains. The synovitis also is apt to be followed by adhesions in the joint, or even to obliteration of a portion of the joint cavity.

It is thus evident that a sprain of a joint should not be lightly treated, as the serious trouble that so frequently follows the injury is largely due to imperfect appreciation of the ill-results that follow neglect. The common saying that a sprain of a joint is worse than a fracture is explained by the fact that the care devoted to a fracture is seldom bestowed upon a sprain, with the result that fluid blood remains in the joint for a long time, that the union of the torn ligaments is defective, that there is a tender cicatrix in the capsule, and that fibrous adhesions form between the opposed synovial surfaces.

TREATMENT.—The treatment of a sprain depends largely upon the severity of the injury and the joint affected, but there are certain principles common to all cases. The first indication is to check the extravasation of blood into the joint, while the second is to promote absorption of the blood already poured out; a third and equally important indication is to obtain satisfactory healing of the injured ligaments, and to restore the movements of the joint to their full degree.

In every instance the treatment for a sprain should commence with full movement of the joint in all directions, so as to make sure that no portion of torn capsule or synovial membrane is left between the articular surfaces. Should this be the case, suitable movements of the joint will probably cause them to become disengaged.

1. *Slight sprains.*—After having moved the joint and ascertained that the movements are free, the surgeon should strap the part firmly with rubber strapping, and for the first twelve hours it is well to apply an icebag so as to diminish any bleeding or effusion which may take place. On the following day the patient may be allowed to move the joint, and walk about. If the strapping is put on properly, the movements of the muscles and joint have practically the same result as external massage: they promote the lymph flow and lead to rapid absorption of the effusion. Further, the pressure diminishes the effusion, and the movement prevents the formation of adhesions. The strapping should be kept on for about a week, being renewed if necessary, and as a rule, no further treatment will be required, or at most a little external massage, for about another week. The strapping must not be limited to the joint, however, but should extend well above and below it. For example, in the case of a sprain of the ankle-joint, the strapping must be applied from the toes nearly to the knee; it must not be limited to the ankle-joint (see Fig. 42). When, however, the sprain affects a joint, such as the hip, in which this treatment is not applicable, external massage, at first gentle, but soon becoming more vigorous should be employed, combined with active and passive movements.

FIG. 42.—METHOD OF STRAPPING THE LIMB FOR A SPRAIN OF THE ANKLE.

2. *Severe sprains.*—When actual rupture of ligaments has taken place, the patient may not be able to bear passive movements, or to use the joint in the early stage, and the treatment consists in massage and elastic pressure. At first the massage should be used once, and subsequently twice a day; in the early stage it should be quite gentle. At the same time it should be combined with such passive movements as the patient can bear, care being taken that the movements employed are not such as would stretch the sprained ligaments and prevent their union. After the massage the joint should be wrapped up in a mass of wool and a firm elastic bandage applied outside it; this should not only surround the joint itself, but should also extend for some distance above and below it. After about ten days, when the joint has become less tender, it may be strapped, and active movements permitted, as in the case of slight sprains. When massage is necessary, however (and

in the more severe forms it may be required for two or three weeks longer), it is more convenient to continue the elastic bandage; indeed, in bad cases, it is as well to wear the elastic bandage or strapping for some six weeks or more. If treated in this way the majority of sprains, without extensive rupture of ligaments, recover without any trouble.

Should a feeling of weakness still persist in the joint (and this is not uncommon), benefit will be derived from douching it for about three minutes at a time with a jet of water as cold as can be borne, with as much force as the patient can stand. This should be followed by massage, and the application of a firm bandage.

3. *When a ligament is ruptured,* there is considerable risk of imperfect union and a permanently weak joint, unless great care be taken in the early treatment. This is especially the case in the ankle-joint, where a portion of one of the lateral ligaments is not infrequently ruptured. In these cases the limb should be fixed on a splint, so designed as to obviate all possibility of movement in directions that would separate the torn ends. Massage should also be employed, special care being taken not to pull on or strain the ruptured ligament. It is desirable that the person who performs the massage should be acquainted with the anatomical structure of the joint, and it should be done by the medical man himself in the first instance. Something like six weeks' complete rest is required for the union of a ruptured ligament, and during that time care must be taken to prevent the formation of adhesions by practising passive movements almost from the commencement. If care is taken not to stretch the torn ligaments the passive movement will permit union, and at the same time leave the joint free from adhesions; but if the joint is simply placed on a splint and left for six weeks without massage or passive movement, severe and possibly intractable adhesions are very likely to form.

When portions of bone have been detached along with the ligament, the limb should be put on a splint and massage and careful movements employed after the first two or three weeks. Should the detached piece of bone be large or should there be any difficulty in getting it into position, a better result will be obtained by cutting down upon it and fastening it in place (see Vol. II. p. 304) or by removing it altogether.

CHAPTER XI.

WOUNDS OF JOINTS.

In speaking of wounds of joints, we shall confine ourselves to wounds which actually penetrate the articulation—a condition recognised in most cases by the escape of synovial fluid or, when the wound is of large size, by actual inspection. Non-penetrating wounds of joints are not, strictly speaking, wounds of the articulation at all, their only importance being that they may be accompanied by sepsis, which may ultimately lead to suppuration within the joint.

VARIETIES.—Wounds of joints may be divided into punctured wounds, and large wounds which freely expose the interior; the latter may be subdivided according as they are clean-cut or contused. The subsequent course may differ in each case. In a punctured wound there is often no introduction of septic material into the joint cavity; in the other forms, especially in contused wounds, septic contamination of the joint will almost certainly occur.

Distinction should also be made between wounds that are quite recent and those in which some hours have elapsed since their infliction. The importance of this lies in the fact that, in the former group, micro-organisms that have gained access to the joint will not have had time to multiply and become diffused throughout the joint and the surrounding tissues before the surgeon sees the case, whereas in the latter this will have taken place.

TREATMENT OF RECENT WOUNDS.

PUNCTURED WOUNDS.—It is generally safe in these cases to regard the articular cavity as free from infection; punctured wounds are inflicted by a slender pointed instrument, and the probability is that any organisms present upon it will be removed during its passage through the skin and subcutaneous tissues. This is a point of great practical importance, because it will not be necessary to open up the

joint and wash it out with an antiseptic. On the other hand, all the tissues superficial to the joint must be looked upon as being possibly infected, and treated accordingly.

The first step in the treatment is to disinfect the skin thoroughly for a considerable distance around the wound (see Vol. I. p. 100). The wound in the subcutaneous tissues should also be disinfected and for this purpose it is often necessary to enlarge the opening in the skin, and, considering the extreme gravity of these cases should the joint become infected, it is well to disinfect this part of the wound most vigorously; in most cases indeed it is advisable to apply undiluted carbolic acid to any visibly soiled parts.

A probe should never be used in order to ascertain whether the wound communicates with the joint. There is no particular object in obtaining this information; it is far better to assume that the joint has been penetrated, and to disinfect the wound in the skin and the soft parts without touching the joint. Beyond ascertaining that the capsule of the joint is wounded—which is not a matter that alters the treatment—the use of a probe may lead to the introduction of septic material from the wound to the interior of the joint, and thus precipitate a disaster which would otherwise not occur.

It is well to leave the wound widely open and not to insert any stitches. The edges of the wound may be allowed to fall together, and the limb is placed on a splint, with the joint in the most comfortable position.

After-treatment.—The dressings should be changed on the following day in order to ascertain the condition of the joint; but unless the temperature rises considerably, or there is severe pain and swelling in the joint, there need be no apprehension of septic infection. An injury of this kind frequently gives rise to considerable synovial effusion, and it is chiefly to ascertain the condition of the joint in this respect that it is advisable to change the dressings at this early period. If after the lapse of twenty-four hours there are no signs of inflammation in the wound, if the temperature is low and there is no more pain than can be accounted for by the effusion into the joint, it may be taken for granted that asepsis has been attained and the dressing need not therefore be changed for several days unless discharge comes through, or some other indication arises in the meanwhile. The limb should be kept at rest until the wound has healed, or at least is quite superficial, when the splint should be left off and passive movement begun.

CLEAN-CUT WOUNDS.—When the wound into the joint is large, retraction of the edges will generally suffice to enable the surgeon to make a thorough inspection of the articular cavity, but if not, suitable incisions must be made. In these cases it is well to assume that the joint has been infected, although the amount of infection may be slight.

In the first place the skin is shaved and disinfected, and the wound in the soft parts washed with 1 in 20 carbolic acid solution, undiluted

carbolic acid being applied to any part which is visibly soiled. To prevent these strong antiseptics passing into the joint a piece of sponge or a swab should be placed over the wound in the capsule so as to shut off the cavity of the joint for the time being. After the superficial wound has been disinfected, the interior of the joint should be examined, the opening in the capsule being enlarged, if necessary; all blood and clots should be flushed out by a stream of warm sterilised saline solution, and the joint should then be filled up with 1 in 20 carbolic lotion. This is left in for about ten minutes, so as to give the antiseptic time to act, and is then washed away with a stream of sterilised saline solution. Pure carbolic acid should be applied to any part of the joint which is visibly soiled. The vigour with which the disinfection is carried out should be governed to a great extent by the length of time that has elapsed since the wound was inflicted, as well as by the degree of soiling that has taken place. If, for example, the wound is quite recent and is not materially soiled, the bacteria are presumably free in the joint cavity, and irrigation of the joint with 1 in 20 carbolic solution for a short time will probably suffice to destroy them. If, on the other hand, some hours have elapsed since the injury, disinfection must be much more energetically carried out, because by this time the bacteria will have begun to spread into the tissues.

When the disinfection is complete, one or more drainage tubes are introduced into the joint, partly with the object of removing the synovial effusion which is certain to occur in considerable amount as the result of the irritation of the antiseptic, and partly also lest the disinfection should not have been successful. If the external wound is large, stitches may be inserted at each angle, but the greater part of it should be left open. The limb must be put on a splint in a comfortable position.

After-treatment.—As a rule the serous effusion will necessitate a change of dressing daily for the first week or more; but, should there be no rise of temperature or symptoms of acute inflammation about the wound after the first thirty-six hours, the fear of sepsis may be dismissed. The drainage tube should be retained for three to five days.

The limb must be kept upon the splint until the wound has become superficial, but gentle passive movement should be employed after the first three days in order to prevent the formation of adhesions in the joint. In doing this it is advisable to throw a large piece of gauze, dripping wet with a 1 in 2000 sublimate solution, over the wound after taking off the dressings, and then, keeping it in position by the hand that steadies the limb, to perform the passive movements. When the wound has become superficial, full movement of the joint should be carried out—in the first instance, under a general anæsthetic. This should be followed by massage and passive movement, which should be continued until the movements are completely restored.

When the attempt to obtain asepsis fails, the after-treatment must

be on the lines laid down for the treatment of septic wounds of joints (see p. 86); the condition is then practically the same as if the patient had not come under the surgeon's care until some days had elapsed since the injury.

CONTUSED WOUNDS.—Here the soft structures superficial to the joint are bruised, and as a rule there is marked soiling of the wound. We may take as the two main types of this kind of injury a machinery accident, in which the skin is torn and the joint opened, and a compound dislocation, in which the bones are forced through the skin. In both cases there is a contused lacerated wound in the soft tissues, and in both the joint cavity will be infected. In the first type the tissues will be much soiled by dirt or grease, while in the second the ends of the bones will be infected by clothing or by contact with the ground or some other object. An aseptic wound can hardly be hoped for unless disinfection be extremely carefully carried out, and these cases therefore are very serious.

A general anæsthetic is indispensable. The skin is shaved and disinfected, and the wound enlarged if necessary so as to expose all the recesses of the joint. All contused and lacerated parts must be cut away with scissors, and the raw surfaces saturated with 1 in 20 carbolic lotion; the whole wound external to the joint should then be sponged over with undiluted carbolic acid. It is important to remove the contused tags of tissue; it is not sufficient merely to apply undiluted carbolic acid to them, for the antiseptic may be unable to penetrate the whole of the soiled area unless the worst parts are clipped away.

The joint cavity is now laid freely open and any obviously soiled areas are disinfected with undiluted carbolic acid, the rest of the joint being washed out with 1 in 20 carbolic lotion. Should the injury be due to dislocation, this should be reproduced in order to get proper access to the ends of the bones, so that they may be cleaned thoroughly. If necessary, portions of cartilage or bone into which dirt is ground must be shaved off with a knife or a chisel. Finally the joint cavity is irrigated with sterilised normal saline solution ten minutes or a quarter of an hour after the application of the strong antiseptic—time being thus given for the antiseptic to act. This procedure doubtless seems severe, but the irritation resulting from thorough disinfection of this kind is small compared with the grave risk of sepsis, which will almost inevitably occur unless the joint surfaces are thoroughly cleansed. Large drainage tubes (Nos. 16 or 17) are introduced into the joint both through the wound and through counter-openings, so as to drain every recess. No attempt should be made to stitch up the rent in the capsule; a few stitches may be put in the skin if the wound in the soft parts is very large or irregular. The limb is put upon a splint in the position in which it will be most useful should anchylosis occur.

After-treatment.—Should sepsis occur, it will usually be indicated

by high fever and local inflammation within forty-eight hours; should the ordinary aseptic pyrexia subside in forty-eight hours, and should no local inflammation supervene, it may be confidently assumed that sepsis has been avoided, and the number and size of the drainage tubes may be reduced. A day or two later all the drainage tubes may be removed with the exception of a moderate-sized one which should be left for two days longer, when it also may be left out if all goes well. Daily dressings are necessary, and at each dressing the skin around the wound should be disinfected, and every means taken to avoid septic contamination.

The risk of subsequent stiffness is far greater here than in the preceding cases, and therefore passive movements should be practised every time the dressings are changed as soon as all danger of sepsis is over, the wound meanwhile being covered with wet gauze so as to prevent dust being sucked into the joint. When the wound has healed, it may be necessary to give the patient an anæsthetic in order to break down adhesions from time to time (see Chap. XVIII.). If sepsis is avoided, an excellent result will generally be obtained, provided that the after-treatment is carried out with vigour and perseverance.

TREATMENT OF SUPPURATING WOUNDS.

Wounds of joints in which free suppuration is established may have to be dealt with, either because the surgeon has failed to obtain asepsis in recent cases, or because the case does not come under notice until sepsis is already established. The condition, then, is one of suppurative arthritis, and is of extreme gravity. There is usually violent inflammation of all the structures of the joint, resulting in its complete disorganisation; the synovial membrane is intensely congested and swollen, the articular cartilages become destroyed and exfoliate, the bone beneath becomes inflamed and sometimes necrosed, whilst septic osteo-myelitis may occur. The best result that can be hoped for in these cases is recovery with anchylosis, which is usually bony, though sometimes a movable joint has been obtained. In the majority of cases, however, very serious consequences ensue. Abscesses form around the joint, acute osteo-myelitis extends along one or both of the bones entering into its formation, and septicæmia and pyæmia commonly result.

The first question that must arise in treatment in any individual case is whether it is advisable to attempt to save the limb, or whether immediate amputation is not better. The answer depends largely on the condition of the patient and the character of the wound. In an old subject or in one who is feeble or is the subject of albuminuria or some other grave general disease, the best chance is undoubtedly given by amputation. When, however, the patient is young, vigorous, and quite healthy, and particularly when symptoms of pyæmia or osteo-myelitis have not yet supervened, an attempt to save the limb is justifiable. Should the

inflammation be mild, and the case be seen comparatively early, the surgeon should try to save the limb in a young patient. If, on the other hand, the inflammation is very acute, the pain extremely severe, and the suppuration profuse, or if there are abscesses around the joint, the best procedure is to amputate.

Amputation.—As a rule, amputation should be performed through the bone above the joint, but when the bone is divided the medullary cavity must be carefully inspected to see whether it is inflamed. Should this be the case, either a second amputation must be performed higher up, or the remains of the bone or bones must be dissected out as far as the joint above.

Drainage.—In any attempt to save the joint, the first essential

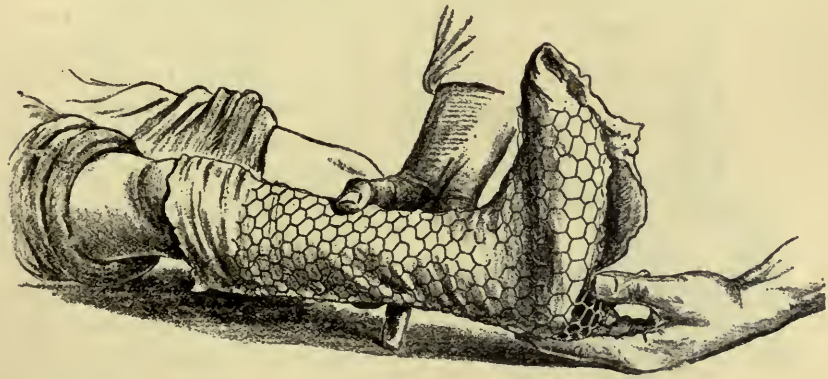


FIG. 43.—WIRE-NETTING SPLINT. The illustration shows the method of incorporating these splints with the dressing. A few layers of gauze are placed directly over the wound, and then a large sheet of gauze is wrapped around the limb; outside this the wire-netting is moulded to the limb, and when this has been done, the gauze is turned down over the free edges of the splint, and more dressing is added over the region of the wound outside the netting. In the figure above, two lateral splints of this netting are being applied, suitable for a wound of the ankle-joint.

is free drainage, and the second is to fix the limb in the position which will be most useful to the patient should anchylosis occur. Free incisions must be made into the joint so as to open up and give free access to every recess, and large drainage tubes must be inserted; small incisions and small drainage tubes are of little value. The skin around the joint should be disinfected in the usual manner and the joint itself should be washed out with sterilised normal saline solution. Following these incisions the best methods of treatment are continuous irrigation or the water-bath, preferably the former.

Continuous Irrigation.—In carrying out continuous irrigation the limb should be fixed upon a splint, and one of the most useful forms is one composed of wire-netting or perforated zinc (see Fig. 43) cut to shape and moulded so as to fit the limb accurately. The great advantage of this form of splint is that the discharge cannot soak into it and make it

foul, that it can be incorporated with any dressing or even applied next the skin, whilst at the same time it is easily procurable, does not require to be specially made, is cheap, and can be sterilised by boiling.

When the splint has been applied, irrigation should be provided (see Vol. I. p. 32). The skin around the wound should be smeared with eucalyptus vaseline, and mackintoshes should be arranged around the limb, so that the fluid is conducted into some suitable receptacle. The nozzle of the irrigator should then be connected with the orifice of one of the drainage tubes entering the joint at its highest level (see Fig. 44). The fluid, which should be at the body temperature, should travel slowly through the tubes, and if necessary the nozzle should be disconnected from time to time and attached to different drainage tubes so as to flush out the joint effectually. It is important to avoid the use of antiseptics which coagulate albumen or destroy the cells; the best lotions are very weak solutions of permanganate of potash (2 grs. to the oz.), sanitas, or tincture of iodine (a drachm to the pint).

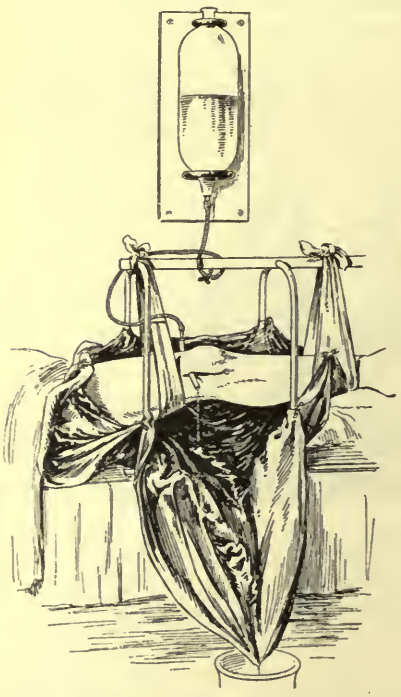


Fig. 44.—Constant Irrigation applied to the Knee-joint. The nozzle of the irrigator is inserted into one end of the supra-patellar drainage tube and a constant flow is thus maintained through the joint. The fluid is conducted by means of a mackintosh, appropriately arranged as above, into a suitable receptacle. For the sake of clearness, the splint fixing the joint has been omitted.

The Water-bath. — When irrigation cannot be practised, the limb should be immersed in a water-bath (see Vol. I. p. 34) containing one of the antiseptics just mentioned; it should at first be kept in the bath night and day, being taken out from time to time for the purpose of cleaning out the bath. The water in the bath should be at the normal body temperature. As improvement occurs, the limb may be taken out at night and wrapped up in warm boric fomentations.

Should it be impossible to employ either irrigation or the water-bath, the next best treatment is to use cyanide gauze dressings, for considerable benefit will be derived from the disinfection of the discharge that occurs in them, although the wound itself is infected. The dressings should be changed at first twice daily, and later on, when the discharge decreases,

once a day. When this method is employed it is unnecessary to wash out the joint each time the dressings are changed; it may be done, but care should be taken to avoid antiseptics such as carbolic acid or even sublimate. Some benefit may result from running a stream of warm boric lotion or sterilised saline solution through the tubes when the pus is very thick, but a strong antiseptic would certainly cause irritation, and kill the superficial layer of granulation tissue and thus provide a nidus for fresh bacterial growth, or open up a route for the entrance of organisms into the body, while it cannot penetrate into the tissues and destroy the bacteria.

When these dressings are employed, the wire splint should be placed

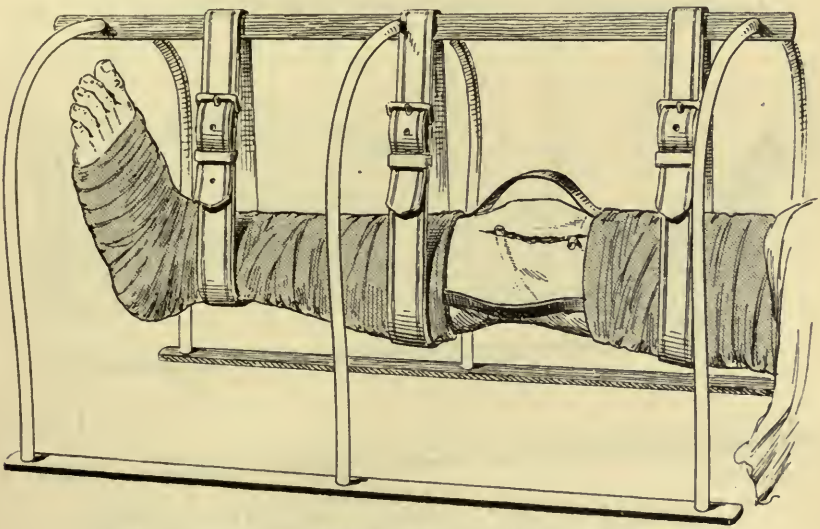


FIG. 45.—INTERRUPTED PLASTER OF PARIS SPLINT FOR WOUNDS OF THE KNEE-JOINT. The metal bands which cross the interval between the plaster bandages around the thigh and those around the leg are bent outwards so as to allow dressings to be applied to the joint.

outside the first few layers of gauze, and, as a rule, will not require changing oftener than once in three days. Even the slight movement inseparable from changing the splint causes the patient severe pain, and therefore, as soon as the discharge diminishes, the limb should be fixed in a plaster of Paris casing. The plaster bandage is applied to the limb above and below the affected joint, and metal bars incorporated with the plaster pass over the joint so as to immobilise it, the bars being bent outwards over the joint so as to allow free access for dressing (see Fig. 44).

The limb must be placed in the position most serviceable to the patient should anchylosis afterwards occur. Thus the knee should be slightly flexed; the elbow should be bent at a right angle with the

forearm and midway between pronation and supination; the shoulder should be abducted; the wrist should be thrown backwards and the thumb allowed to hang down; the hip should be slightly abducted and fully extended; the ankle should be fixed so that the foot is at right angles to the leg.

As the discharge diminishes, the drainage tubes should be gradually shortened until finally they are removed. It is well to leave those that drain the most dependent parts of the joint to the last; for example, in the knee the lateral tubes should be shortened so that they only project from the lateral aspect of the limb and no longer emerge through the

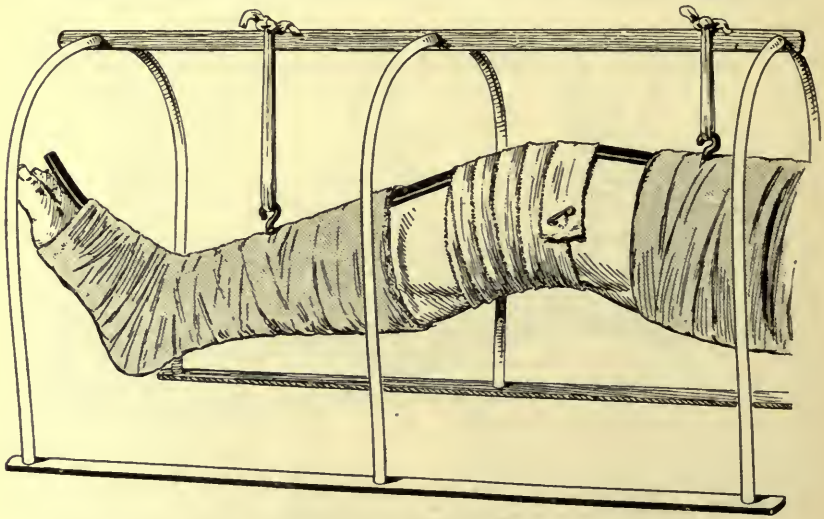


Fig. 46.—Anterior Suspension Bar for Wounds of Joints. The figure shows the splint applied for a wound of the knee-joint. The metal bar is secured to the limb by plaster of Paris bandages above and below the joint, which is left free for the application of dressings. The apparatus is slung from a cradle by the two hooks shown above, or by slings of bandage. It is a very useful form of splint, as it can be extemporised easily.

anterior opening, while those that pass across the joint may be cut in two so that there is a tube on each side, and these should be gradually shortened. Care must be taken that the drainage tubes do not slip into the articular cavity; they may be secured by safety pins passed through their free ends. Gentle passive movement should be attempted as soon as the wound has become superficial, but great care must be taken, because recrudescence of the inflammation may be brought about by rough usage. The movements should not be carried so far as to cause pain to the patient, but they should be steadily increased in range. So long as some amount of movement remains and no increase of inflammation is produced by the passive motion, this should be persevered with for months if necessary, in the hope of obtaining a useful joint.

In rare instances complete restoration of movement has taken place. On the other hand, it is useless to try to obtain movement when bony anchylosis has occurred. Attempts to break up the bony union will not only fail to obtain movement, but may light up the inflammatory condition. The case must then be looked upon as one of firm anchylosis and the appropriate treatment adopted (see Chap. XVIII.).

SECTION II.—DISEASES OF JOINTS.

SUB-SECTION I.—DISEASES OF JOINTS IN GENERAL.

CHAPTER XII.

INFLAMMATORY AFFECTIONS OF JOINTS.

Inflammation of joints may be either acute or chronic, and the process may involve one or all of the structures entering into the composition of the articulation.

ACUTE INFLAMMATION.

Acute inflammation may affect either the synovial membrane alone —when it receives the name of acute synovitis; or the whole of the structures of the joint—when it is spoken of as acute arthritis.

ACUTE SYNOVITIS.

Acute synovitis may be due to various causes—such as injury, gonorrhœa, specific fevers, or rheumatism. The joint becomes distended with fluid, which is not simply serous, but readily coagulable if blood corpuscles gain access to it. In superficial joints the skin may be reddened; frequently, however, it is only slightly more vascular than that over the corresponding joint on the opposite side, but it is warmer to the touch. There is pain on pressure over the inflamed joint, although movement or jarring one bone against the other is generally easily borne.

As the inflammation subsides, the effused material becomes absorbed, but there is always a tendency to the formation of adhesions between the opposed surfaces of the synovial membrane. Every joint capable of free movement has a synovial membrane which is much more extensive than the joint itself—a condition necessary to allow of proper movement. Hence, in whatever position the joint may be, the synovial membrane is always thrown into folds, the opposing surfaces of which are in contact

at some point or other. In acute synovitis, the lymph poured out on the surface of these synovial folds glues them together when the limb is kept at rest, and this lymph will organise, and, unless the folds are separated, will produce fibrous adhesions between the two surfaces or even complete obliteration of that portion of the synovial membrane.

TREATMENT.—The treatment depends to some extent upon the cause, and will be referred to again in speaking of acute synovitis as it occurs under various circumstances; there are, however, certain points common to all cases.

At the commencement of the trouble *absolute rest* of the affected joint is of primary importance; the limb should be placed on a splint in the position which will be most useful should adhesions form. Hot fomentations should be applied to the joint, and if there is much pain the flannel may be sprinkled with laudanum, and should be frequently renewed (see Vol. I. p. 12). In very acute synovitis benefit may be derived by first applying *leeches* over the joint followed by hot fomentations.

When the pain has subsided, *pressure*, preferably by means of a cotton-wool and starch bandage (see p. 80), may be substituted for the fomenation. The amount of pressure should be regulated by the sensations of the patient; it should never be so great as to cause pain, and it can generally be increased in a few days. The object is to bring about rapid absorption of the synovial fluid.

Massage should be combined with the pressure after two or three days. Gentle rubbing should be practised at first and should be increased gradually in extent and in vigour as the patient is able to bear it. In the case of simple synovitis not due to gonorrhœa or other acute infective cause *passive movement* may generally be begun about the end of the first week; the splint should then be left off, and the joint supported by a firm elastic bandage. In a good many cases *Bier's congestion treatment* combined with massage is of great value when the acute symptoms have passed off (see Vol. I. p. 13).

Not uncommonly the massage and passive movements are delayed for a considerable time, because they cause a good deal of pain when first employed. The presence of pain alone must not be looked on as a contra-indication to massage, because the young adhesions are often highly sensitive, but gradually become less so under the influence of gentle massage. The real guide as to whether movement is doing harm or not is the occurrence of swelling and inflammation. Should swelling in the joint come on after massage or movement, it is an indication that the synovial membrane is still too inflamed to be treated by these means, and therefore it is advisable to delay the treatment for a short time. When movements are very painful, but do not set up stiffness or swelling, and when it is necessary to repeat the movement, some surgeons inject small quantities of a two per cent. sterilised solution of cocaine. In bad

cases ten drops may be injected into the joint itself; in about ten minutes fairly free movements can be carried out without pain. If movements and massage are begun as soon as the acute inflammatory stage has subsided, they should be carried out gently. There will then be no great trouble with adhesions, and there may be no necessity for breaking them down under an anæsthetic at a later date. Should it be necessary to keep the joint at rest for a prolonged period, however, the adhesions may become so firm that they will not yield to gentle massage and movement. This matter is referred to again in connection with anchylosis (see Chap. XVIII.).

ACUTE SUPPURATIVE ARTHRITIS.

This is an acute inflammation involving all the structures entering into the formation of a joint, and is due to the presence of pyogenic organisms. It may follow a wound of a joint, but it may also occur without any wound in diseases—such as pyæmia, acute septic infection, and acute epiphysitis—in which pyogenic organisms have gained access to the joint from the blood.

When pyogenic organisms gain access to a joint the synovial membrane becomes intensely congested and swollen, and pours out large quantities of synovial fluid mixed with pus. The bone beneath the cartilages becomes inflamed; the cartilages soften and exfoliate, whilst the ligaments become swollen and softened, and before long the articulation is completely disorganised and the bones are dislocated by muscular action.

There is considerable risk of a fatal result from some form of septic disease—such as septicæmia or pyæmia. Abscesses may form around the joint and burrow in the fascial planes, and there may be deformity of the limb due to partial dislocation of the articular surfaces from the pull of strong muscles which are no longer opposed by the ligaments. When the affection is subsiding, the synovial pouches become obliterated by firm fibrous adhesions, whilst fibrous tissue forms between the opposed cartilaginous surfaces; should the cartilages be entirely destroyed, bony union may take place between the joint surfaces.

TREATMENT.—This has been described in connection with the treatment of septic wounds of joints (see p. 86). The first point is to decide whether an attempt should be made to save the limb; this depends chiefly on the constitution and age of the patient, and the severity of the local and general symptoms.

When an attempt is made to save the limb, the first essential is to provide free exit for the pus. The details for *the drainage* of joints in general will be found on p. 87. Here we shall merely indicate the best incisions for the various joints. No hesitation need be felt about making free incisions, for anchylosis is almost certain to occur in any

case, and large incisions will not interfere with the ultimate usefulness of the limb, while they may make all the difference to the possibility of retaining the limb or of saving the patient's life.

For suppuration in the knee-joint we make long vertical incisions, one on each side of the patella, extending from the top of the synovial pouch to the upper border of the tibia; openings are also made at the side and back of the joint so as to drain the posterior part of the cavity (see Fig. 47). These lateral and posterior incisions are best made by introducing a pair of stout dressing forceps through the wound on each side of the patella, pushing them through the capsule and soft tissues, and cutting down on the closed blades. The forceps are protruded through

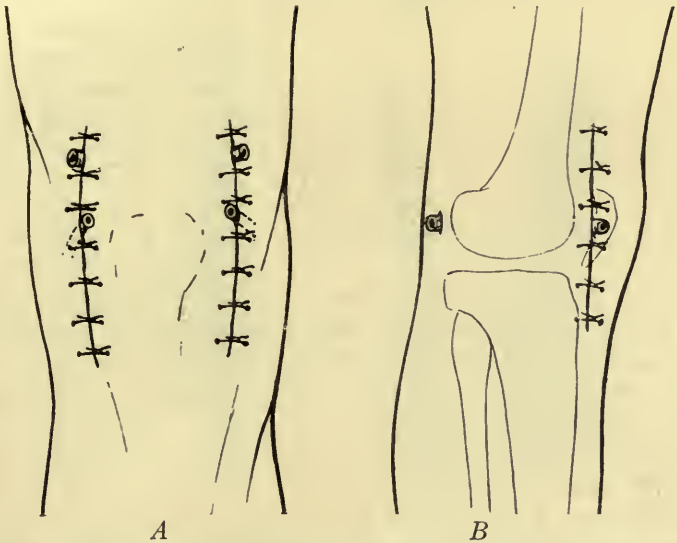


FIG. 47.—DRAINAGE OF A SUPPURATING KNEE-JOINT. *A* shows the anterior incisions with the drainage tube passing across the supra-patellar pouch and the lateral tubes projecting in front. *B* shows the course of the lateral tubes.

the openings in the skin, the blades are separated and the soft tissues forcibly separated to allow of the passage of a drainage tube. A large tube should be inserted on each side, one end emerging from the incision beside the patella and the other through the lateral opening; besides these, tubes should be inserted through counter-openings at the posterior aspect of the joint. It is well also to pass a long tube transversely beneath the quadriceps tendon, and to make the ends emerge on each side from the incisions beside the patella.

In the *hip* the joint should be opened by the anterior incision employed for excision of the hip (see Fig. 35); a pair of stout dressing forceps may then be pushed through the posterior part of the capsule and made to protrude in the buttock where the blades are cut down upon, and through the aperture thus made a tube may be pulled in so as to

drain the posterior part of the joint (see Fig. 48). In the *ankle*, an opening should be made in front of each malleolus and another behind the inner malleolus so as to drain the posterior part of the joint (see Fig. 49). In the *elbow*, incisions should be made on each side of the olecranon so as to drain the olecranon fossa, and others in front of each condyle so as to drain the front of the joint (see Fig. 50). In the *shoulder*, the best drainage is obtained through the vertical incision usually employed for excision of the shoulder (see Chap. XXII.) reinforced by another just in front of the posterior fold of the axilla which will drain the posterior part of the capsule (see Fig. 51). In the *wrist*, proper drainage is very difficult to obtain, and can only be got by laying the joint freely open in several places, especially on the posterior and inner aspects (see Fig. 52).

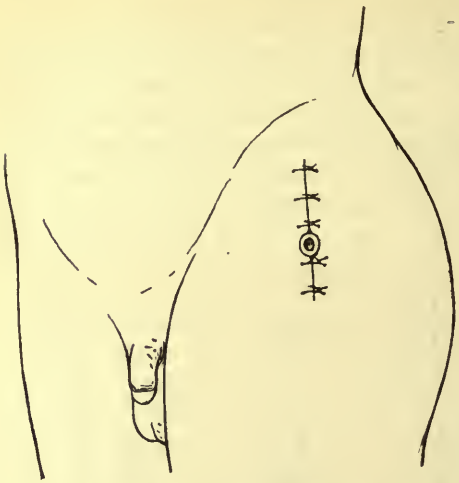


FIG. 48.—DRAINAGE OF A SUPPURATING HIP-JOINT.

The limb should be fixed upon a wire *splint* with the joint in the position that will be most useful when anchylosis occurs. The *after-treatment* is identical with that for a suppurating wound of a joint (see p. 87); continuous irrigation is the most useful plan in the early stage.

As the discharge diminishes boric fomentations or cyanide dressings may be substituted for the irrigation and the drainage tubes should be gradually shortened until finally they are removed. It is well to leave to the last those that drain the most dependent parts of the joint. In the knee-joint, for example, the lateral drainage tubes should be shortened so that they project from the lateral aspect of the limb and

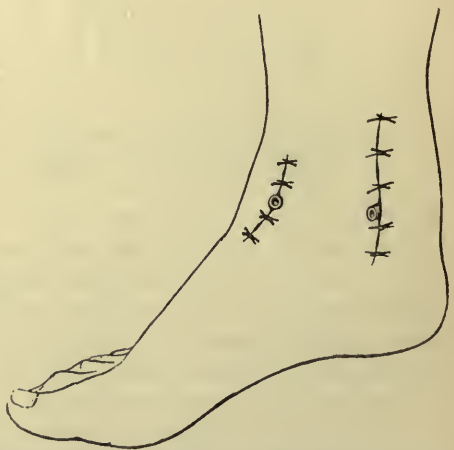


FIG. 49.—DRAINAGE OF A SUPPURATING ANKLE-JOINT. Showing the incisions in front of and behind the malleolus.

no longer emerge through the anterior opening, while those which pass across the joint may be cut in two so that there is a tube on each side, and these should be gradually shortened. The drainage tube in the most dependent situation should be removed last.

No attempt should be made to save the limb when the general condition of the patient is bad, or when there is spreading osteo-myelitis or general septic infection, as indicated by asthenic fever, rigors, and hectic temperature. Radical measures also become necessary in most cases when the bones become denuded of periosteum, when the pain is intense, and when abscesses form around the joint. In these cases amputation through the shaft of the proximal bone, should this be

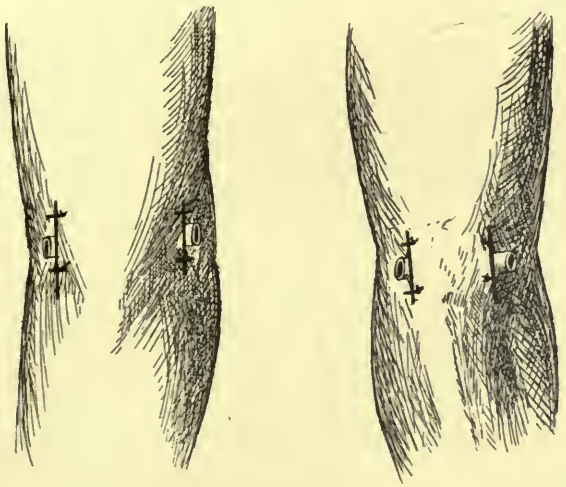


FIG. 50.—DRAINAGE OF A SUPPURATING ELBOW-JOINT. Showing the incisions in front and behind, with drainage tubes across from side to side.

healthy, or through the articulation above, should there be osteo-myelitis, is usually necessary.

When amputation is performed through the shaft of one of the affected bones, care must be taken to go well above the joint, and the medulla at the point of division of the bones should be examined in order to make sure that osteo-myelitis is absent. Should pus be found in the medulla, a second amputation must be done higher up, or should the first amputation have been performed near the upper end of the bone, the latter should be disarticulated. Some surgeons advocate excision in these cases, but in our opinion the operation is rarely justifiable for reasons that we have given on p. 86.

When arthritis affects joints that cannot be removed by means of an amputation—as for example, the sterno-clavicular or the temporo-maxillary joints—the only alternative to simple drainage is excision

of the articulation. In performing this operation, great care must be taken not to infect the medulla of the bone. Hence, when the joint has been opened, the pus should be washed out and the articular cavity swabbed freely with undiluted carbolic acid before any bone is removed. After time has been allowed for the carbolic acid to produce its effect, sufficient bone is taken from the articular surfaces to lay the

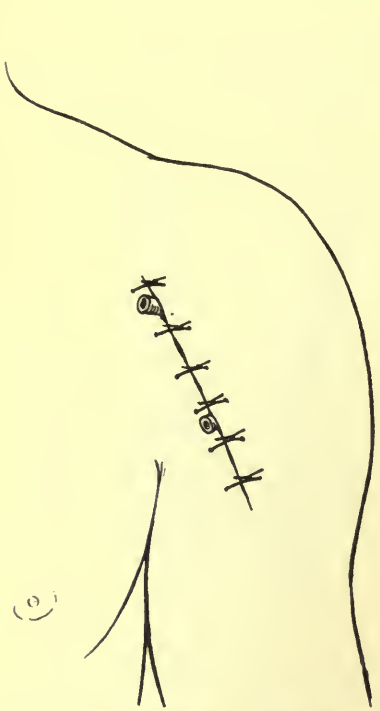


FIG. 51.—DRAINAGE OF A SUPPURATING SHOULDER-JOINT. The upper tube drains the front of the joint, the lower one drains the posterior part and emerges at the posterior axillary fold.

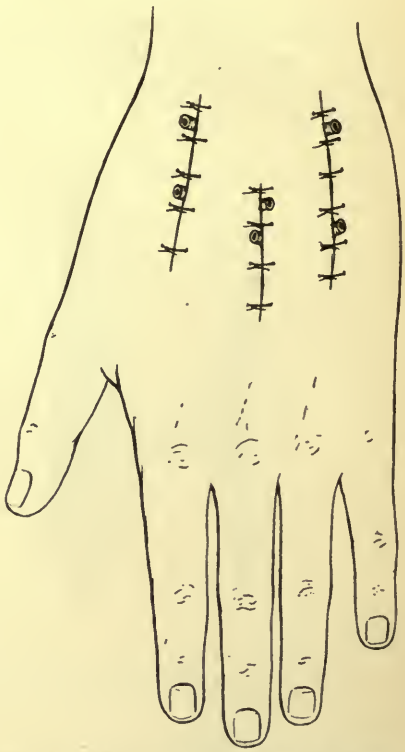


FIG. 52.—DRAINAGE OF A SUPPURATING WRIST-JOINT.

joint cavity freely open, and then the raw surfaces of the bone are sponged over again with the undiluted acid. The cavity should then be packed with cyanide gauze impregnated with iodoform and the skin incision left open. By dealing with the wound in this way a cavity is left, from which discharge can escape freely, and which can be kept clean. As soon as granulation is complete, the packing should be left out. As a rule the cases treated thus do well.

GONOCOCCAL ARTHRITIS.

During an attack of gonorrhœa, inflammation of joints may occur, which is clearly associated with the primary disease. The affection attacks not only the fibrous structures of joints, but also similar structures over the body—such as the plantar and palmar fasciæ and ligaments. Arthritis is a somewhat rare complication of gonorrhœa; it is commonest in the knee, but the ankle and the hip are also frequently affected, whilst almost any joint in the body may be attacked. It may occur in several joints simultaneously. It does not appear at any fixed period in the disease, but is most usually met with between the third and sixth week after infection.

There is no obvious relation between the acuteness of the gonorrhœa and the occurrence of the articular affection. When the urethral affection has arrived at the gleety stage it is common to find by inspection through the urethroscope that there are congested patches in the urethra, through which probably the gonococci enter the blood and are carried to the articulation. In support of this view is the fact that the trouble not infrequently follows the passage of an instrument during the sub-acute or chronic stage.

On the other hand, some constitutional condition seems to exist, which predisposes to the occurrence of the arthritis, for it is not uncommon to find that certain patients suffer from the affection every time they contract gonorrhœa. The disease occurs chiefly in men, but is met with in women.

Examination of the fluid from the affected joint may demonstrate the presence of gonococci, whilst in certain cases of the more acute type the ordinary pyogenic organisms are also present. It is probable that these latter cases are really pyæmic in nature rather than purely gonorrhœal.

VARIETIES.—Clinically the disease varies in acuteness in different cases. From the point of view of treatment we may differentiate four groups.

(*a*) The simplest form is a painful affection of the joint without any swelling or synovial effusion. There is tenderness on pressure, with pain on moving the limb, and occasional shooting pains in the joint. There is here probably an inflammation of the fibrous structures around the joint rather than an affection of the synovial membrane itself.

(*b*) The typical gonococcal arthritis is more acute. The first symptom is stiffness and slight swelling of the joint, which is soon followed by acute pain, lasting for several days, and accompanied by synovial effusion which is either clear or somewhat turbid from the presence of white corpuscles. The acute symptoms may subside in a week or ten days, but a similar condition may affect another joint, and gonorrhœal inflammation may

occur in the fasciæ and ligaments elsewhere in the body. Recovery is usually protracted, and relapses are frequent.

(*c*) The disease may be chronic from the first, and consist rather in a persistent accumulation of fluid in the joint than in an acute inflammatory attack; the condition, in other words, is more one of hydrops articuli than of acute synovitis.

(*d*) Extremely acute cases are occasionally met with, in which actual suppuration occurs in the joint. These are probably pyæmic in nature.

The tendency of this affection is to spontaneous recovery—generally after a protracted convalescence. The acute form of the disease, however, is often followed by extensive adhesions in the joint, which will entail considerable stiffness unless great care is taken in the treatment. On the other hand, those cases accompanied by extensive effusion may lead to so marked and prolonged a distension of the capsule, and consequent laxity of the ligaments, that permanent weakness of the joint may be left. In the severe cases accompanied by suppuration the result may be very disastrous, either from disorganisation of the joint or from the occurrence of general septic infection.

TREATMENT.—There are certain points common to the treatment of the various types referred to above. In the first place it is of great importance to subdue the urethral inflammation as soon as possible, and this is best done by topical applications; internal remedies, such as oil of sandal-wood and copaiba, have little influence upon the lesion in the urethra, which is of an essentially chronic nature, while they are apt to depress the patient, to upset his digestive functions, and thus do harm. The chief reliance must therefore be placed on *intra-urethral medication*, effected in the manner described in connection with gonorrhœa (see Vol. V.). It is also well to warn the patient that he is very likely to be affected similarly should he again contract gonorrhœa.

A second point common to the treatment of the various types is the use of vaccines. In cases of gonococcal arthritis *vaccine treatment* often seems to be of decided benefit, and therefore vaccines should be employed from the first in all cases of moderate severity. This subject is fully discussed by Dr. Emery in Vol. I. p. 514. As a rule it is well to use gonococci obtained from the patient himself either from the joint, or failing that, from the urethra. In addition, *Bier's congestion treatment* is of considerable value in many cases, and should be employed especially in cases which resist other means of treatment. The details of this method are given in Vol. I. p. 13.

(*a*) **Of the simple rheumatic form.**—In the early stages the best results are obtained by a combination of counter-irritation with rest, in addition to the vaccine treatment referred to above.

Rest is best obtained by enveloping the affected joint in a thick mass of cotton-wool, which is firmly bandaged on so as to exert *pressure* and restrict movement. When the joints affected are in the upper extremity,

the arm should be kept in a sling ; when the lower extremity is the seat of the disease, the patient need not be confined to bed, but may rest on a couch or in a chair provided with a suitable foot-rest. When the inflammation affects the tarsal joints, the patient must not bear any weight upon the foot, otherwise there is a great risk of the supervention of flat-foot. *Counter-irritation* is often of value, and in the milder cases the linimentum iodi may be painted over the joint affected until the skin becomes sore ; this should be employed in addition to the pressure above described. *Bier's treatment* may also be used if recovery is slow.

As soon as the pain has disappeared, the pressure may be increased by applying an elastic bandage outside the wool, and in about a week *massage and passive and active movements* should be begun. In the less accessible joints, such as the hip and shoulder, pressure is not easily applied and more severe counter-irritants—such as blisters—are indicated.

Drugs are of little use in these cases : the best are quinine in doses of 3 to 5 grains thrice daily, and iron in the form of Blaud's capsules in 10-grain doses three times daily after food when the patient is anæmic. Exposure to cold and wet must be avoided, and woollen underclothing should be insisted upon.

Although many of these cases recover without any trouble, some of them are very obstinate, and this is particularly the case when the tarsal joints or the plantar ligaments are affected. Under these circumstances a change to a *warm dry climate* or a sea voyage is often of great help. *Vaccine treatment* is specially valuable in these cases.

(*b*) **Of the ordinary acute variety.**—Attention must first be directed to moderating and arresting the inflammation ; secondly, the effusion must be got rid of ; thirdly, subsequent stiffness in the joint must be avoided.

The bowels should be cleared out by a purge, and the diet should be light and nutritious ; no stimulants should be given—at any rate, in the early stages. The other general treatment is similar to that for the variety already described.

The limb should be fixed upon a suitable *splint*, and if the lower extremity is the seat of the mischief, the patient should be confined to bed. Indeed in the early stage the pain is usually so great as practically to prevent the patient from getting about.

In the early stages, and especially in superficial joints, such as the knee, the application of *leeches*, followed by hot *fomentations*, is often very beneficial ; a little laudanum may be sprinkled on the fomentations if there is much pain. In many cases the pain, particularly at night, is so severe that morphine has to be administered.

After treatment by rest and fomentations for a few days, the acuter symptoms generally pass off, the pain subsides, and the synovial effusion diminishes. Should there be any delay in the absorption of the fluid, the joint should be freely *blistered*, the patient being confined to bed

meanwhile. As a rule two or three blisters in succession are required, and as an interval of five or six days is necessary between each blister, this stage of the treatment will extend over two or three weeks. If there is any delay in recovery, *Bier's treatment* should be employed.

The joint will then probably be ready for more energetic treatment, which should consist of *massage and passive movement* with the employment of *pressure* in the intervals between the manipulations. The massage should be very gentle at first, and, as the effusion subsides, passive and active movements may be begun. The vigour with which the massage is applied, and the extent to which the movements are carried, must be gauged by the sensations of the patient and the local conditions, more especially the inflammatory symptoms. As a rule, massage may be employed once daily for about a quarter of an hour ; after a few days, this period may be increased and the massage practised twice daily. The pressure should be applied by means of cotton-wool and a bandage (see p. 80), reinforced later on by an elastic bandage.

As the inflammatory condition subsides, the movements and massage should be carried out with increasing vigour. Coincidently, the use of splints and bandages should gradually be abandoned. During this period the case should be carefully watched for any increase in the inflammatory symptoms, which would indicate that the treatment is being pushed too rapidly.

In freely movable joints, such as the knee, these attacks of acute or sub-acute arthritis are generally recovered from pretty readily, but when the affection occurs in the tarsal or carpal joints there is often great difficulty in completely restoring the functions of the articulations, because the inflammation does not remain limited to the synovial membrane of the joint itself, but affects the tendon sheaths and the ligaments and fascial structures around, so that very extensive adhesions have to be dealt with.

A good method of getting rid of any stiffness that remains after a prolonged trial of passive movement and massage is by means of *Bier's method of congestion*, and of *superheated air* applied around the joint for about half an hour prior to the massage. This method is referred to in connection with rheumatoid arthritis (see Chap. XVI.).

(*c*) **Of cases accompanied by excessive effusion.**—As distension of the joint is prejudicial to its ultimate recovery, the stretching of the ligaments being apt to leave the joint loose afterwards, it is of importance to get rid of any fluid that does not become absorbed after a good trial of the measures just recommended. In the first instance it should be aspirated. The greatest care must be taken to disinfect the skin and the aspirating needle, and the puncture should be covered by collodion. It is well to blister the joint immediately after aspiration has been performed, and to keep up pressure as soon as the blister has healed.

In a good many cases the fluid will re-accumulate unless more vigorous

measures be taken. Some surgeons *wash out the joint* after the aspiration with a three per cent. solution of carbolic acid. Schuchardt states that he has obtained still better results by irrigating with a one per cent. watery solution of protargol. We use a 1 in 4000 sublimate solution. A small incision should be made through the skin sufficient to allow the entrance of a trochar and canula of fair size into the synovial cavity, the former is withdrawn, and the fluid evacuated by pressure. The irrigating fluid is now injected into the joint in sufficient quantity to distend it thoroughly, and, the finger being placed over the end of the canula so as to prevent the escape of the fluid, the capsule is freely manipulated so as to distribute the fluid evenly over the interior. The finger is then removed from the canula and the fluid is squeezed out. This procedure may be repeated two or three times, after which the joint cavity is distended with sterilised saline solution, and emptied so as to get rid of the irritating lotion ; unless this is done, a smart attack of synovitis is likely to follow, as the sublimate solution is too irritating to be left in the joint. Although an attack of acute inflammation not infrequently cures the dropsical condition of the joint, just as it cures hydrocele, it is apt to give rise to considerable effusion of fibrinous material into the joint which may lead to the formation of adhesions. Hence massage and passive movement must follow as soon as possible.

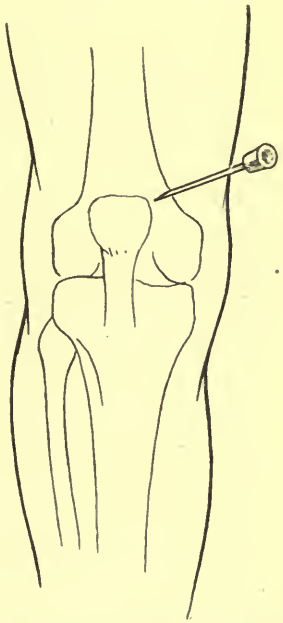


FIG. 53.—ASPIRATION OF THE KNEE-JOINT. The diagram shows the best spot at which to puncture the joint and the direction in which the needle is to be introduced.

(*d*) **Of cases complicated by suppuration.**—These are practically cases of pyæmia, and *free drainage* of the joint by incision and the insertion of drainage tubes will be called for. In many cases the septic condition is not very virulent and large incisions are not therefore necessary, two or three full-sized drainage tubes (No. 20) being sufficient. When, however, the condition is more acute, or when the inflammation continues in spite of the insertion of drainage tubes, more vigorous measures, similar to those described for acute suppurative arthritis, must be adopted (see p. 94).

LEUCORRHŒAL ARTHRITIS.

A form of arthritis indistinguishable clinically from that due to gonorrhœa is sometimes met with in women who are the subject of leucorrhœa. It is usually of a mild type, but it may be severe and may

even end in suppuration. It is possible that some of these cases are gonococcal in origin, but others are not, and are probably due to a septic condition complicating the ordinary leucorrhœa.

TREATMENT.—The most important point is to ascertain the cause of the leucorrhœa and to treat that. As soon as the cause has been removed, the joint affection subsides rapidly. Its disappearance may be hastened by the use of appropriate local treatment, similar to that employed for mild cases of gonococcal arthritis.

PNEUMOCOCCAL ARTHRITIS.

This variety of arthritis is not at all uncommon in children, and adults may also be affected. It may occur independently of pneumonia or it may follow or accompany that disease. The knee-joint is most frequently affected, but any joint and more than one joint may be involved. The onset may be slow or acute, and clinically the local condition of the joint is like that of septic arthritis, though the symptoms as a rule are less severe. The true nature of the infecting organism is easily demonstrated in films of the pus or by making a culture of the joint fluid.

TREATMENT.—If the joint is opened and drained whilst the disease is in its early stages, complete restoration of function may follow. In some cases, aspiration and washing out the joint cavity with saline solution may be sufficient. At a later stage, incisions must be made as in the case of septic arthritis (see p. 94), though they need not be so large. It is very important in the after-treatment to employ careful aseptic precautions and so prevent the access of other micro-organisms, otherwise prolonged suppuration and disorganisation of the joint will occur.

OTHER FORMS OF INFECTIVE ARTHRITIS.

Infective arthritis may occur in acute constitutional diseases—such as smallpox, scarlet or typhoid fever. A similar condition may occur in dysentery, and is common in pyæmia or septicæmia. In the latter there is no difficulty in understanding how the affection occurs, but its relation to the specific fevers is not yet quite clear.

The inflammation is usually acute or sub-acute, and it does not necessarily end in suppuration, except in the pyæmic cases. In the non-suppurative form the question arises whether the disease is really set up by the specific organisms producing the fever, or by other organisms which have got into the blood. The problem is similar to that in gonorrhœal rheumatism, and the symptoms are closely allied. The disease may be confined to one joint, but not uncommonly several joints are affected. It resembles gonococcal arthritis, moreover, in that it does not exhibit the typical migratory character of ordinary acute rheumatism, and it not infrequently passes into a condition of chronic effusion into the joint.

When several joints are affected, they are generally inflamed at the same time, or the inflammation in the second joint comes on before that in the first has subsided. In typhoid fever the hip-joint is not infrequently affected, and a peculiar character of this affection is that spontaneous dislocation is very apt to occur. In fact, it sometimes happens during convalescence from typhoid or other acute fevers, that spontaneous dislocation of the hip occurs without any previous symptoms having called attention to the affection of the joint.

TREATMENT.—This closely resembles that of gonococcal arthritis (see p. 100). Should dislocation occur, as in the hip, reduction should be carried out immediately, and recurrence should be guarded against by employing extension.

The general health of the patient must be attended to. The treatment suitable for the disease which is the cause of the trouble should be employed, followed later on by general tonic treatment by iron and quinine, good hygienic conditions, nourishing food, and a moderate amount of stimulants.

When suppuration takes place, the treatment must follow the lines laid down for acute suppurative arthritis (see p. 94). Although of a suppurative character, the arthritis in these cases is not usually very virulent or destructive, and it is not uncommon for an excellent result to be obtained by drainage alone.

CHRONIC INFLAMMATION.

Under this heading we shall only describe cases of chronic inflammation of the synovial membrane or chronic synovitis. Chronic inflammatory conditions affecting the other structures of the joint are described separately. By chronic synovitis is meant a chronic inflammation of the synovial membrane which may be accompanied by marked effusion into the joint, or thickening of the synovial membrane, often of a villous type.

CHRONIC SYNOVITIS WITH EFFUSION.

The chronic form of synovitis with effusion of fluid into the joint may follow an attack of acute synovitis or may be chronic from the first. In the latter case it may arise from a sprain or other injury to the joint, or it may commence without any apparent cause. It may also be associated with changes within the joint—such as a loose body in the joint, or injury to an intra-articular fibro-cartilage. It may also be due to roughness of the synovial membrane—such as is produced by hypertrophied synovial fringes.

Whatever be the cause, the result is that the joint becomes distended with a clear, limpid and serous fluid, whilst in many cases the synovial membrane remains practically normal. The distension of the joint

usually occurs slowly and remains stationary for a long time, so that in the early stages the patient continues to use the joint and only notices that it is slightly stiffer than the other. Under rest and appropriate treatment the fluid will diminish or even disappear, but there is apt to be a recurrence as soon as the joint is used again. When the effusion has lasted a long time, laxity of the fibrous structures of the joint results, so that ultimately the articulation may be much weakened. Patients suffer so little in the first instance that they are apt to neglect the affection, particularly when they have to earn their living. It is not until the disability produced by the stretching of the ligaments is so great as to prevent the patient using the joint properly that he seeks advice.

TREATMENT.—In the treatment of these cases steps must be taken, firstly, to ascertain and, if possible, remove the cause; secondly, to get rid of the fluid and arrest the inflammation; and, thirdly, to restore the functions of the joint. The *cause* should always be removed, if possible; a careful examination must be made to ascertain which of those enumerated above has led to the trouble. Fringes of the synovial membrane, injured inter-articular cartilages or loose bodies, must be dealt with in the appropriate manner; often, however, no definite conclusion can be come to as to the cause, owing to the distension of the joint.

A most important point in the treatment is to *remove the fluid, and treat the inflammatory condition.* The most efficient way of doing this is by rest, and if the affected joint is in the lower extremity, the patient must lie up, and the limb must be fixed upon a splint. At first the rest should be absolute, as the disappearance of the fluid will be much delayed if the patient is allowed to get up, even for a few hours. In the case of the knee, for example, the limb should be placed on a back splint with the joint slightly bent, and somewhat elevated upon a pillow. Blisters should be applied over the lateral aspects of the joint, and also over the supra-patellar pouch. As soon as one blister has healed, a second should be applied, and after that a third, if necessary. If the fluid be markedly less after two or three blisterings, massage should be carried out twice daily, and in the intervals pressure should be applied by means of cotton-wool and a bandage (see p. 80). When the fluid has disappeared, the joint should be strapped with Scott's dressing (see p. 117), and the patient may then be allowed to get about. Under this treatment the fluid generally disappears in three or four weeks.

Should the fluid re-accumulate after the patient begins to walk it would only be waste of time to repeat the above treatment. Should no cause—such as the presence of hypertrophied synovial fringes—be found, the patient should be again put to bed and the fluid withdrawn by an aspirator; and it is a good plan to *wash out the joint* with some slightly irritating fluid as described for gonorrhœal arthritis (see p. 103); we prefer 1 in 4000 sublimate solution for the purpose.

As an alternative to washing out the joint, or as a method of treatment when this has failed, *aseptic drainage* may be practised. Provided that asepsis can be secured, there is no doubt that this is a very effectual procedure. Particular care is necessary as regards asepsis, because suppuration in a comparatively healthy joint is a very disastrous occurrence.

An incision should be made in the capsule of the joint sufficiently large to admit a No. 14 drainage tube, which is stitched to the skin and surrounded by the usual antiseptic dressings. The dressings must be changed daily at first, and at less frequent intervals subsequently, according to the amount of discharge present. In most cases this treatment is sufficient to subdue all tendency to effusion into the joint in about ten to fourteen days, when the drainage tube should be left out and the wound allowed to heal. When healing has occurred, massage and passive movement must be begun and gradually increased in amount, so long as they do not produce any further effusion. In about three weeks the patient may be allowed to get about with the limb strapped with Scott's dressing, careful watch being maintained to see that no further effusion takes place.

In the most obstinate cases, even this method will not succeed. The most common condition keeping up the synovitis under these circumstances is the presence of enlarged synovial fringes in the joint (*vide infra*), and therefore we advise that, whenever the surgeon employs drainage of a joint, he should make the incision into the capsule large enough to introduce his finger, examine the interior of the joint, and deal with any abnormal condition which may be present.

CHRONIC SYNOVITIS WITH SYNOVIAL THICKENING.

The thickening may affect either the surface or the substance of the synovial membrane.

Thickening of the synovial fringes.—This condition is not uncommonly the primary cause of obstinate cases of chronic synovitis with effusion. The change in the synovial membrane varies from hypertrophy of a few fringes—generally at the point where the synovial membrane joins the cartilage—to an almost universal papillomatous condition of the surface. If a piece of the affected synovial membrane be floated in water its surface presents an appearance resembling seaweed. Microscopic examination of the fringes shows that they consist of fibrous tissue with loops of blood-vessels, but without any marked signs of inflammation unless they have been repeatedly nipped between the articular ends, when they become swollen and inflamed. There may also be a marked deposit of fat in the fringes, so that large fatty masses hang into the joint. The condition has been described under the name of 'lipoma arborescens' (see Fig. 75).

The pathology of this hypertrophy of the synovial fringes is

obscure. We have included it among the inflammatory affections, but it is not certain that it is really of this nature. It is described here merely because it is more convenient to consider it in this connection on account of the chronic synovitis to which it gives rise. By some it is considered to be allied to rheumatoid arthritis, and no doubt the condition is found in many rheumatoid joints. On the other hand, a most extensive papillomatous condition of the synovial membrane may be met with without any other sign of rheumatoid change in the joints, and it is most probable that when osteo-arthritic changes are found they are the result of the constant irritation of the joint from the presence of these villi.

The affection is often multiple, and may involve several joints. Those most frequently attacked are the knee and the ankle, and the result is not only persistent effusion of fluid into the joint, but frequent attacks of sudden disability, which closely resemble those caused by displaced cartilages, and which are due to nipping of the fringes between the ends of the bones. Besides the effusion of fluid, which varies in amount, there is often tenderness over various parts of the joint. When the articulation is palpated, the fringes may often be felt rolling under the finger, and giving rise to marked crepitation.

Schuchardt gives the following as the most frequent seats of proliferation in the various joints. In the shoulder the fringes mostly occur round the articular surface of the scapula, in the bicipital groove and in the neighbourhood of the anatomical neck of the humerus; in the elbow they are met with most frequently about the head of the radius, beneath the annular ligament and in the pockets of synovial membrane in front and behind; in the radio-ulnar joint they are on the dorsal surface; in the hip they are most frequent in the neighbourhood of the head of the bone; in the knee they surround the patella and are present at the reflection of the synovial membrane and in the supra-patellar pouch. In this joint we have found them most frequently over the lateral reflections of the pouch, so that they can be felt over the condyles; they also occur in connection with the ligamentum mucosum. In the ankle they occur at the anterior attachment of the synovial membrane to the tibia.

Treatment.—This is very difficult, and it is not easy to see how a uniformly good result can be obtained; no constitutional remedies are of any value. When the trouble is limited to one joint, it is clear that the most promising measure is to dissect away the whole of the affected area of the synovial membrane; and when this does not involve removal of the entire synovial membrane, we have obtained excellent results, particularly in the knee. Should the condition be more or less universal, however, the whole of the synovial membrane must be removed, and, seeing that the ligaments must be freely divided in order to enable this to be done, considerable

restriction of movement may occur—in fact, under these circumstances, it is hardly likely that there will be complete restoration of function in the joint. When only one joint is affected this is not necessarily a matter of great importance, but, should a number of joints be attacked, it is a serious undertaking to dissect away the synovial membrane in each. At the same time it must be remembered that the condition cripples the patient, and that a painless though somewhat stiff joint is preferable to one so painful that the patient cannot use it.

The operation consists in opening the joint freely with full antiseptic precautions, and clipping away the affected synovial membrane as completely as possible. This gives rise to considerable oozing into the joint, which, however, will stop partly from mere exposure to the air and partly by irrigating the joint with hot normal saline solution.

A large drainage tube is inserted, the incision in the capsule is stitched up, and the wound closed, the limb being put on a suitable splint. The drainage tube may be left out at the end of three or four days and the wound allowed to heal. When healing has taken place, passive movement is begun in order to prevent adhesions.

Thickening of the substance of the synovial membrane.—These are chiefly cases of prolonged synovitis after an injury, in which a local thickening persists at some part of the synovial membrane—in the knee, for example, about the fatty pad beneath the ligamentum patellæ. It is rare to find generalised thickening of the synovial membrane which is not of a tuberculous or syphilitic origin.

Treatment.—The best treatment is prolonged massage accompanied by the employment of douches, and, if necessary, a visit to one of the thermal stations, where the hot-air treatment and the proper douches can be obtained. The cases are very troublesome, and the condition may be so persistent that it may be advisable to cut down upon the thickened area and remove portions or the whole of it.

CHAPTER XIII.

TUBERCULOSIS OF JOINTS.

TUBERCULOSIS is one of the commonest affections of joints and may end in disorganisation of the articulation. The disease is due to the tubercle bacillus, aided by some predisposing or exciting cause, and generally follows a slight injury or sprain in a person who is the subject of tuberculosis elsewhere, or in whose blood tubercle bacilli happen to be present.

PATHOLOGICAL CHANGES.—As a rule the disease begins as a localised deposit in the joint. It is only in rare cases, such as in acute tuberculosis, that the affection commences with an eruption of tubercles over the whole of the joint. The typical form of the disease met with in surgical practice is the result of the spread of the tuberculous infection from one or more foci until the whole joint becomes affected. These primary foci may be situated in the cancellous ends of the bone or in the synovial membrane, and the early symptoms of the disease and its treatment differ considerably according to the mode of origin. Primary deposits of tubercle in the bone are perhaps most common in children, whilst in adults the affection more frequently starts in the synovial membrane. There is not, however, a great difference between the frequency in the two cases.

Primary Osseous deposits.—These commence as a localised tuberculous osteo-myelitis, and one of two results may follow as the deposit extends. The softening of the bone in which the tubercle is deposited may lead to the formation of a *soft caseating deposit*; or sclerosis of the bone trabeculæ may occur, with marked thickening of the bone, caseation of the tissue in the remains of the alveolar spaces, ultimate necrosis of this portion of the sclerosed bone and the *formation of a sequestrum.* Hence, when there is a tuberculous focus in a bone, a soft caseating deposit or a tuberculous sequestrum or both may be met with. The tuberculous focus gradually increases in size and makes its way to the surface of the bone, which it may reach either beneath the articular cartilage—which is most frequently the case—or just at or beyond the point of reflection of the

synovial membrane on to the bone. When the deposit reaches the under surface of the articular cartilage, it perforates it and thus a communication is established between the joint cavity and the tuberculous deposit. This results in rapid infection of the whole surface of the synovial membrane and is generally marked by the onset of acute symptoms in a case in which they had been previously only slight. These cases were formerly described as ' acute ulceration of cartilage.'

On the other hand, when the deposit reaches the surface about the point of reflection of the synovial membrane on to the bone, the tuberculous material does not escape into the joint cavity—at any rate, at first—but leads to infection of the neighbouring synovial membrane and a gradual spread of the disease from this point over the rest of the joint ; these cases resemble in many respects those of primary synovial disease. In the third case, in which the deposit opens beyond the articular surface, an abscess forms outside the joint, and the latter may not become affected.

Primary Synovial disease. — When the tuberculous disease begins primarily in the synovial membrane it usually commences at one particular spot and from this gradually infects the remainder. Two different conditions are met with in these cases : in the one there is a localised deposit which gives rise to a mass of *thickened synovial fringes* hanging down into the joint and forming a pedunculated body ; in the other, the disease, spreading from the primary focus, may extend uniformly over the whole of the synovial membrane and lead to *general thickening* of it.

While the disease is spreading over the synovial membrane it also extends gradually over the cartilages from the point of reflection of the synovial membrane, destroys them and penetrates into the cancellous spaces at the ends of the bone, leading to the condition known as *tuberculous caries*. Abscesses frequently form in the substance of the synovial membrane and these burst outwards, inwards, or in both directions, in the latter case leaving sinuses leading down to carious bone. If recovery takes place after these changes have occurred, anchylosis with deformity may result.

SYMPTOMS.—The symptoms of tuberculous joint disease differ according to the stage of the disease, and whether it is primarily osseous or synovial. In the earliest stage of the *primary osseous affection* the symptoms are not at all marked. At most the patient complains of a feeling of weight and aching about the end of the bone, which may be found to be somewhat enlarged. In the lower extremity there may also be a slight limp in walking, although there is no limitation of, or pain on, movement. Should such a group of symptoms occur in a patient previously the subject of tuberculous disease, or in one who has a strong tuberculous family history, tuberculous disease of the bone should be suspected.

At a later stage, when the osseous deposit establishes a communication

with the joint and leads to infection of its interior, these slightly marked symptoms suddenly become acute ; the patient is seized with severe pain and there is considerable swelling of the joint, with starting pains at night and marked flexion. It is often not until these acute symptoms have appeared that any history is given of previous trouble in the joint. The later history of these cases is that the joint cavity becomes filled with semi-purulent fluid, the synovial membrane thickens (although not very markedly), while abscesses form around the joint and burst, leading to sinuses connected with carious bone. The general health suffers, for the patient cannot sleep on account of the starting pains in the limb, which come on just as he dozes off ; he gradually wastes, and acute tuberculosis may be the final result.

When the disease is primarily synovial, or when an osseous deposit reaches the surface of the bone at the point of reflection of the synovial membrane on to it, the symptoms are less acute, and the local signs consist mainly of thickening of the synovial membrane, which at first is often localised, but which gradually extends over the whole membrane. In the early stage there is only slight interference with the mobility of the joint, and little pain. As the affection advances, movement diminishes, and, when the cartilages become destroyed, the more severe symptoms, such as starting pains at night and abscesses around the joint, begin to appear. A patient with pure synovial joint disease is generally free from pain as long as the limb is kept at rest.

In the rare cases of *localised thickening of the synovial membrane* forming a pedunculated mass projecting into the joint, the symptoms at first are effusion into the joint with some tenderness on pressure over the thickening, which may suggest the presence of a loose body. The nature of the disease is made evident by the gradual extension of the thickening to the rest of the synovial membrane.

In all cases of tuberculous joint disease a remarkable and early feature is rapid wasting of the muscles which act upon the joint. This condition is common to many acute joint affections, but is more marked and more rapid in the tuberculous form than in any other, and is probably caused to some extent by a neuritis spreading from the articular nerves, or by some reflex trophic disturbance.

GENERAL POINTS IN THE TREATMENT OF TUBERCULOUS JOINT DISEASE.

From the point of view of treatment, cases of tuberculous joint disease may be divided into the following groups :—

1. Localised tuberculous deposits in the bone without affection of the joint.

2. Localised pedunculated tuberculous deposits in the synovial membrane.

3. Cases of empyema tuberculosum and hydrops tuberculosus.

4. Cases in which the tuberculous deposit has burst into the joint and has produced sudden infection of it.

5. Cases of general synovial thickening without marked bone disease.

6. Cases in which there are unopened abscesses around the joint.

7. Cases in which these abscesses have burst and have left sinuses.

8. Cases accompanied by anchylosis and deformity, with or without sinuses.

In connection with the treatment, it is always necessary to ascertain whether there is tuberculosis elsewhere—*e.g.*, in the lungs, glands, or abdomen. Before referring to the special treatment of the types enumerated above, it will save repetition to give a brief description of the methods of treatment applicable to tuberculous disease of joints in general.

GENERAL TREATMENT.—**Climatic.**—The patient should be placed under the best possible hygienic conditions. He should have plenty of fresh air, and if possible should be sent into the country, the particular place depending largely upon the idiosyncrasies of the individual. It is the rule to send these patients to the seaside, but it must be remembered that some do much better in a dry inland spot than at the seaside, and, therefore, before deciding where the patient is to go, it is essential to ascertain, if possible, from which of these localities he is likely to derive most benefit. The patient's taste should be consulted as far as possible—the more contented he is, the better for his general health. Broadly speaking, robust patients, with a local lesion, which does not prevent them from walking, do best at a bracing place. For a frail patient who cannot walk, a warm place is better—at any rate, until his general condition has improved.

For those who are best suited by the seaside in a cool and bracing climate, any of the ordinary English watering-places on the East Coast from Deal to Cromer, or on the Yorkshire coast, may be recommended. As a rule, patients are sent to Margate, but there is no particular virtue in that resort over many other places upon the East Coast. For patients who do well at the seaside, but who require a warmer climate, there are various suitable resorts on the South Coast from Folkestone to Bournemouth. For a patient desiring a change of scene abroad, the coast of France, south of Boulogne, has a well-established reputation. Towns such as Berck-Plage, where there are several large hospitals for the treatment of surgical tuberculosis, are laid out for the benefit of these patients. Suitable chalets provided with verandas may be rented, and invalid requirements of all sorts are readily obtainable. For those who do best in an inland bracing atmosphere, the Yorkshire moors are excellent; whilst for others, who require a somewhat warmer climate, the higher parts of Devonshire are suitable.

The patient should be kept out of doors as much as possible, and movement of, or pressure on, the affected joint must be avoided. The

amount of outdoor exercise, and the form which it takes, must therefore depend in the main upon the joint affected. When the mischief is in the lower extremity, it is best in the early stages to keep the patient recumbent on a couch, upon which he may be wheeled out of doors. When the affected joint is in the upper extremity, the patient may walk about from the first. All exercise must be of the gentlest description in the first instance; a slight injury to another joint may readily set up similar disease there. The patient should not join in any violent games or any unduly vigorous exercises.

Unfortunately, it is only comparatively well-to-do patients who can properly avail themselves of the best hygienic treatment, which, to be of real value, should be persevered with until recovery is complete; this usually means a period not of weeks or months, but of years. In the case of the poor such treatment is not easily obtained, and it seems advisable that every hospital for the treatment of these diseases should have a department in the country, to which the patient can be sent and where he can be kept under careful treatment for as long as may be necessary. At Paddington Green Children's Hospital we carry this out by having a Convalescent Home in the country, to which tuberculous cases are sent as soon as the local condition permits, and at which they are kept as long as may be necessary. The Home is within reach of town, and the treatment can therefore be superintended by those who have had charge of the case from the first. To send a patient with tuberculous joint disease—especially if any operative interference has been practised—to one of the ordinary Convalescent Homes for the usual period of three weeks is not only useless, but actually objectionable, in so far as the patient passes out of the hands of the surgeon just at a time when it is inadvisable to make any change in the local treatment. Nor should private patients be sent for an indefinite period out of the ken of the surgeon who did the operation; they should be seen by him at short and regular intervals.

This question of proper hygiene not only affects the ultimate recovery of a patient, but also has an important bearing upon the treatment, because, when prolonged rest and other hygienic measures are unobtainable, it is often advisable to undertake operative interference at an earlier date and upon a larger scale than would be necessary were the patient able to afford prolonged hygienic treatment.

Dietetic.—The diet must be as nourishing as possible, and should consist of the most easily digested foods, especially those with abundance of fat. A meat diet is preferable to a vegetable one. The consumption of potatoes and vegetables containing much potash should be restricted.

Medicinal.—Among drugs the chief reliance is placed on *cod-liver oil*, particularly in the form of an emulsion. It should be given even when the patient is fat and well nourished, but not in too large doses,

as it may upset the digestion. It is usually best to begin with a teaspoonful twice a day, and to increase the dose gradually until a tablespoonful is being taken thrice daily ; it is well to leave it off in warm weather. *Iron* is of value when the patient is anæmic, whilst *guaiacol* is also recommended in two-minim doses in capsules, three times a day. The latter drug may, if preferred, be administered by subcutaneous injection.

Tuberculin is in general use for these joint diseases as for tuberculosis elsewhere. A full account of the method of administration will be found in Vol. I. p. 522.

Although these general points are of the greatest importance, careful local treatment is always required. In the early stages of the disease, indeed, the local treatment is of greater importance than the general.

LOCAL TREATMENT.—It will save repetition if we refer to the various methods of local treatment in the first instance, and afterwards consider the applicability of each method to the various types of disease already enumerated.

Palliative Measures.—Several methods of treatment are employed which do not act directly by destroying the tubercle bacilli, but indirectly by making the tissues better able to resist their attack. In a tuberculous joint we have to do not only with tubercle bacilli and the tuberculous tissue produced by their presence, but also with chronic inflammation of the tissues around, which is set up by the presence of the tuberculous tissue, and which in its turn paves the way for extension of the disease. It is by the agency of this chronic inflammation in the tissues that the tubercle bacillus overcomes their resistance and is enabled to prepare for itself a suitable soil for growth. The bacillus is often unable to grow at all, or grows only with difficulty in perfectly healthy tissues, but if the latter be weakened by a previous attack of inflammation or by injury (which produces a certain amount of inflammation) the bacillus is able to grow with greater freedom. Hence when it is not advisable to take radical measures to root out the tubercle bacilli and the tuberculous tissue, it is important to try to subdue the chronic inflammation of the tissues, so as to place the latter in a better position to resist the advance of the bacillus.

Indeed, the main feature of what may be termed the 'expectant' treatment of tuberculous joint disease, as opposed to the radical methods, is the use of measures directed against chronic inflammation. We have already (see Vol. I. Chap. I.) discussed fully the procedures indicated in the treatment of chronic inflammation ; here we need only consider their applicability to the affection under discussion.

Rest.—Quite apart from the presence of the tubercle bacillus, the chronic inflammation may be kept up by movement, by the presence of septic organisms, or by pressure of the diseased surfaces against one

another. The first requisite therefore is to place the part absolutely at rest, and it is striking to see the improvement that sometimes results from this even in bad cases. The means adopted will vary with the joint affected, but consists essentially in the application of suitable splints.

Extension.—In many cases, however, particularly when the articular cartilages have been destroyed and the bony surfaces are carious, the inflammatory condition is kept up not so much by movement as by the tonic contraction of the muscles surrounding the joint, which press the inflamed surfaces against one another. One of the symptoms that enables the surgeon to diagnose extension of the disease to the bone is this fixation of the joint which, in the early stages, is not due to anchylosis, but to reflex contraction of the muscles surrounding the joint. The resulting pressure of the inflamed surfaces against each other keeps up the inflammation in the bone, and rapid destruction of the bony surfaces which are in contact also takes place. This is well seen in the hip, for example, where flattening of the upper surface of the head and enlargement of the acetabulum upwards and backwards occur before long, unless means are adopted to prevent this pressure. It is important to remember that this condition of contraction is almost pathognomonic of destruction of the articular cartilages and extension of the disease to the bone. In pure synovial disease there may be very marked swelling of the joint, but there will be comparatively little interference with movement, and nothing like complete rigidity.

Hence, when the bone is inflamed it is impossible to obtain proper rest to the joint by any form of fixation apparatus. The muscles are able to contract and press the inflamed surfaces together in spite of it, and thus perpetuate the inflammatory condition. It is therefore necessary to combine with immobilisation of the joint an amount of extension of the limb which is sufficient to tire out the contracted muscles, cause them to relax, and thus relieve the pressure of the inflamed surfaces against one another. Actual separation of the joint surfaces is not the object of extension, and, as its only aim is to tire out the muscles and prevent them from pressing the inflamed surfaces together, only a very moderate weight is required.

In the case of pure synovial disease without marked rigidity of the muscles, there is no object in employing extension unless deformity is present—in fact, extension would almost certainly do harm by stretching the inflamed ligaments, and would thus keep up the chronic inflammation. On the other hand, when the bony surfaces have become affected, great and immediate relief follows the employment of moderate extension; the pain ceases, and the nocturnal startings, which are the most distressing symptoms of this condition, are overcome. It must be remembered, however, that an amount of extension which is necessary to relieve the patient's pain at first may, if continued after the tonic muscular con-

traction has been overcome, cause recurrence of the pain from stretching of the diseased ligaments. It is not uncommon to find that, when a weight of about five pounds is applied, it will relieve the pain at first, but the latter will recur in a week or two as a result of the stretching of the inflamed ligaments after the muscular contraction has been overcome. The mistake commonly made in these cases is to think that the recurrence of pain implies that the contraction of the muscles has overcome the weight, and that the latter must be increased accordingly. It often implies, on the contrary, that the contraction has been overcome, and that the weight is too great and must be diminished. That this is so is borne out by the fact that the recurrent pain is not accompanied by starting pains at night. It is therefore most important to watch the result in all cases in which extension is being employed, and to reduce the weight as soon as it is evident that the muscular resistance has been overcome.

Counter-irritation.—In many cases benefit follows the employment of other measures which are of value in chronic inflammation unaccompanied by tuberculosis. Among these is counter-irritation, which, although a favourite remedy in chronic inflammation and formerly also in tuberculous joint disease, has been largely given up in the latter because it has no specific action against the tubercle bacillus itself. Its true therapeutic effect in diminishing the chronic inflammation has been much overlooked.

In pure synovial disease improvement sometimes follows the application of a succession of *blisters*, over or around the articulation, a fresh blister being applied as soon as the raw surface produced by its predecessor has healed. When, however, there is much pain in a deep-seated joint, which continues in spite of rest and extension, the *actual cautery* may be used with advantage (see Vol. I. p. 20). The most striking results are obtained from it in hip- and shoulder-joint disease, and in spinal caries; it does not seem to be of any particular value in pure synovial disease or in the more superficial joints, such as the knee.

Pressure.—As a rule, pressure is only of use when recovery is taking place. While the disease is active it is likely to cause irritation and actually to increase the inflammation. Hence, it should not be employed in the initial stages of the affection. The usual procedure is to *strap the joint with Scott's dressing—i.e.* unguentum hydrargyri compositum spread upon chamois leather. This is cut into strips two inches wide and long enough to more than surround the joint. The skin should be shaved and the strips applied from below upwards, each strip overlapping the one below it; as each strip is applied, pressure is brought to bear on the joint, just as in applying ordinary strapping. Scott's dressing combines mild counter-irritation with pressure, and the latter may be reinforced by surrounding the dressing with a mass of cotton-wool, over which an elastic bandage is applied. If preferred, a silicate bandage may

be put on outside the wool instead of the elastic one, so as to maintain constant pressure. The dressing should not be renewed oftener than once a week; in some cases it can be left a good deal longer. When it is removed the parts should be washed with ether soap and shaved afresh.

Should the Scott's dressing irritate the skin, its place may be taken by simple pressure applied through the medium of a mass of cotton-wool fixed on by a silicate bandage. If the wool be sufficiently thick, the bandage may be pulled as tight as the surgeon can apply it without fear of causing undue pressure. *Massage*, which is of much value in the later stages of simple chronic inflammation, is not permissible in active tuberculous disease.

Injection of Iodoform emulsion.—Injections of iodoform and glycerine and the artificial production of venous congestion—the method known as Bier's—have been strongly advocated, especially in Germany; the former method certainly often gives remarkably good results when there is fluid in the joint. The iodoform emulsion contains 10 per cent. of iodoform, and it is well to prepare it so as to insure freedom from micro-organisms, for iodoform is not an active antiseptic, and, although glycerine destroys septic organisms, it is hardly safe to trust entirely to its germicidal powers. We therefore recommend that the iodoform should first stand submerged in a 1 in 20 watery solution of carbolic acid for at least forty-eight hours, the bottle being frequently shaken so as to insure free access of the acid to the powder. Instead of using pure glycerine for the emulsion, we add to it a four-thousandth part of corrosive sublimate. The iodoform is strained from the carbolic acid, and is mixed with the glycerine in the proper proportion—10 per cent. The emulsion should be put in a sterilised bottle and allowed to stand for another twenty-four hours before use.

The emulsion is injected into the joint cavity, the amount employed varying with the age of the patient. In children the total amount used may be as much as two drachms, whilst in adults double that quantity may be employed should the size of the joint permit; indeed, a still larger quantity may be used in joints that have been distended with fluid, provided that the synovial membrane has not been scraped. No serious symptoms are likely to result from this, although complications have followed the injection of large quantities of iodoform and glycerine into chronic abscesses. Poisonous symptoms may be due to an excessive dose of iodoform, or to the glycerine. The symptoms produced by iodoform are delirium, pyrexia, rapid pulse, spasmodic movements and the presence of iodine compounds and sometimes albumen in the urine. Glycerine alone, however, may produce rise of temperature, blood pigment in the urine, increasing rapidity of pulse, vomiting, restlessness, and stupor ending in coma.

In a superncial joint, such as the knee, a fair-sized needle should be

introduced into the substance of the synovial membrane, and the emulsion injected into it in small quantities, a drop or two here and there. The point of the needle of the syringe should be moved about all over the synovial membrane so as to distribute the emulsion. Finally, the needle should be made to penetrate the joint cavity itself, into which one or two drachms should be injected and left behind. In children, anæsthesia is necessary as a rule, but in adults the injection can usually be made without it. It is not necessary to make more than two or three punctures through the skin; the needle can be pushed from one point to another subcutaneously. The injection should be repeated about once a week, the frequency mainly depending on the amount of reaction produced. The result is generally an increase in the swelling of the joint and some pain, which, however, pass off in two or three days.

This treatment should be persevered with for a considerable time, until it is evident that no good is resulting, or that the disease is well on the way to recovery. Should abscesses form, this need not necessarily lead to the abandonment of the treatment. They should be washed out and injected with iodoform and glycerine or aspirated in the manner already described (see Vol. I. p. 236).

Krause has indicated the principal spots in the chief joints where injections can be made most conveniently. *In the wrist* the needle should be introduced below the styloid processes of the radius and ulna; *in the elbow* it should be inserted over the head of the radius in front, and on each side of the olecranon behind; *in the shoulder* either from the coracoid process in front or from the junction of the spine of the scapula with the acromion behind. *In the ankle* the most suitable spot is in front of or below the tips of the malleoli, the needle being thrust first inwards and then upwards (it may also, if necessary, be introduced behind, on either side of the tendo Achillis); the best access to the *tarsal joints* is gained from the dorsum or sides of the foot. When it is desired to inject the *hip*, the thigh should be extended, adducted, and slightly rotated inwards and a long needle should then be entered above the great trochanter at right angles to the long axis of the thigh, and pushed in until it strikes the head of the femur, or the neck just beyond the head; it is then guided upwards along the bone until it enters the joint. Another method for the same purpose is described by Bünger as follows: A line is drawn to the tip of the great trochanter from the point where the femoral artery crosses the brim of the pelvis, and the needle is entered at the spot where this line crosses the inner border of the sartorius muscle. If pushed upwards and backwards it will enter the joint. The back of the joint can be reached from the posterior border of the great trochanter. To inject the *knee*, the needle should be entered on each side of the patella and also in the supra-patellar pouch.

Bier's Method.—This method, by which venous congestion of the joint is produced, has been employed either alone or in combination

with the iodoform and glycerine injections just referred to, and some surgeons have reported good results from its use. Its object is to produce congestion of the parts and so lead to the formation of fibrous tissue around the tuberculous area which will encapsule it, and thus prevent its spread. We cannot say that we think that this method is of very wide application. It can only be used advantageously for the joints below the hip and the shoulder.

The limb is first bandaged firmly from below upwards to within a few inches of the affected joint. An india-rubber bandage is then applied around the limb above the joint sufficiently tightly to interrupt the venous circulation and to cause a distinct, dull-red discoloration of the skin ; it is well to put a piece of boric lint beneath the india-rubber bandage. This congestion is maintained as long as possible ; generally it cannot be tolerated at first for more than twenty minutes to half an hour at a time. By slow degrees, however, the time may be extended until finally the bandage may be worn for eight to ten hours out of the twenty-four ; when the bandage is removed, elastic pressure should be applied over the joint itself, so as to get rid of the resulting œdema. The site of the pressure must be varied from time to time so as to avoid ulceration of the skin. The method may be continued for several weeks —in fact, as long as good results are produced by it.

Operative Measures.—The operative measures which may be called for in cases of tuberculous joint disease are :—

1. *Arthrectomy*, or removal of the diseased tissues without more of the healthy structures around than is absolutely necessary.

2. *Excision*, or removal of all the diseased tissues and certain definite portions of the ends of the bones.

3. *Amputation*, by which the limb is removed well above the limit of the disease.

Both expectant and operative measures may be combined in many instances ; when for instance an abscess is present, it may be washed out, injected with iodoform and glycerine, stitched up and the limb put on a splint. Again, sinuses may be thoroughly opened up, cleared out and stuffed with iodoformed gauze, after which the limb is similarly immobilised.

Indications for operation.—The following are the chief points in determining whether expectant treatment or operative measures should be employed. It may be stated here that the tendency of modern surgery is towards limitation of operations in the treatment of tuberculous joint disease. Although excisions and arthrectomies are excellent as regards the eradication of the disease, the functional result is not always the best that could be obtained; while, either because the disease is less virulent than formerly or as a result of better hygienic conditions, the results of expectant treatment have much improved. The poorer classes yield the majority of patients needing these operations, but the

increase of philanthropic societies and country hospitals, has made it possible to obtain for an increasing number of these patients the favourable conditions which were formerly confined to the rich. Operations are therefore much less frequently called for, and are diminishing in number every year.

Operative treatment may be necessary in the following cases: When chronic suppuration occurs early; when the disease is localised to one part of the synovial membrane or bone; at a later stage, when there is a deposit in the bone, with general synovial thickening; in cases of diffuse synovial thickening when the disease continues to progress in spite of careful expectant treatment; when a better functional result can be obtained by operative means than can be hoped for by expectant treatment; in adults with deformities which can be remedied only by operation; in some cases complicated by septic sinuses; in certain cases in which phthisis is present, or in which the general condition is such as to require immediate and complete removal of the local disease; in adults more frequently than in children; in the poor more often than in the rich.

Expectant treatment should be employed in cases of diffuse synovial disease without suppuration, in which none of the indications for immediate operative interference are present; in children when there are osseous deposits in parts that cannot be reached without excision—as, for example, in the hip-joint; and in some cases in which septic sinuses are present. Much will also depend upon the joint affected. For example, in the hip-joint expectant treatment should be persevered in much longer than in the more accessible joints.

Many circumstances will influence the choice of the particular operative method to be employed. The principal are the age of the patient, his general condition and the state of the joint itself. With regard to the last factor, the chief points are the presence or absence of chronic suppuration, the presence or absence of sinuses, and the distribution and character of the local disease.

Choice of operation.—The question as to which of the three radical operations—arthrectomy, excision, or amputation—should be performed in any given case is of great importance.

Amputation.—Amputation is the least dangerous of the three radical operations and is accompanied by the least shock. Hence in weakly subjects who cannot stand a necessarily prolonged operation like an arthrectomy or an excision, but in whom some radical measure is nevertheless essential, amputation is the best practice. When phthisis is present, or when the patient, is going steadily downhill, amputation is better than either of the other procedures. The improvement that takes place in the condition of the patient, and even in the condition of the lungs, after amputation through healthy tissues well above the seat of the disease, is often very remarkable. Should there be amyloid degeneration of the kidneys or other organs, amputation is the least dangerous of the

radical operations. In adults, and especially in old people in whom there is much suppuration about the joint, or in whom there are numerous septic sinuses present, amputation should be preferred. In the young, amputation may be better than excision in some joints, such as the knee when the disease is extensive and particularly when the bone is widely affected. When bad recurrence takes place after excision or arthrectomy amputation is generally necessary. Beyond this, no general rules can be laid down ; the decision must be made in each case according to the local condition and the general state of the patient.

Arthrectomy.—By arthrectomy is understood an operation in which the whole of the tuberculous tissue is removed with as little interference as possible with the surrounding healthy structures. In some cases this may merely mean removal of the osseous deposit; for example, where the deposit has not yet made its way into the joint and infected the synovial membrane. In other cases again it involves removal of the entire synovial membrane along with portions of the cartilage and even of the bone. As a rule, a complete arthrectomy is a very extensive operation and requires much patience and great care for its satisfactory performance. The whole of the diseased structures must be carefully removed by dissection. Scraping is inadmissible except over small areas of cartilage or bone, and, if employed at all, must be done with the greatest thoroughness. The exact details of how best to effect these objects are given in connection with the individual joints.

Excision.—In excision the synovial membrane must be removed with as much care and completeness as in arthrectomy, but, in addition, definite portions of the articular ends of the bones are removed, and, as a result, the operation is shortened and the risk of leaving disease behind is diminished. The operation is described in detail in connection with the individual joints.

The choice between arthrectomy and excision.—The first point of importance is *the relative danger of the two operations.* The risk from shock and loss of blood, which is by no means slight, is nearly equal in the two cases. *The possibility of dissemination of the disease throughout the body* is possibly greater in arthrectomy than in excision ; it is certainly greater if scraping is employed in place of clean cutting. There is not, however, a sufficient preponderance of danger in one operation over the other in this respect to influence our choice.

As regards *the chance of eradicating the disease* it must be admitted that recurrence is less likely to occur after a properly performed excision than after an arthrectomy. In the latter it is always difficult to be sure that the disease is entirely removed from the margins of the cartilages, as small fragments of synovial membrane containing tuberculous tissue may be overlooked in this situation, and also in the recesses of the joint, such as the inter-condyloid notch in the knee or the olecranon fossa and the neighbourhood of the orbicular ligament in the elbow. In an excision

these parts are cut away. Deposits in the bone are also more likely to be overlooked in arthrectomy than in excision, although they may be missed, even in the latter operation. Nevertheless, experience shows that the greater the care with which the operation is done, the better is the result ; and when arthrectomy can be thoroughly performed, it is a very satisfactory operation.

An important point for consideration is *the relative utility of the limb* after the two operations. When the cartilages are left intact, bony anchylosis after arthrectomy will not occur, and a certain amount of movement will sometimes be retained, especially if the joint is not kept at rest too long after the operation. In the joints of the upper extremity and in the ankle and the hip, this is a matter of considerable importance ; in the knee, on the other hand, a satisfactory movable joint can seldom be obtained; and no doubt the joint left after arthrectomy is weaker and more apt to become badly flexed than is the firm anchylosed one obtained by excision. After the latter operation the mobility depends in most cases on the amount of passive movement employed, and a perfectly firm joint can be usually obtained if desired.

Besides mobility, *the subsequent development of the limb* has to be considered ; this is of such immense importance in children as practically to outweigh all other considerations. In this respect arthrectomy is far more favourable than excision. There should be no interference with the growing portions of the bones in a properly performed arthrectomy unless a deposit actually involves the epiphyseal line, and consequently there should be no material arrest of development. After excision in children, on the other hand, the results in this respect are very bad, and in them excision—of the knee-joint particularly—is contra-indicated, as it is practically impossible to perform the operation without interfering with the subsequent growth of the limb. Serious shortening may occur even after excision of the hip ; in some cases there has been as much as eleven inches by the time the child has attained adult life.

The conclusion with regard to the choice between arthrectomy and excision, which seems warranted by all the facts, is that arthrectomy is the proper radical operation up to sixteen or eighteen years of age, and excision is the operation of choice later in life. Exceptions as regards arthrectomy in adults may be made in connection with certain joints. These will be dealt with later.

SPECIAL POINTS IN THE TREATMENT OF THE VARIOUS STAGES.

We shall now summarise shortly the methods of treatment most suited to the different local conditions enumerated on p. 112.

1. Localised tuberculous deposits in the bone which have not yet reached the joint.—These cases are rarely met with in practice,

mainly because the patient does not realise that there is anything serious the matter until the joint itself has become affected. Even when such cases do come under observation, it is difficult to recognise the existence of these deposits at an early stage. The chief point in the diagnosis is localised thickening of some part of the epiphyses of the bones entering into the joint, unaccompanied by marked pain or tenderness, and often occurring after some slight accident in a patient who either has a tuberculous family history or is the subject of tuberculosis elsewhere; this thickening tends to increase steadily. A radiogram should always be taken and may show the lesion quite definitely. In the early stages, however, they are not always evident.

Treatment.—When the deposit can be diagnosed sufficiently early, the point for consideration is whether it is possible to *remove the deposit* before the joint is affected and without opening it. In superficial and easily accessible bones very successful operations of this kind have been performed.

It is essential that the joint itself should not be opened, otherwise it may be infected during the removal of the deposit. The incisions should therefore be planned so as to avoid wounding the synovial membrane; at the same time, however, they must be sufficiently free to give full access to the affected region. When the bone is exposed, the periosteum is detached, and the dense compact tissue is cut away with a gouge over the affected area. The cancellous tissue may be cleared out with Barker's flushing gouge until the deposit is reached. A soft caseating deposit is recognised either by the presence of cheesy material or by its semi-gelatinous character and the absence of bone trabeculæ. On the other hand, a sequestrum is a yellow, dense, bony mass in the substance of the cancellous tissue.

When the deposit has been cleared out, the cavity in the bone should be packed firmly until the oozing has ceased. The packing is then removed and undiluted carbolic acid is applied to the interior of the cavity, the edges of the wound in the soft parts being held widely open. As this application is immediately followed by some oozing which tends to dilute the acid, the procedure should be repeated two or three times. The cavity in the bone should next be washed out with a 1 in 2000 sublimate solution, and then some of the 10 per cent. iodoform and glycerine emulsion (see p. 118) is introduced and the wound stitched up without a drainage tube. Should the operation be successful, the wound heals by first intention and the cavity in the bone gradually fills up with fibrous tissue which ultimately undergoes ossification. The limb should be kept on a splint for several weeks so as to favour the organisation of the clot.

In some cases there may be a tuberculous deposit in bones that are not readily accessible and where, therefore, there is no question of immediate operation. In these cases complete rest should be insisted upon, together with the application of splints. In a certain number of cases the actual

cautery applied to the skin over the joint seems to arrest the disease; it probably does so by causing a subsidence of the inflammation around the deposit, which finally becomes encapsuled.

2. Cases of localised deposits in the synovial membrane.—This is also a rare form of tuberculous disease, in the diagnosis of which there is often great difficulty. The deposits may occur either as pedunculated masses hanging into the joint (as described by König), or as simple localised thickenings of the synovial membrane.

The *treatment* is to cut down and remove the mass, whether it be pedunculated or merely a localised thickening. A curved incision is made, and a flap of the skin and subcutaneous tissues turned aside, and then the whole of the thickened tissues is cut away with scissors along with a portion of the healthy synovial membrane all round. It is well to immobilise the joint afterwards for three to six weeks in case any tuberculous disease has been left behind. In a number of cases the result is satisfactory; there is no recurrence of the disease and a movable articulation is secured.

If these cases are not operated upon at an early stage, the thickening spreads until the entire synovial membrane becomes involved, and the case is then one of typical diffuse synovial disease. The condition may be met with in any joint, but we have observed it most frequently in the elbow, in the neighbourhood of the head of the radius.

3. Cases of Empyema tuberculosum and Hydrops tuberculosus.—Special attention has been called by König to the fact that tuberculous disease of joints sometimes commences as a rapid effusion into the joint of fluid, which in some cases is of the semi-purulent, flaky nature so characteristic of tuberculous pus, while in others the fluid is clear. He has therefore applied the terms empyema tuberculosum and hydrops tuberculosus to these affections. At first sight it is easy to mistake the condition for one of chronic synovitis with effusion, as there is no marked pain, although generally there is more than is met with in the latter condition. The diagnosis is arrived at by observing that after a short time the synovial membrane begins to get thickened. This is in marked contrast to the simple hydrops articuli, in which the effusion may exist for a long time without any distinct thickening of the synovial membrane. Von Pirquet's test (see Vol. I. p. 520) is often of help in making a correct diagnosis. The cases which commence with the effusion of a semi-purulent fluid into the joint are usually grave, and imply considerable malignancy of the bacilli.

The *treatment* should generally be operative. The simplest plan consists in withdrawing the fluid by a trochar and canula, washing out the joint with a weak sublimate solution (1 in 6000), and injecting into it two to four drachms of the 10 per cent. iodoform and glycerine emulsion (see p. 118). Should the fluid re-accumulate, this procedure may be repeated, and in any case the iodoform injections should be made once a

week. At the same time the limb must be placed on a splint, and the general treatment of tuberculosis (see Vol. I. p. 231) attended to. Should it be found that the disease continues to progress, it will be necessary to resort to arthrectomy if the patient be a child, or to excision if an adult.

4. Cases in which an osseous deposit has burst into the joint.—Here sudden infection of the synovial membrane takes place, the symptoms being great tenderness, pain on movement, starting of the limb at night, and the other symptoms formerly described under the term 'ulceration of cartilage.' On investigating the history, it will usually be found that, for some time previous to the sudden onset of pain, the patient has limped and complained of a feeling of weight, uneasiness, or pain in the limb.

The *treatment* depends to a considerable extent on the general condition of the patient, his age, and the particular joint affected. Expectant treatment usually gives unsatisfactory results, and it is only in joints which are not readily accessible—such as the hip—or when the patient is not in a condition to stand a long operation, that the surgeon will be tempted to employ it.

It is in some of these cases that the actual cautery (see Vol. I. p. 20) applied over deep-seated joints—such as the hip or the shoulder—is of most value. A patient, after suffering agonies from starting pains at night in spite of fixation of the joint by splints or extension apparatus, will often lose the pain immediately after the application of the cautery. It is, however, not infrequently found that, should the wound be allowed to heal too soon, the pain recurs quickly.

When improvement does not follow in spite of local treatment, it is advisable to have recourse to operative measures at once; the choice will lie between arthrectomy, excision, and amputation. The meaning, value, and relative uses of these have already been discussed (see p. 121). Another indication for operative interference is when the disease affects a joint such as the elbow, ankle or shoulder in which the movable joint procured by operation is preferable to the stiff one resulting from non-operative methods.

5. General synovial disease without destruction of the cartilages or inflammation of the bone and without abscesses.—These cases are the ones best suited for expectant treatment, and there is no need to consider the question of operation until it is evident that no progress is taking place or that the local disease is extending. An exception, however, may be made in the case of bread-winners, to whom it is of the greatest importance to get back to work within a reasonable time; in them it may be wiser to resort to operative measures earlier, so as to restore them to health more rapidly. When the patient is well-to-do and can afford the time, however, palliative measures (see p. 115) should be employed in the first instances.

When expectant treatment is employed, years must elapse before

the disease can be considered cured; indeed, two or three years should be looked on as quite a short limit. Should the treatment be abandoned too soon and the patient allowed to move the limb freely or to bear weight upon it, the disease is almost certain to recur. It is far better to err on the side of waiting too long than to run the risk of a recurrence. The chief difficulty in carrying out prolonged treatment of this kind is, that the patient is afraid that the limb will become stiff, and while this is no doubt frequently the result, it must be impressed upon him that the cure of the disease is the primary object; in many cases in which the disease has undergone arrest before destructive changes are advanced, however, considerable movement and in some cases even a perfect joint results. This is far more likely to occur after rest than after attempts to keep up movement during the treatment so long as the disease is active. If movement is allowed, inflammation will continue, and fresh cicatricial tissue will form, so that there will be more adhesions inside the joint and greater contraction of the fibrous structures outside. If, on the other hand, the joint is kept at rest, the inflammation will subside sooner, and there will be less formation of cicatricial tissue, and therefore less difficulty in stretching this by the natural movements.

A most important point to bear in mind after recovery is, that it is never permissible to attempt to restore movement forcibly. Although the 'cure' of tuberculous joints is commonly spoken of, recovery is seldom complete. In the great majority of cases tuberculous material is still present, and, having undergone encapsulation, it gives no trouble so long as no fresh injury occurs. These deposits may remain quiescent indefinitely unless forcible movements are employed, when there is great risk of lighting up the disease once more. Patients are frequently met with who, having suffered in early life from tuberculous joint disease, and thinking that it is time for movement to be improved, go to a bone-setter and have the joint forcibly moved, with the result that the disease recurs in a worse form than before.

When it is obvious that no progress is being made in spite of careful treatment on these lines, or when the occurrence of pain or rigidity points to extension of the disease to the cartilages and the bone, operative interference is indicated. The particular operation chosen will depend upon the circumstances of the individual case (see p. 122).

6. Cases complicated by unopened abscesses which may or may not communicate with the joint.—Here operative measures must be undertaken at once, because the chance of absorption of the abscess is extremely remote, whilst the risk of its spreading in undesirable directions is very great. The important point for consideration is whether it will not save time, and also be of advantage to the patient, to combine arthrectomy or excision with the treatment of the abscess. The decision will depend to a considerable extent on the joint affected, on the local condition (particularly with regard to the number, size, and situation of the abscesses),

and on the general health of the patient. In the hip-joint, for instance, it must be remembered that excision does not give a good functional result, and, should only a single abscess be present about the joint and should the patient be in good health, it is usually best to treat the case on the lines laid down for the treatment of chronic abscess (see Vol I. p. 233) without resorting to excision until it is evident that this is absolutely called for. Something like 70 per cent. of cases of hip-joint disease accompanied by a single abscess may be cured in this way.

In the more superficial joints, on the other hand, such as the knee, where it is possible to dissect out the abscess, and where the functional result after operation is good, it is usually best to go on at once to the radical operation. In most of these joints the functional result after arthrectomy or excision is as good as can be obtained by expectant treatment, while the risk of complications is diminished by the more thorough method. An additional argument in favour of a radical operation under these circumstances is, that the formation of an abscess in connection with a tuberculous joint indicates that there is a strong tendency to breaking down of the tuberculous tissue, and that in all probability similar caseating processes are going on elsewhere, and therefore the chances of recovery by natural means are correspondingly less.

The rules already laid down (see p. 121) as regards the choice of a radical operation apply here as elsewhere, but in elderly people amputation will be more frequently called for than in the other types of the disease, especially if there are a number of abscesses about the joint. To excise the joint or to perform arthrectomy without removing the abscesses completely would be futile, because the cut surfaces would become infected afresh, while the length of time and the extent of the operation required for the removal of extensive and numerous abscesses would be so great as to jeopardise the patient's life from shock or loss of blood.

7. Cases complicated by septic sinuses.—Here, as a rule, operation is called for. In young children in whom there is no actual sequestrum or bony deposit, healing may occur, however, even though septic sinuses are present, if the limb be fixed and free drainage provided. In children, therefore, this should be done unless there be some reason to the contrary. The limb should be immobilised, free drainage provided by opening up the sinuses as far as may be necessary, and the child should then be placed under the best hygienic conditions. The treatment of septic sinuses in connection with the tuberculous process has already been referred to (see Vol. II. p. 457). In the treatment of these sinuses, it is most important that they should be dressed with full antiseptic precautions. It is common to find that precautions are relaxed in these cases, on the ground that the sinuses are septic already, the presumption being that a few organisms, more or less, do not matter. This is not the case; on the contrary, the fresh organisms may be much more virulent than the old ones: whereas in an efficiently drained sinus which is dressed

antiseptically the pyogenic organisms may die out, or become much reduced in virulence.

Should it be found after a reasonable time, that the sinuses show no tendency to heal, and should the discharge from them be free, one of the radical operations must be considered. This will be more often called for in adults, especially in old people, in whom there is little likelihood of the sinuses healing.

At first sight it would seem that arthrectomy is out of the question in these cases, because the large raw surface left after the operation might become infected from the sinus. As a matter of experience we have found, that if care is taken to scrape these sinuses and disinfect them with undiluted carbolic acid before commencing the operation, and then to dissect them out along with the rest of the tuberculous tissue, the chances of sepsis are slight, particularly if the wound be afterwards sponged over with undiluted carbolic acid and good drainage arranged for. Hence we are of opinion that the presence of septic sinuses is not necessarily a contra-indication to arthrectomy or excision.

With regard to the choice between excision and amputation, that will depend upon the number of sinuses, on the amount of sepsis, on the general condition of the patient, and on the presence or absence of tuberculous disease elsewhere. In all cases when the patient is unable to stand a prolonged operation, excision is not advisable, for the removal of the septic sinuses adds considerably to the length of the operation, and consequently increases the shock and loss of blood.

8. Cases accompanied by anchylosis and deformity with or without sinuses.—These cases occur when the disease has been neglected or when splints have either not been applied at all or have been inefficient. The limb may be quite useless from malposition, and the treatment of this complication will depend upon the stage at which the disease has arrived, for the case may come under notice either while the disease is still active or after it has subsided and only the deformity is left.

When the disease is still active, an attempt may be made to restore the limb to its proper position either by mechanical means, or by operative measures. When the deformity is slight, splints or other apparatus may be employed, but care must be taken to rectify the malposition gradually and without force. When the deformity has been forcibly reduced the result commonly is that marked exacerbation of the disease occurs. Attempts to improve the position of the limb must therefore be made very gradually and gently during the active stage of the disease, and much can be done either by allowing the weight of the limb itself to tell—as is done by Thomas's splint in flexion of the hip-joint—or by gentle extension with weights or elastic bands.

When the activity of the disease is considerable there is, however, considerable risk in attempting to restore the limb to its proper position by mechanical means, and the question of operative interference must

therefore be put in the foreground. In children the best treatment in most cases is to perform arthrectomy if the joint is accessible. By so doing, the disease is not only removed and the patient cured, but the limb can be restored to its normal position. Any obstacle to reposition after arthrectomy is usually due to a contracted tendon or band of fascia which can be divided. When tenotomy is required it is necessary to employ a fresh knife, so as not to infect the tendon sheath. In adults excision should be employed, and the limb can generally be brought into good position by removing sufficient bone.

When the disease is entirely cured and a deformity only is left behind, suitable operative measures for the deformity should be employed. The nature of the operation which may be necessary depends, however, so much upon the particular deformity present that this matter must be dealt with in connection with the individual joints concerned.

CHAPTER XIV.

SYPHILITIC AFFECTIONS OF JOINTS.

During the course of syphilis various joint affections may be met with; they occur during the secondary or the tertiary stage, and are also seen in hereditary syphilis.

JOINT AFFECTIONS DURING THE SECONDARY STAGE.

Two forms of joint affection are met with during the secondary stage. About the period when the earliest secondary symptoms manifest themselves, it is not uncommon to find the patient complaining of indefinite pain and stiffness in a joint, unaccompanied by any marked tenderness on pressure, but generally associated with pains in the bones and muscles. There may be some effusion into the joint, with a certain amount of fever, and several joints may be affected. It is probable that the affection is simply a congestion of the synovial membrane and the other joint structures similar to the congestive eruptions on the skin.

In the later stages of the secondary period, true synovitis with effusion is sometimes seen. This commences slowly and painlessly, and is accompanied by slight stiffness followed by swelling due to effusion, which though usually moderate in amount, may sometimes be considerable. The affection is most common in the knee, and may be bilateral. The effusion consists of a clear serous fluid, and there is no tendency to suppuration, nor are there any signs of acute inflammation. A marked feature of this secondary syphilitic synovitis is its intermittent character; at one time the joint may be much distended, whilst a few days later the fluid may have entirely disappeared; then again, for no known reason, the fluid reappears.

TREATMENT.—The general treatment is identical with that of secondary syphilis (see Vol. I. Chap. XI.). As a rule no local treatment is required or at most an elastic bandage, or strapping with Scott's ointment may be used (see p. 117).

JOINT AFFECTIONS DURING THE TERTIARY STAGE.

At this period there may be a gummatous deposit either in the synovial membrane or in the peri-synovial tissues. It is most common to find definite nodules or gummata, but occasionally there is a diffuse gummatous infiltration of a part or the whole of the synovial membrane.

When left untreated, these gummata extend on the one hand towards the interior of the joint, and on the other towards the skin, so that finally the skin may give way and leave a typical tertiary syphilitic ulcer extending down to the joint, with which it may actually communicate. Septic infection and acute arthritis result.

In the rarer forms, marked by diffuse gummatous infiltration of the peri-synovial tissue, the joint becomes somewhat irregularly enlarged and the synovial membrane is apparently thickened, so that it may be difficult to distinguish the condition from tuberculosis. The syphilitic thickening, however, is not so uniformly diffused over the whole joint as is the tuberculous lesion, and movement, although restricted, is unaccompanied by pain. Effusion of fluid is usually present.

Gummata may also be met with in the epiphyseal ends of the bone, and may open into the joint and cause swelling of the synovial membrane and effusion into the joint. In some very rare cases the symptoms which accompany this communication with the joint are fairly acute, and are not unlike the result produced by the bursting of a tuberculous deposit into the joint (see p. 111).

TREATMENT.—*General.*—The most important point is to adopt the general treatment suitable for tertiary syphilis (see Vol. I. Chap. XI.).

Local.—Local treatment is also of value. Benefit may be obtained by applying *mercurial ointment* over the joint, which may be done by rubbing half a drachm of unguentum hydrargyri well into the skin, and then putting on a mass of wool with an elastic bandage over it, so as to combine pressure with the mercurial application. It is also well to apply a splint during the early stage, especially in the case of the knee-joint. This treatment often suffices to cure the disease, but sometimes very rebellious tertiary joint lesions may improve up to a certain point and then come to a standstill. This is most likely to be the case when there is an extensive deposit in the bone rather than an affection of the synovial membrane, and the question of operative interference will then have to be considered. The X-rays are very useful in determining whether a sequestrum is present.

The *operative measures* have been discussed in connection with syphilitic diseases of bone (see Vol. II. p. 461, and also Vol. I. p. 225). Should there be a syphilitic ulcer communicating with a gummatous deposit, it will certainly be advisable to scrape away as much of the

gummatous material as possible, and to remove any diseased bone or any sequestrum that may be present. In this way the amount of morbid material that has to be removed by the agency of drugs is much diminished, and the prospects of a speedy cure are proportionately increased.

JOINT AFFECTIONS IN HEREDITARY SYPHILIS.

It is not uncommon for a joint to become affected in hereditary syphilis as the result of the inflammatory condition of the articular ends of the bone known as osteo-chondritis (see Vol. II. p. 462). As a rule, there is simply some effusion into the joint cavity without any definite syphilitic affection of the joint structures; sometimes, however, there may be a deposit of gummatous material in the synovial membrane. The condition is most common in the knee, generally on both sides, and may or may not be associated with the presence of gummata in the epiphyses.

TREATMENT.—This is essentially that already described for hereditary syphilis (see Vol. II. p. 462, and Vol. I. p. 236). The treatment usually results in complete recovery.

SYPHILITIC DACTYLITIS.

There is an affection termed *dactylitis syphilitica*, which occurs in hereditary syphilis and is often confounded with the strumous form. In syphilis, the affection is primary in one of the joints, whereas in the strumous variety it is an osteo-myelitis of the phalanx. Syphilitic dactylitis is usually multiple, affecting the joints in several fingers, and giving rise to a fusiform swelling, the centre of which is opposite the affected articulation. It is due to a gummatous infiltration of the synovial membrane, and yields readily to the treatment appropriate for hereditary syphilis.

CHAPTER XV.

NERVOUS AFFECTIONS OF JOINTS.

AFFECTIONS DUE TO ORGANIC LESIONS OF THE NERVOUS SYSTEM.

In certain cases of disease or injury of the spinal cord or the main nerve trunks, peculiar and characteristic affections of the joints are met with, which are clearly the result of the nervous lesion. These affections are most commonly seen in locomotor ataxia, when the joint trouble receives the name of 'Charcot's Disease'; similar conditions are also met with in cases of syringo-myelia. Joint affections have been noted in connection with other nervous lesions—such as hemiplegia and inflammation of the main nerve trunk supplying the articulation. In the latter cases the affection usually occurs in the smaller joints—such as the phalangeal or metacarpo-phalangeal joints—and consists of painful swelling of the joint followed by stiffness, and sometimes complete anchylosis, or by disorganisation of the articulation.

CHARCOT'S DISEASE OF JOINTS.

In locomotor ataxia the joints most frequently affected are those of the lower extremity, especially the knee and hip. The disease may be monarticular or may affect several joints, and generally occurs in the early stage of locomotor ataxia before the onset of the ataxic symptoms. In syringo-myelia the affection attacks the joints of the upper extremity much more frequently than those of the lower; the shoulder is its most common seat.

Pathological Changes.—Among the most striking features of Charcot's disease are the rapid atrophic changes which occur in the articular ends; the cartilages disappear and the bone beneath often becomes so destroyed and altered in shape as to change the appearance of the joint entirely. In many cases there is subsequently a tendency to

hyperplasia, and new bony outgrowths are met with at the articular edges of the bones, or masses of bone are deposited in the capsule. The relative amount of these changes depends largely on the joint affected; in the hip and shoulder, for example, the changes are essentially atrophic and there is but little formation of new bone; in the knee and the elbow, on the other hand, the atrophic changes, which at first are as marked as in the case of the other joints, are followed by considerable hyperplasia, and a large amount of new bone may be formed and may help to fix the articulation.

Symptoms.—The most marked characteristics of Charcot's joint disease are the rapidity with which the changes occur—the joint may be entirely disorganised within a few days—and the extraordinary painlessness of the whole process. The first symptom is usually sudden swelling of the joint, to which the patient's attention is called by finding that the joint is somewhat stiff. The swelling is mainly due to synovial effusion, but there may also be œdema of the structures around; sometimes the synovial membrane is so distended that it gives way and the fluid becomes diffused outside the joint. The effusion begins to disappear in a few weeks, but considerable enlargement of the articulation usually remains. The bursæ around the joint are often distended with fluid.

Soon after the onset of the disease, examination shows that the ends of the bones have undergone remarkable alterations. There is coarse, bony grating on moving the joint, while the normal outlines of the bones are lost. The ligaments undergo destruction to such an extent that a flail joint results, and the limb can be moved freely in abnormal directions, whilst it is often possible to produce dislocation and to reduce it again quite easily; these movements cause no pain. When the patient has been bearing weight upon the limb, the chief destruction of bone will be found at the points of greatest pressure. In the cases accompanied by a tendency to hyperplasia, bony outgrowths will be found after a short time springing from the edges of the articular surfaces and embedded in the capsule; if this process is extensive, sufficient fixation of the joint may occur after the lapse of some time to enable the patient to bear weight upon the limb. Indeed, it is sometimes remarkable how well the patient can walk with such a joint.

Complications.—It is not uncommon for the capsule and the skin to give way, so that a sinus leads into the joint. It is, however, a remarkable fact that in a considerable number of cases in which no antiseptic precautions have been adopted, suppuration either does not occur, or, when it does, is only very slight, and is not marked by constitutional or local symptoms. Sometimes, however, the reverse is the case and acute arthritis is set up.

A joint that is the seat of Charcot's disease may occasionally become the seat of *tuberculosis*. Several cases of this kind have been noted, and it is found that they run much the same course as other tuberculous joints.

Treatment.—Since the joint affection is dependent upon the nervous lesion, we cannot expect to do much for it unless the primary disease can be cured. Since that is at present apparently impossible, the functions of the joint cannot be restored. Treatment must therefore be directed to limiting the destructive processes and to giving the joint as great a measure of stability as possible.

Removal of the synovial fluid.—Should the joint be seen in the early stages, when the capsule is distended with fluid, the fluid should be withdrawn as soon as possible. The continued distension of the capsule is a great menace to the future stability of the joint, on account of the stretching and atrophy of the ligaments and capsule to which it gives rise. The fluid may be removed by aspiration, repeated if necessary, but a more efficient plan is drainage. An incision sufficiently large to admit a No. 16 drainage tube should be made into the joint, which is drained for two or three weeks, until the tendency to effusion has passed off. Naturally the strictest precautions as regards asepsis of the wound must be taken in these cases.

Splints.—The limb should be put on a splint so arranged that the ends of the bone are not pressed against one another. After the drainage has been dispensed with, and the wound has healed, the limb may be put up in a plaster of Paris or silicate bandage. This keeps the joint in good position and at the same time gives it sufficient rest to allow of the deposit of new bone in situations which will give support to the articulation.

Apparatus.—In about six months' time the plaster or silicate casing may be abandoned, and some form of orthopædic apparatus should be worn so as to enable the patient to use the limb. The best of these in the lower extremity is Hessing's splint (see Vol. II. p. 375). The apparatus must be worn for the rest of the patient's life, for, although the joint may become fairly firm from the formation of fresh bone, it rarely becomes strong enough to support the weight alone.

It has been proposed to excise joints thus affected, but the operation may be definitely rejected as useless; no union occurs and, consequently, the patient may be considerably worse off than he was before.

Amputation.—Amputation may have to be considered in some cases; the chief condition likely to demand it is disease of the ankle-joint—when one side alone is affected, and when the ataxic gait has not yet developed. Under these circumstances it may be impossible to control the joint by an apparatus sufficiently to enable the patient to get about, and matters may be improved by performing a Syme's amputation (see Vol. II. p. 538) so as to enable an artificial foot to be worn. In the great majority of cases, however, no operative interference beyond the removal of the effusion in the early stages is at all promising

JOINT AFFECTIONS FROM NEURITIS.

When the affection is due to neuritis or to injury of the peripheral nerves, the question of operation will have to be considered. Operation will have for its object either the arrest of the neuritis or the union of divided portions of the nerves, after which a certain amount of recovery from the joint trouble may be hoped for. For the treatment of these nerve lesions, the reader is referred to Vol. II. Chap. X.

NEUROSES OF JOINTS.

These affections generally occur in women between the ages of eighteen and thirty, but may be met with at any period; they also occur in hysterical men. Any joint may be affected, but the hip and the knee are the most common. In some cases the diagnosis is extremely difficult. True joint disease may be simulated almost perfectly, but, as a rule, examination reveals a material discrepancy between the symptoms complained of, and those which should be present were the case one of organic disease. This is particularly noticeable in respect of the pain, which, in hysterical cases, is often said to be extremely severe and even excruciating. It will, however, usually be found that the pain is superficial and is not excited on jarring the articular ends together. One of the marked symptoms of the hysterical condition is hyperæsthesia of the skin and structures around the joint. The general condition of the patient also frequently denotes the presence of hysteria.

Another great characteristic of these affections is contracture of the muscles around the articulation, so that the limb is usually flexed and attempts to extend it cause great pain. Notwithstanding this, it will generally be found that there is no thickening of, and no morbid changes in the joint. These contractures usually disappear completely under an anæsthetic, and do not return until the patient comes round again. Hence one of the most important points in the diagnosis, and also an important element in the treatment, is the examination of the joint under an anæsthetic. At a later stage, however, organic contracture of the muscles may occur, or adhesions may form in the peri-articular tissues and interfere with the mobility of the limb; in these cases the deformity does not disappear entirely when an anæsthetic is administered.

TREATMENT.—The best results are usually obtained in young patients, and the main lines of treatment are to encourage the use of the joint and to interest them in various matters, and so to prevent them from concentrating too much attention on their particular ailment. In some cases it may be advisable to impress the patient by the application of some painful counter-irritant to the joint.

In adults the treatment is very difficult, and it is essential to acquire the patient's confidence and to realise that she really does suffer pain,

although this may not be due to organic causes. It is quite useless to treat the case as if it were trivial, to make light of the pain, and to set the patient down as an hysterical person, with whom there is nothing the matter. The only result is that the patient loses confidence in her medical man; when she does this, the sooner she calls in another the better.

General Treatment.—The first essential in the treatment of all these cases is to encourage the patient to look forward to complete recovery, to provide cheerful surroundings and to interest her in matters other than her own ailments. Her friends should avoid directing her attention to her trouble by sympathetic references to it. In addition, the general health must be attended to, and tonics, particularly iron, should be administered.

The Weir Mitchell Treatment.—In really bad cases when no improvement follows milder measures, the employment of the method of treatment introduced by Dr. Weir Mitchell is often of the greatest benefit. The first essential is to remove the patient from her relatives and friends completely for a time, and thus get rid of the injudicious sympathy which keeps the patient's attention constantly concentrated on her troubles. This is done by placing her under the care of a firm but cheerful nurse in some suitable home, cutting off all communication with the friends, and promoting the vigour of the body by nourishing diet, massage, and exercises. The following is a short sketch of the main points in the treatment.

The first step is to *remove the patient from her home* and place her in charge of a suitable nurse. Although not absolutely necessary in all cases, this is of the highest importance and is indispensable in the worst forms. The patient should not be allowed to see, or communicate with, her relatives or friends without permission. The surgeon will be wise to refuse to undertake the case except upon this understanding. When the hysterical condition is not very marked, some relaxation of this rule may be permitted, but care must be exercised not to go so far as to defeat the primary object of the plan—viz. the abolition of the injudicious sympathy by which these patients are surrounded.

For the first two or three weeks *the patient should be confined to bed*, even though the joint affected be in the upper extremity, and should not be allowed to sit up, to read, or even to feed herself, until the general condition has much improved. Drugs, especially narcotics, should be avoided; the massage and feeding soon render them unnecessary, the patient rapidly losing her pain and sleeping well.

The *massage* should be done by a special masseuse, and not by the nurse in charge of the patient, who has enough to do with her ordinary duties. It should be applied to the whole body, working upwards from the extremities, and its aim is to improve the circulation generally, and produce extensive tissue-changes. The skin is anointed with oil

previous to the manipulations, and the muscles operated upon must be relaxed as fully as possible. Specially vigorous manipulations are directed to the joint affected, and passive movements of all the joints should be carried out. At first the rubbing should be done for about twenty minutes daily, but the length of the sitting should be increased until, at the end of a week or so, it occupies an hour and a half twice a day. At first it causes great exhaustion and some pain ; soon, however, it becomes grateful and soothing. The faradaic current may be used simultaneously with the rubbing and should be applied to the entire body, but chiefly to the muscles in the neighbourhood of the affected joint. The two electrodes, well wetted and held about four inches apart, are moved firmly over each muscle in turn, and a current strong enough to cause vigorous contraction is employed for about half an hour twice a day.

The patient is placed upon a milk *diet* for two or three days. The milk is given at intervals of three hours, in quantities of three ounces, rapidly increasing up to half a pint at a time ; before the end of the first week the patient is taking as much as two or three quarts daily. After the first few days a steadily increasing amount of solid food is given in addition, until the patient is taking three large meals daily besides the milk. In favourable cases this stage may be reached in a fortnight and, as a rule, the patient will put on flesh rapidly. The massage and electricity apparently cause so much tissue-change that there is no dyspepsia.[1]

When this treatment is successful, the pain and insomnia rapidly disappear, and the masseuse is soon able to handle the affected joint without pain and carry out movements steadily increasing in range ; it is not uncommon for the patient to be able to use the joint fairly well within the first week. The improvement progresses rapidly until, in a good many cases, the cure is complete.

Hypnotism.—Hypnotism may be of value in susceptible subjects. They can be made to receive suggestions that the joint has become well and can therefore be freely moved, and this may lead to complete and rapid disappearance of all the symptoms. Sudden mental shock may also lead to recovery, even when the affection has persisted for a long time, but it is a method of treatment which must necessarily be more the result of accident than of design.

Local Treatment.—In the early stages, no local treatment of the joint besides massage should be employed ; splints and other forms of apparatus should be avoided. In the later stages, however, when the contracture of the muscles has led to true organic shortening, or when there are contractions in the capsule of the joint, surgical measures may become necessary. When the contracture does not disappear under

[1] *Fat and Blood.* By S. Weir Mitchell, M.D., Philadelphia. *The Systematic Treatment of Nerve Prostration and Hysteria.* By W. S. Playfair, M.D., F.R.C P., London.

an anæsthetic, and is due to adhesions about the joint, the latter may be treated by occasional movement under an anæsthetic, combined with daily passive and active movements. When, however, the muscles are permanently shortened, recovery cannot take place until their tendons have been divided. After this operation the joint must be fixed in proper position until union of the divided ends of the tendons has occurred, or, at any rate, for two or three weeks; the apparatus meanwhile should be removed daily, and massage and electrical treatment (*vide supra*) should be practised.

When there is excessive pain, it has been proposed to excise the joint or amputate the affected limb, but this should never be done. The pain recurs either in another joint or in the nerves of the limb, fresh amputations may be called for, and the patient is not benefited at all. No active surgical intervention should be adopted for hysterical joints in adults. It is well to bear in mind that a joint that has been the seat of an hysterical affection may become affected with some organic lesion, in which case it will be necessary to treat the latter; while doing so, the fact that the patient is neurotic must influence the treatment to a certain extent.

CHAPTER XVI.

RHEUMATOID ARTHRITIS: OSTEO-ARTHRITIS.

ACUTE RHEUMATOID ARTHRITIS.

This disease occurs especially in young female subjects, and runs an acute or subacute course. Some authors consider that the affection is related to rheumatism, some that it is due to an altered condition of the blood, some to reflex irritation, some again to disease of the anterior cornua of the spinal cord; while lately Bannatyne and Blaxall have described micro-organisms, to which it is possible that the disease may be due.

The affection may be preceded by vague neuralgic pains and usually begins in the smaller joints, particularly the fingers, which become swollen and hot; there may be pyrexia of the hectic type. The disease apparently begins in the synovial membrane and is accompanied by some effusion into the joint in the first instance, while softening and destruction of the cartilage, with erosion of the subjacent bone, set in before long. The joint becomes swollen and the ends of the bones are apparently enlarged, though radiograms show that this is not so in the early stage, and that the appearance is due partly to swelling of the synovial membrane, and partly to wasting of the muscles in the neighbourhood of the joint. The disease is frequently accompanied by considerable anæmia, and there is often pigmentation of the skin. A marked feature is the muscular wasting, which is too rapid and too extensive to be accounted for by mere disuse. When the fingers are affected, the joints become spindle-shaped and the digits are deflected to the ulnar side.

TREATMENT.—The affected limb should be put upon a splint and the joint aspirated if necessary. Guaiacol and cod-liver oil should be administered, and it is well to send the patient to a suitable place where thermal treatment may be obtained; the latter point is referred to below. These cases usually come under the care of the physician, and need not be further considered here.

CHRONIC OR MONARTICULAR RHEUMATOID ARTHRITIS (OSTEO-ARTHRITIS).

The nature of this disease has given rise to much dispute. Some authors limit the term 'rheumatoid arthritis' to the form which closely resembles the acute—viz., it is polyarticular and affects the small joints. The monarticular form they speak of variously as 'senile arthritis,' 'osteo-arthritis,' or 'traumatic arthritis.' Similar changes, however, occur in all these cases, whether the disease follows an injury or arises spontaneously, and these changes resemble those found in rheumatoid arthritis proper so closely that it seems best to group together all the cases under one heading, whatever be the apparent mode of origin. The parasitic theory as to the origin of rheumatoid arthritis is not sufficiently well established to enable the presence or absence of bacteria to be used as a point of diagnosis. The latest view is that the affection is due to chronic sepsis, such as occurs from pyorrhœa alveolaris or from intestinal stasis.

The disease is usually limited to one or two joints and chiefly affects the larger ones, such as the knee or the hip. Its progress is steady with only occasional exacerbations. The patient first notices that the joint is stiff and somewhat painful; in the morning the stiffness passes off to some extent as the joint is exercised. After a time the pain increases and may be the marked feature of the case. The difficulty in movement may also increase, and the changes taking place in the joint surfaces may cause the limb to assume abnormal positions or even to undergo actual dislocation.

As time goes on, the stiffness increases, partly from the shrinking of the capsule, but mainly from the formation of osteophytic outgrowths around the joint. Alterations in the shape of the articular ends interfere with the normal movements, and the patient becomes more and more crippled as the disease progresses; if several joints in the lower extremity are affected, he may be entirely bed-ridden.

Little is known as to the *causation* of the disease. It is more frequent in cold, damp climates than in dry, warm ones, and it is always worse in those individuals who are exposed to cold and damp. A very common history is that the disease followed an injury, such as a sprain or twist of a joint, or a fracture in the neighbourhood of, or extending into one; a loose body in the joint is very apt to set up changes characteristic of this disease. By some it has been attributed to rheumatism, by some to gout, and by some to a combination of the two; hence the term 'rheumatic gout.' There is no evidence, however, that either gout or rheumatism play any part in the affection. The influence of chronic sepsis has been already referred to.

The *pathological changes* are most marked in the articular cartilage, which becomes converted into fibro-cartilage, and is often worn away entirely in parts by the movements of the joint. As the cartilage disappears, the bone beneath becomes sclerosed, so that the surfaces in contact are dense and smooth like ivory; beneath this dense layer, softening occurs and absorption takes place. Bony outgrowths appear in the neighbourhood of the joint, and may form a ridge around the articular surface, which is often spoken of as 'lipping' of the articular ends. Large bosses of bone may also be formed, and the same change may occur in the synovial fringes or the capsule of the joint, so that movement may be considerably interfered with; portions of these bony masses may become broken off and form loose bodies in the joint. It is not uncommon to find bony masses at the insertions of muscles about the joint. The synovial membrane may or may not be thickened, but there is generally a villous condition of its surface—an affection practically identical with villous disease of the synovial membrane (see p. 107).

TREATMENT.—Treatment is very unsatisfactory. It may be possible to arrest the progress of the disease to some extent, but it is impossible to cure it, since the joint can never be restored to its normal condition. Indeed, it is only in the early stages that any marked improvement can be obtained; in the more advanced cases the trouble progresses, very slightly influenced by any treatment with which we are at present acquainted.

General Treatment.—The patient must give up, if necessary, any occupation involving exposure to cold or damp, and, if possible, should live in a *warm, dry climate*, such as that of Egypt, California, or Queensland. Besides being placed under the best possible hygienic conditions, the patient should be carefully dieted. A mixed *diet* is best, but the stronger animal foods should be taken sparingly and white or raw meat substituted for them; plenty of fat should be insisted upon, and an excess of farinaceous food should be avoided. The patient may be encouraged to drink large quantities of hot water between meals, with the object of eliminating waste or toxic products from the blood. When the patient is very obese, it will often be advisable to put him on a diet which aims at reducing the fat. For this purpose a diet consisting almost entirely of minced beef or mutton with green vegetables, beef tea, and white of egg is a good deal in vogue at the present time. Large quantities of hot water are taken between meals. Any source of sepsis must be carefully looked to; pyorrhœa alveolaris must be efficiently treated and the bowels regulated.

The best *drugs* are iron (if the patient is anæmic) and arsenic, which should be ordered in the early stage in all cases. Guaiacol carbonate in five- to ten-grain doses, in cachets, three times daily after food, is also beneficial. Cod-liver oil is valuable, especially in the poor; it should

be given at meal-times in quantities as large as the patient can take without interfering with digestion. When cod-liver oil cannot be taken, proportionate quantities of fat should be added to the diet.

Local Treatment.—A good deal may be done to arrest the progress of the disease, to prevent stiffness, and to relieve the pain, which is often considerable.

Relief of pressure.—The joint should be relieved from all undue pressure or movement. When the lower extremity is affected, walking need not be prohibited unless the pain be very severe, but in stout and anæmic patients, it should be restricted as much as possible. In the case of well-to-do people, Hessing's splint (see Vol. II. p. 375) is useful as it allows them to walk about without bearing weight upon the joint. When the upper extremity is affected, the limb should be supported in a sling. Care has to be taken to avoid injuries, such as twists or sprains, as these, apparently, often start the disease.

Thermal treatment.—The local treatment most generally applicable is a combination of the thermal bath with massage and movement, and the best results are obtained in the early stages of the disease. If possible, the patient should be sent to some watering-place specially organised for the treatment of these cases ; this is far better than attempting to carry out treatment at home. The best thermal stations are Bath, Harrogate, Buxton, Droitwich, or Strathpeffer, in this country, and Aix-les-Bains abroad. Bath is probably the best for the majority of cases requiring treatment in this country ; but, should the patient require a more bracing climate, or should he be markedly anæmic, Buxton or Harrogate are preferable. The object of sending patients to these baths is not merely that they should take the waters internally, which no doubt are of some value, but particularly that they may obtain proper douching and massage. As regards drinking these waters it is probable that any benefit which may result is due to the diuretic and laxative effects of the large quantity of water consumed rather than to any specific substances that it contains. The essential thing is the local treatment.

When the patient is sent to a thermal station he should be directed to a medical man in the place who is well acquainted with, and superintends, the treatment. In order to give some idea of the course undergone by a patient at these baths, we subjoin a sketch of the treatment which Dr. Leslie Walsh, of Bath, has been good enough to give us. His remarks refer more especially to acute rheumatoid arthritis, but they may be made to apply equally to the monarticular forms of which we are now speaking, if local douching be substituted for the general form. Dr. Walsh writes as follows :—

' The case having been carefully examined, and found to be a fit one for the baths,[1] I should order, in the case of a fairly strong person, the *deep bath* at a temperature of about 98° F. for twenty minutes, followed by

[1] *I.e.* the patient having no bad cardiac disease or any acute affection.

a *pack*[1] for fifteen minutes, the patient drinking ten ounces of mineral water while in the pack. If the patient be weakly, however, or suffer from some cardiac lesion, I should order instead of the deep bath a *reclining bath* at the same temperature and for the same time, also followed by the pack.

'The next bath would be taken on the second day after the first—that is to say, with one day's interval; and I should most probably order at this time a douche at 100° F., to be used during the last ten minutes while the patient is in the bath, and to be specially directed against the painful, swollen, or stiff joints. After another two baths, taken every other day, I should increase the temperature to 99° or 100° F., and the douche up to 103° F. If I found the sweating excessive and the patient at all weak, the pack would be made lighter and the time diminished. Some cases improve wonderfully under these baths alone, but most cases of rheumatoid arthritis require in addition some massage, either dry, which is done at home with or without electricity, or the wet or Aix massage, in which two douches are used, one directing a stream of hot water down the patient's spine in order to keep him warm, and the other so arranged that it plays upon the part while it is being rubbed. The temperature of both douches is usually about 100° F. Fifteen minutes is usually the time for an Aix massage bath, one or two rubbers being employed according as to whether the whole body or only some of the limbs are to be treated. The massage bath is often followed by a plunge into the swimming bath at about 80° F., or the Scottish douche, in which two powerful streams of water, one hot and the other cold, are played alternately up and down the patient's spine. A light pack may or may not be used after the Aix massage, but the usual plan is to pack the patient for a short time.

'Other baths used are the *vapour bath*, where the vapour of water is brought into contact with one or more limbs, at a temperature up to 108° F. or even higher; another plan is what is termed the *dry douche*, in which the limb to be douched is enclosed in a bath, the rest of the body being screened off with a mackintosh arrangement, and a strong stream of water gradually warmed up from 98° to 103° F., or even higher, is allowed to play upon it.

'The time of day for taking the baths is immaterial, and patients have to wait their turn during the season, often till late in the afternoon. They drink the water generally twice a day, eight to ten ounces at a time, but many patients cannot take so much as it sometimes causes dyspepsia and often constipation.

[1] By the *deep bath* is meant a large bath in which the patient sits or even walks about. Passing into this bath at various levels are pipes through which douches can be directed against any desired part of the body while the patient is in the bath. As regards the *pack*, after the patient comes out of the bath he is wrapped up in hot towels and a big dressing-gown; the number of hot towels and the general thickness of the material in which he is swathed is varied according to the strength of the patient.

'With regard to the frequency of bathing we are often much handicapped by the short time patients allow themselves for the course. With gout, rheumatism, sciatica, etc., it does not perhaps matter so much, but with rheumatoid arthritis it is very different. The disease itself is debilitating and, if the baths be taken either too often or too hot, the effects are not altogether satisfactory. In these cases I never order baths oftener than every other day; and if the patient be able to stay about six weeks, a bath twice a week is about often enough, some gentle dry massage being given at home on two other days during the week. For similar reasons I am not inclined to order the baths hotter than about 103° F., although some go to 105° F., and even higher.'

A visit to one of these watering-places should last from three to six weeks, and the patient should not be disappointed if the immediate improvement is comparatively slight. It is not uncommon to find that the condition does not improve for some little time afterwards. Subjects of confirmed rheumatoid arthritis should spend several weeks every year at these baths; one visit is of little use.

Superheated air.—When a patient is unable to afford the time or money necessary for a visit to one of these resorts, the effect of exposing the joint to superheated air should be tried. The joint is enclosed in an apparatus so arranged that the articulation is surrounded with dry superheated air; unless the air be dry, scalding may result. After the limb has been thus exposed for a quarter to half an hour, massage and passive movements are carried out twice a day. Exercise to a limited extent may be permitted, should there be little pain; otherwise the patient should be wheeled out in a bath-chair on every opportunity.

Radiant heat.—Another method of securing a similar result is to expose the limb to radiant heat at a temperature of 300°–400° F. in one of the numerous electro-thermal baths now upon the market.

Electricity.—The galvanic current is of value in some of these cases, and it may with advantage be combined with the massage. A weak current should first be employed, the electrode connected with the negative pole being placed over the upper end of the limb, whilst the positive electrode is applied to the immediate neighbourhood of the joint. The current should be passed for ten or fifteen minutes at a time, once or twice daily immediately after the massage, and afterwards the limb should be enveloped in hot flannel.

All subjects of rheumatoid arthritis should wear flannel and should keep the affected joint thickly swathed in it. When there is considerable pain benefit may be obtained by using a liniment of one drachm of menthol to three drachms each of linimentum belladonnæ and linimentum camphoris. Another useful local application is a mixture of equal parts of guaiacol and olive oil painted over the joint and surrounded by cotton wool.

Ambulatory treatment.—The most difficult subjects to treat, and,

unfortunately, those who come most frequently under notice, are poor people who cannot afford to give up their work and are unable to obtain massage, douches, or any of the ordinary methods of treatment. In these cases all that one can do, besides employing such general treatment as is feasible, is to try to enable the patient to get about with as little pain as possible. For this purpose *moulded splints* may be employed to fix the joint when the pain is severe; stimulating liniments (*vide supra*) should be rubbed in night and morning, the joint being exercised at the same time. The patient should avoid exposure to cold and wet as much as possible. The joint may be firmly *strapped* with Scott's dressing with advantage before the splint is applied. Other counter-irritants are of little value. The general hygienic, dietetic, and medical indications (*vide supra*) should be attended to.

Operative treatment.—In advanced and very painful cases of rheumatoid arthritis many operative procedures have been practised. Drilling or gouging the ends of the bones in order to diminish the inflammation, removal of osteophytes which interfere with the movements of the joint, excision of the joint, and various operations upon nerves, such as nerve-stretching, or freeing nerves that have become adherent around the joint, have been tried at various times, but most of them without anything more than temporary benefit.

A good deal of temporary relief may be obtained from drilling or gouging the articular ends in cases in which there is much pain. Of the two methods gouging a hole in the bone, taking care not to encroach on the articular surface, is the more effectual; simple drilling is of little value. Unfortunately the pain frequently recurs.

When the patient's chief trouble is due to the presence of osteophytes around the joint interfering with movement, much benefit may be obtained by removing the obstructing masses. A further advantage of the operation is that any adherent nerves in the neighbourhood may be freed, and also that the bone is opened up to a certain extent so that the advantages following gouging will result. It is however comparatively seldom that the operation is advisable; it may be called for in the hip-joint, when the patient suffers severe pain from pressure upon the nerves in the vicinity by osteophytic outgrowths or by actual adhesion of the nerves to the capsule. Should any adherent nerves be found, they should be separated and well stretched (see Vol. II. p. 128). This gives considerable relief, which, however, is seldom permanent.

When the disease is limited to one or two joints, when the patient is crippled and when previous treatment has failed, *excision* may be done. When several joints are affected, excision can hardly be called for, but when the trouble is limited to one joint, especially when this is in the upper extremity, and is one in which mobility may be reasonably looked for as a result of the operation, there does not seem to be any serious objection to excision. In the hip-joint the operation is out of the question;

excision gives an extremely bad functional result, and further osteophytic outgrowths are very apt to occur around the divided end of the bone, so that the operation is likely to result in an increase of the trouble.

In the knee, on the other hand, excision may be justifiable when the pain is so great as to prevent the patient getting about, and when this joint is the only one affected. The bones unite readily and a stable limb is obtained. Excision of one knee may, however, be followed comparatively rapidly by the appearance of the disease in the other knee, probably brought about to some extent by the increased strain thrown upon the movable articulation by the stiff limb. At the same time, the risk of this is not sufficient to warrant our refusing to relieve the patient of his existing trouble by excision. In the elbow, operation gives a very fair result; and in the shoulder, excision often gives marked relief, although it seldom gives a perfectly useful joint. The excision in these cases need not be the prolonged proceeding that is necessary in tuberculous cases. There is no need to remove all the synovial membrane, and therefore the operation should not be accompanied by any shock.

CHAPTER XVII.

LOOSE BODIES IN JOINTS.

By a loose body in a joint is understood an abnormally movable structure, which is apt to get between the articular ends of the bones and to interfere with their movements.

Loose bodies may be divided into those originating inside the joint and those introduced from without; the latter should strictly be called foreign bodies, examples being bullets, pieces of glass, etc. The loose bodies having an intra-articular origin may be divided into two classes, namely: (*a*) structures which normally form part of the articulation, but which have become detached; and (*b*) those derived from the growth or deposition of new materials which form no part of the normal joint. Of the former class a typical example is a detached fibro-cartilage, but this will be considered more appropriately in connection with the particular joints in which the fibro-cartilages occur. Sometimes portions of cartilage may be detached from the underlying bone by injuries, and may form loose bodies. The common type of loose body in the joint belongs to the second group of which we have spoken, and is formed within the joint. Three conditions may be mentioned: (1) detached hypertrophied villous processes; (2) the so-called 'rice bodies'; and (3) the true loose cartilages which are not the result of injury, but are due to the development of cartilage in the synovial fringes.

We have already referred to the villous condition of the synovial membrane (see p. 107), and the rice-like bodies occurring in tendon sheaths and joints have also been discussed (see Vol. II. p. 83). We need therefore only deal here with the true loose cartilages.

Loose cartilages are usually few in number in any joint and are very often single. They are generally smooth, ovoid, and flattened, and consist of a layer of true hyaline cartilage which may be undergoing ossification in the interior. They originate in the synovial fringes, in which a few cartilage cells may be present and may undergo development. In the early stage these bodies are not free, but are attached to the synovial

membrane by a delicate pedicle which may be so long and narrow as to allow the cartilage to move in various directions. Some accident sets the body free in the joint by tearing across or twisting the pedicle. It would appear that loose bodies may actually increase in size after all organic connection with the synovial membrane has been severed. Loose bodies are not uncommon in connection with osteo-arthritis, but it is doubtful whether they are the result of the rheumatoid change or whether their presence in the joint sets up the rheumatoid condition.

The joint most frequently involved is the knee ; the next in frequency is the elbow, but the bodies may occur in any joint. The inconvenience caused varies according as the cartilage is loose or attached. If the cartilage is loose, it is very apt to become caught between the articular surfaces, when sudden and intense agony is caused, and the joint is temporarily locked. On the other hand, when it remains attached to the synovial membrane, it may not get between the ends of the bones, and may only cause some slight obstruction to certain movements and occasional effusion into the joint.

TREATMENT.—The only treatment of value is early removal by operation, and it is well to remember that in all such operations a healthy joint is opened, and that therefore the strictest asepsis is necessary. The chief difficulty in the operation lies in finding the body, which slips about extremely easily. Unless the body can be located and fixed before operation, it is quite possible to open a joint and fail to find it, even after a very prolonged and thorough search. This particularly applies to the knee, in which the body may slip behind the femur and cannot be got out. It was formerly the practice not to operate unless it could be found and fixed just before the operation was undertaken, notwithstanding that the surgeon knew from actual examination that there was a loose body in the joint ; at the present time, however, this rule does not hold good.

In the knee, the best position in which to fix the loose body, if this is possible, is on one side of the supra-patellar pouch, preferably the inner. The patient may be able to keep it in place with the finger, or strapping and a pad may be fixed over it, so as to prevent it from slipping whilst the anæsthetic is being administered. During disinfection of the skin, fixation may be secured by transfixing the loose body by means of a stout needle thrust into it through the skin. A curved incision is made, a flap of skin and subcutaneous tissue is thrown back, all bleeding is arrested, and the capsule is incised directly over the loose body which is held steady by the needle thrust through it. When the capsule has been opened, a sharp hook is inserted into the cartilage, which is then pulled out.

When, as sometimes happens, the loose body recedes deeply into the joint at the moment of incision, a very useful manœuvre is to flush out the joint with the saline solution under considerable pressure; the body

may be dislodged by the fluid and carried within reach. Should this fail, the opening in the capsule must be enlarged sufficiently to expose the interior of the joint and the loose body searched for; it will almost certainly come into view, especially if the knee be flexed and extended rapidly several times. After the loose body has been removed, the joint is flushed out with normal saline solution, the incision in the capsule accurately stitched up with fine catgut, and the flap sutured in place. A drainage tube is unnecessary; no splint need be used, and the patient may move the limb as soon as he wishes to do so after the wound has healed.

CHAPTER XVIII.

ANCHYLOSIS.

TRUE anchylosis implies absolute rigidity of the joint, and is usually due to actual osseous union between the bones; but, from the practical point of view, it is well to include under this term other less extensive interferences with movement. Anchylosis may therefore be described under four heads: (1) osseous union between the ends of the bones; (2) partial or complete obliteration of the synovial cavity by fibrous adhesions; (3) contraction and rigidity of the peri-articular tissues; (4) adhesion of muscles to the bones in the vicinity of the joint. In the treatment of the affection, we have also to consider whether the position of the limb is good or bad.

BONY UNION BETWEEN THE ARTICULAR SURFACES.

Before bony anchylosis can occur, the articular cartilage must have been completely destroyed.

TREATMENT.—The only circumstances under which the surgeon is called upon to interfere, in cases of true bony anchylosis, are: when there is much pain, when there is deformity of the limb from faulty position, and when the patient desires to obtain a movable joint in place of a stiff one. When the joint is in good position and free from pain, and when a movable joint is not required, it is unnecessary to employ any treatment.

Painful bony anchylosis is comparatively rare, but it may be met with when anchylosis accompanies a still active osteitis of the articular ends; in some cases there may be an abscess in the end of the bone. Under these circumstances it will be necessary to cut down upon the thickened and painful bone, gouge a hole in it, and seek for an abscess as recommended for osteitis and abscess of bone (see Vol. II.). This procedure usually relieves the pain completely, even though pus is not found.

In bony anchylosis accompanied by deformity the condition cannot

be remedied without dividing the union, and, as a rule, it is necessary to remove a certain amount of bone before the limb can be brought into position. In a knee, for example, which has undergone anchylosis in the flexed position, it may be necessary to take out a wedge to allow the limb to be brought straight. In remedying a faulty position of this kind it must be remembered that tendons and other structures around the joint have become altered in length, and may therefore offer obstacles to the proper replacement of the bones after the latter have been divided. If these structures are not dealt with, it may be necessary to take away an undue amount of bone before the limb can be brought straight, and this may cause material shortening. Hence the best procedure is first to remove rather less bone than is probably necessary to get the limb straight; then, after the limb has thus been loosened, it is easy to put the tendons and fascial structures on the stretch, and to divide anything that may be necessary. Firm extension is then made so as to stretch the soft structures, when, if advisable, more bone may be removed. It is, however, generally found that, after dividing the tight structures and employing steady traction, the displacement may be overcome without the removal of much bone. When the limb has been straightened, it is well to fix the bones in close apposition by plates or wires (see Vol. II. p. 303).

It is important that this operation should not be performed until the growth of the limb is nearly complete, otherwise considerable shortening and arrest of development may result. It is practically impossible to avoid encroaching upon the region of the epiphyseal line in any of the operations that involve taking out a wedge, and serious distortion of the limb from partial arrest of development may result.

Cases of bony anchylosis in which a movable joint is required.—A typical example of this is the elbow-joint, in which excellent movement may be obtained after excision, provided that the anchylosis has not lasted long enough to have led to complete atrophy of the muscles around the joint.

Recently, Dr. J. B. Murphy, of Chicago, has attempted to widen the scope of operations in this direction by means of *arthroplastic methods* that are very promising. The details vary with the joint concerned, but briefly his plan embraces the following steps. In the first place the bony union is divided, and the ends of the bones are shaped so as to retain the normal contour of the articular surfaces as far as possible. Flaps of fascia are then turned in over the ends of the bones so as to prevent fresh bony union. Lastly, after healing has taken place, movement of the joint is begun, and massage and exercises are employed with the view of restoring the power of the disused muscles.

The exact procedures vary according to the different joints. For example, in the case of the *hip-joint* the fascial flap used to cover the head of the femur is taken from over the great trochanter, and in order

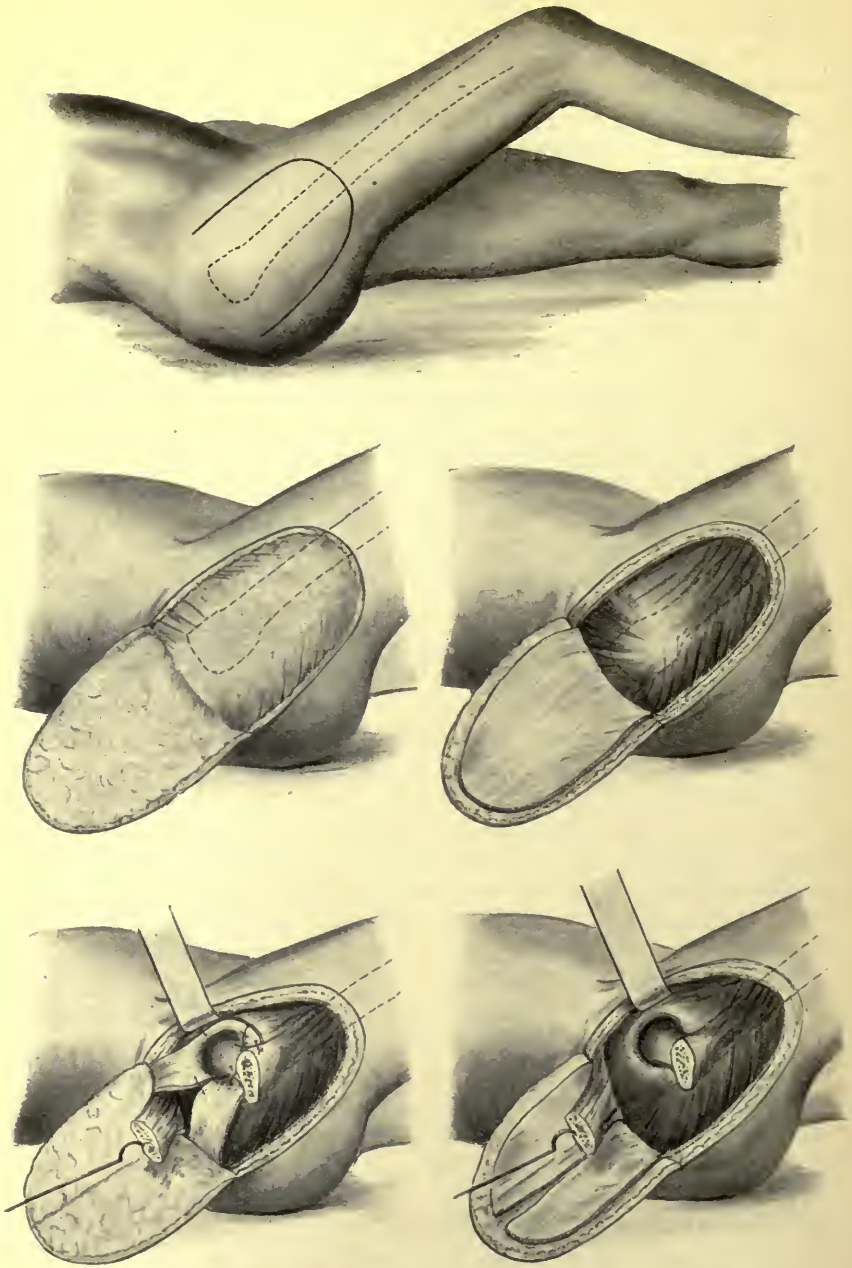


FIG. 54.—MURPHY'S ARTHROPLASTY APPLIED TO THE HIP. The various steps of the operation are shown, viz. the incision, reflection of the skin flap, reflection of the fascial flap, detachment of the summit of the great trochanter and splitting of the fascial flap, and finally suture of the fascial flap in position, one portion of the split flap being on either side of the gluteal insertion, which is then fastened into position.

to gain access to the joint the trochanter is detached and turned aside with the muscles attached to it (see Fig. 54). In the *knee-joint* the fascial flaps are taken from the inner and outer sides of the upper part of the leg; in the elbow from the outer side of the forearm.

ADHESIONS AND FIBROUS ANCHYLOSIS.

Here movement may often be obtained without operation. When there are adhesions between the ends of the bones, however, and the position is bad, it may be necessary to cut down upon and remove portions of the articular ends, or perform Murphy's arthroplasy (*vide supra*); but, with this exception, improvement and almost complete restoration of function can often be obtained by massage and exercises aided if necessary by breaking down the adhesions under an anæsthetic.

Massage and passive movement should be employed in the first instance, immediately preceded by exposure of the joint to superheated air or radiant heat in a suitable apparatus (see p. 146). This produces congestion of the part, and the adhesions become softer, and stretch more readily. In the case of poor patients who cannot obtain a suitable apparatus, a good alternative plan is to suspend the limb in a wire cage covered with a blanket and a mackintosh outside, and introduce beneath this the nozzle of a bronchitis kettle, taking care that the steam does not play directly on the skin.

As soon as it is evident that no further progress is being made—which will generally be in a week or ten days—an anæsthetic should be administered and the adhesions broken down. At the first sitting all the adhesions may be broken down if they are not numerous or dense; if they are, it is well to carry the movements of the joints only through about half their range and to complete the movement at a subsequent sitting. If too much is done at one sitting so much inflammation may follow that the movements may have to be left off for several days. On the other hand, if too little is done in the way of breaking down adhesions at one sitting, the result is that those left behind are so tender that movements cannot be carried out. Any swelling resulting from the manipulation may be treated by fomentations for a day or two, when gentle massage and movements should be resumed.

In connection with these cases it must not be forgotten that trouble has frequently resulted from attempts to move tuberculous joints. It is not at all uncommon to meet with old tuberculous joints which have been forcibly moved by a bone-setter, and in which the disease has been lighted up afresh. In anchylosis after tuberculous disease, even when accompanied by deformity, it is usually best to allow the patient to grow up, and then to operate for the deformity rather than to make an attempt to move the joint forcibly, even though the union be only fibrous.

ADHESION OF MUSCLES AROUND THE JOINT.

This may be met with after fractures, or necrosis. As a rule, perseverance in massage and movements, along with cataphoresis of carbonate of soda and electrical stimulation of the muscles will improve the condition, but in obstinate cases it may be necessary to detach or divide the muscles; this condition has already been referred to (see Vol. II. p. 280).

SUB-SECTION II.—DISEASES OF INDIVIDUAL JOINTS.

CHAPTER XIX.

DISEASES OF THE HIP-JOINT.

INFLAMMATORY AFFECTIONS.

SIMPLE ACUTE SYNOVITIS.

Simple synovitis of the hip-joint is not common, but it occasionally follows a sprain or twist. The symptoms are not very characteristic. The most marked are pain and difficulty in movement. It is most frequent in children, and is often very difficult to distinguish from early tuberculous disease. The distension of the capsule with fluid is not easily made out, owing to the depth of the joint from the surface, but on comparing the two groins some increased fullness can generally be demonstrated in front of the joint and also behind the trochanter on the injured side. The position assumed by the limb is one of slight abduction, flexion, and outward rotation.

TREATMENT.—The chief essential in the treatment is rest, and for the first few days the patient should be kept in bed; fomentations should be applied to the region of the joint if there is much pain. It is generally unnecessary to employ splints or any form of extension. If the pain is very severe, however, a Liston's splint may be put on for a few days. When the pain has passed off, passive and active movements and massage should be begun. The patient may be allowed to walk about in a week or ten days.

When there is difficulty in excluding the possibility of early tuberculous disease, it is well to put the patient to bed for three or four weeks; should the affection be simple synovitis from a strain, it will be well by that time; whereas, if it is commencing tuberculous disease, the condition

will not have improved and will often be considerably worse. An X-ray photograph may be taken, but a negative result does not necessarily exclude tuberculosis.

INFECTIVE ARTHRITIS.

Acute or sub-acute inflammation of the hip-joint occurs in various infective diseases, such as typhoid fever, pyæmia, and osteo-myelitis of the upper end of the femur. It is also caused by the pneumococcus or the gonococcus. Infection due to the latter organism differs from the other forms, in that it does not as a rule end in the formation of pus.

ACUTE SEPTIC ARTHRITIS of the hip most frequently occurs in connection with acute epiphysitis of the upper end of the femur.

The infection of the joint is a necessary consequence of the anatomical conditions of the part, and the symptoms are extremely grave and acute. The patient is usually seized with sudden pain in the hip, rigors are common, and the typhoid condition rapidly supervenes ; there is marked swelling about the joint, and intense pain on movement or pressure. Necrosis and separation of the head of the bone are very likely to occur, and the pus frequently burrows widely in the surrounding tissues. Acute septic arthritis also occurs in the course of a pyæmia, and curiously enough, in some cases which recover, the inflammation may subside without any great destruction of the joint.

Treatment.—Free incisions should be made into the joint as soon as possible ; the joint is most conveniently reached through the anterior incision already described (see p. 62). The pus is evacuated, the articular cavity flushed out with sterilised normal saline solution and the condition of the neck of the femur examined. Should the case be one of acute epiphysitis, the best plan is to remove the head and neck of the bone. In every case, counter-openings for drainage should be made through the posterior part of the joint. This can readily be done by pushing a long stout pair of dressing forceps through the posterior part of the capsule from the anterior wound, and making them project in the buttock as close as possible to the trochanter. The skin is then incised over the tip of the forceps, which are pushed through, the blades expanded so as to enlarge the opening, and made to grasp the end of the drainage tube (No. 18), which is then pulled into the joint (see Fig. 48). If the head of the bone has been removed, undiluted carbolic acid should be applied freely to the cut osseous surface. The great danger of removing the head of the bone is that the organisms (which are extremely virulent) may spread into the cut surface and set up an acute osteo-myelitis of the upper end of the femur ; the saturation of the bone section with undiluted carbolic acid is of extreme importance as a preventive. It gives time for cellular invasion of the superficial cancellous spaces to

take place before the infection can spread, and thus makes a barrier against extension of the infection. In some cases, however, it will be found that the cut surface of the neck of the femur becomes necrosed; the fragment will separate in three or four months and must then be removed.

Before the wound is closed, one or more large drainage tubes (size No. 18) must be introduced into the joint from the front as well as from behind. Antiseptic dressings are applied, and the hip is put up in the abducted position, with sufficient weight extension to keep the limb from becoming flexed. The trunk is fixed between sand-bags and the arrangement shown in Fig. 55 is placed behind the knee, in order to prevent rotation of the limb. It is also well to use a divided mattress, so as to avoid unnecessary movement when the bedpan is used and the dressings are changed.

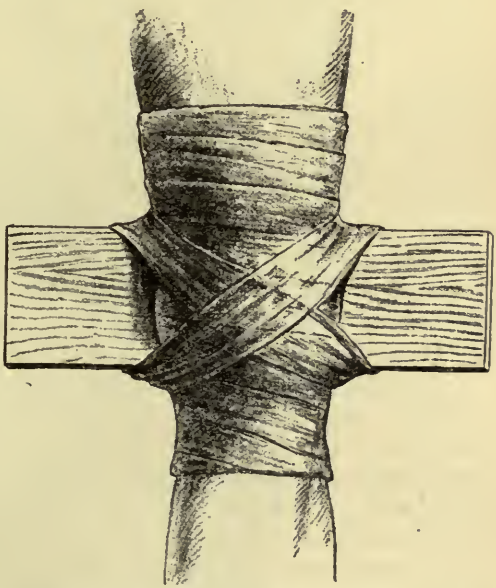


Fig. 55.—Method of Preventing Rotation of the Femur during Weight Extension. A plaster of Paris bandage is applied to the knee and made to include a piece of board placed behind the limb as shown in the figure.

When the osteo-myelitis affects the acetabulum, the results of treatment are not so satisfactory. The joint becomes distended with pus, and must be opened in the manner just described. It will be necessary to remove the head of the bone to get proper access to the acetabulum, and that cavity should be gouged out, and the diseased area removed as completely as possible. The whole thickness of the bottom of the acetabulum should be taken away, so as to make sure that any collection of pus on the inner wall of the pelvis is properly drained. Examination by the rectum should be made from time to time to ascertain if any pus is accumulating in the pelvis. If an accumulation is present and the pus cannot escape through the wound, it should be evacuated through an incision at the inner side of the tuber ischii. Pus may also be found in the iliac fossa, and must be let out through an incision made internal to the anterior superior iliac spine, care being taken not to open the peritoneal cavity.

If the patient recovers, the joint will almost certainly become anchylosed; and therefore, during the period of recovery, the limb must be kept in the abducted position. Murphy's arthroplasty (see p. 153) may

possibly be employed at a later period to restore the mobility of the joint.

GONOCOCCAL ARTHRITIS.—The hip is not infrequently affected in gonorrhœa. It is important to remember the liability to anchylosis, though recovery of movement may be complete in some cases.

Treatment.—This has been discussed on p. 100, and must be directed to the cure of the gonorrhœa, as well as of the joint affection. The patient should be kept in bed; no splint need be employed unless there is commencing deformity, or the pain is great. If any muscular spasm is present, weight extension may be applied. The use of gonococcal vaccine is of value; a small dose should be employed to begin with, and the amount should be increased if necessary. Large doses—250 millions or more—are not infrequently necessary before a good result is obtained. Passive movements must be made from time to time during the course of the affection to prevent anchylosis.

It is most difficult to determine the best time for commencing passive movement in these cases; if it is begun too soon, the inflammation recurs; if postponed too long, anchylosis will result. The best plan is to move the joint very gently after all signs of acute inflammation have subsided, and, if this gives rise to no swelling or pain, a little more should be done on the following day, and so on, until the full range of movement is obtained.

ARTHRITIS AFTER TYPHOID FEVER.—The hip is the joint most often attacked during recovery from typhoid fever. The affection is sub-acute, and the joint is distended with turbid fluid which may be purulent. Suppuration does not necessarily occur, but the ligaments become softened and spontaneous dislocation is not infrequent; indeed the first thing which attracts attention to the joint is not uncommonly the occurrence of dislocation.

The infection of the joint may be due to the typhoid bacillus, or it may be caused by infection with other organisms such as staphylococci or streptococci.

Treatment.—On account of the great tendency to dislocation, it is necessary to fix the limb in a suitable apparatus, such as a Liston's long splint or a plaster of Paris casing. The patient must be placed upon a *water bed*, otherwise bed-sores will almost certainly result from the rigid confinement to one position. As a rule, no further local treatment is necessary, and the inflammation rapidly subsides as the patient convalesces. The splint should be kept on for three or four weeks, after which passive movement and massage are employed to overcome the stiffness.

When the inflammatory symptoms are more acute, and there are signs of suppuration, *the joint should be opened* and washed out, and a drainage tube introduced. This is best done through an incision similar to that employed for the anterior excision of the hip, namely, just in

front of the anterior edge of the tensor fasciæ femoris (see Fig. 56). The incision commences just below the anterior superior iliac spine. After the skin and deep fascia have been divided, the interval between the tensor vaginæ femoris and the sartorius is opened; these muscles are separated and held apart by retractors. The loose cellular tissue lying between the deeper muscles is then divided; a large branch of the

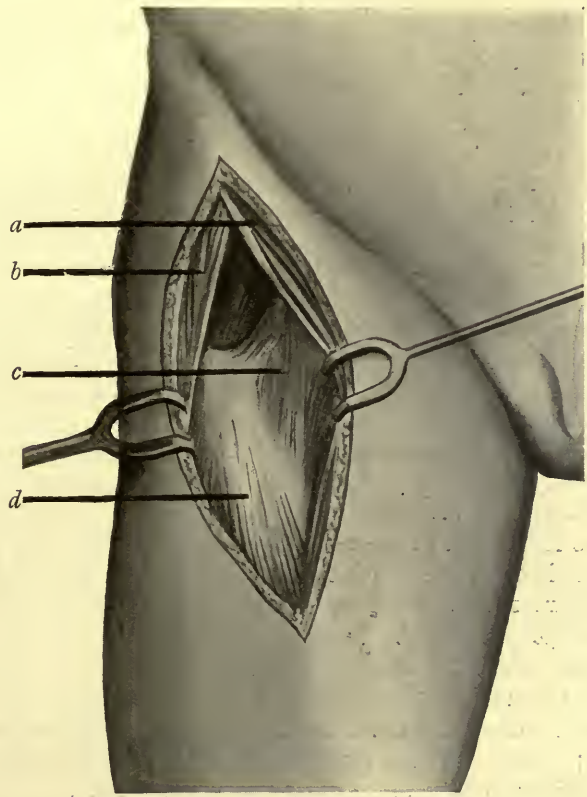


FIG. 56.—INCISION FOR DRAINAGE OF THE HIP-JOINT. *a*, Sartorius; *b*, tensor fasciæ femoris; *c*, capsule of the hip-joint; *d*, quadriceps.

external circumflex iliac artery often requires to be ligatured. When the capsule of the joint is exposed it is freely incised and the pus evacuated. The joint is washed out with hot sterilised normal saline solution. In most cases it is advisable to make a counter-opening posteriorly (see Fig. 48) for a drainage tube (No. 18), a large tube being also placed in the anterior incision.

When the discharge has become quite small in amount (not covering an area on the dressing greater than a shilling in twenty-four hours), the

drainage tubes should be removed and the wounds allowed to heal; passive movements and massage should then be employed.

If dislocation has occurred, the head of the bone must be replaced in the acetabulum, and the limb fixed in the abducted position by means of a plaster of Paris splint. In applying the plaster splint great care must be used to avoid pressure on the prominent parts or on the skin.

Among other forms of infective arthritis, that due to the **pneumococcus** is not uncommon. This form of arthritis has already been referred to on p. 104, and its treatment does not differ materially from that of the other forms of acute arthritis. The symptoms are often not so acute and the prognosis as regards a useful joint is rather more favourable.

CHRONIC SYNOVITIS.

Simple chronic synovitis is rare in the hip-joint. The treatment must follow the lines laid down for the disease in general (see p. 106).

TUBERCULOUS DISEASE.

After the spine, the hip is the joint most frequently affected with tuberculosis. Hip-joint disease is essentially an affection of childhood, more than half the cases occurring before ten years of age, and over 90 per cent. before puberty.

The disease may arise either in the bone or in the synovial membrane, probably oftener in the former than in the latter. *When the disease commences in the femur*, the primary focus is most frequently found at the lower part of the neck just external to the epiphyseal line. It may sometimes be met with further out towards the trochanter, or deeply in the substance of the neck, and, in some rare instances, in the epiphysis of the head itself. Tuberculous sequestra seem to be rather more frequent than soft caseating deposits.

Primary disease in the acetabulum is also not uncommon. When it commences in this situation its usual seat is the neighbourhood of the Y-cartilage; this structure may be destroyed, and mobility of the various constituents of the innominate bone may result.

COURSE.—The general course of tuberculous disease in joints has already been fully described, and nothing further need be said as to the pathology and progress of primary synovial disease. When the disease commences in the neck of the femur, it generally opens ultimately into the cavity of the joint (see p. 110), and leads to general infection of the synovial membrane; occasionally, however, it may reach the surface outside the synovial membrane and give rise to an abscess which does not communicate with the joint. This is most common when the primary deposits in the femur are situated in the immediate neighbourhood of the trochanter. When the disease is in the acetabulum, the deposit not only infects the joint, but, owing to the thinness of the bone, it generally

gives rise to thickening of the periosteum inside the pelvis, often followed by the formation of a chronic abscess in that situation.

Enlargement of the acetabulum.—Whether the case is one of bone or of synovial disease in the first instance, caries of the joint surfaces takes place after a time and tonic spasm of the muscles surrounding the joint follows, and causes the head of the femur to press firmly against the upper and back part of the acetabulum. This pressure leads to absorption of those parts of the inflamed head of the femur and of the acetabulum which are chiefly in contact, the result being that the upper part of the head of the bone becomes flattened, while the acetabulum is enlarged in an upward and backward direction. Fresh bone is formed beyond the area of absorption of the margin of the acetabulum and thus there is always an imperfect rim of new bone at the upper part of the cavity. This enlargement goes on until the acetabulum loses its round shape and becomes oval and much elongated upwards and backwards; the head of the femur follows the enlargement of the acetabulum and thus shortening of the limb takes place. This is the condition commonly spoken of as 'dislocation' in hip disease, but it should be more correctly termed 'wandering acetabulum' (see Fig. 57).

Fig. 57.—'Wandering Acetabulum' in Hip-joint Disease. The shallow, newly formed acetabular cavity is seen above and behind the deeper normal cavity.

Dislocation.—True dislocation is of very rare occurrence in tuberculous disease. It may however happen, especially in the earlier stages, as the result of destruction of the ligamentum teres and filling up of the acetabular cavity by new tissue. The head of the bone thus becomes loosened and partially pushed out of the acetabulum, and then some sudden movement brings about the dislocation. The head of the bone, however, does not follow the course of the true traumatic dislocation, but simply slips upwards over the rim of the acetabulum and may then pass either backwards or forwards. Sometimes the dislocation is only partial, the head of the femur being caught on the margin of the acetabulum, which may make a deep groove on it.

Abscess.—Chronic abscess is very common; it most commonly points towards the outer part of the joint in front, less frequently about the gluteal fold. Sometimes it presents at the upper and inner part of the

thigh close to the perineum, and in rare cases abscesses forming in front of the joint may burrow upwards beneath Poupart's ligament, occupy the iliac fossa, and give rise to one of the forms of pelvic abscess.

Abscesses may also form in the pelvis in connection with primary acetabular disease, and thence spread upwards into the iliac fossa, downwards into the ischio-rectal fossa, or into the buttock through the sacro-sciatic notch.

A third source of origin of abscesses in the iliac fossa is suppuration in the iliac glands without any direct connection with the diseased joint.

CLINICAL STAGES.—From the point of view of treatment it is convenient to divide tuberculous hip-joint disease into four clinical stages, although in practice it is not always easy to distinguish where one stage ends and another commences. These four stages are as follows :—

In the first stage there is no enlargement of the acetabulum and no absorption of the neck of the femur. There is consequently no shortening of the limb, which, however, is slightly flexed, abducted, and rotated outwards. The patient tilts the pelvis downwards on the affected side in walking, and this causes apparent lengthening of the limb. The muscles of the thigh and buttock rapidly waste, and their electrical reaction is somewhat impaired. There is some limitation of movement and a varying amount of pain and limping when the patient walks.

In the second stage the articular cartilage is being destroyed and enlargement of the acetabular cavity is occurring, but there is no abscess formation. Here the limb is shortened to a degree corresponding to the amount of enlargement of the acetabulum and absorption of the head and neck of the femur. There is considerable pain, with starting of the limb at night. The limb is flexed to a greater or less extent, rotated inwards and somewhat adducted. The affected side of the pelvis is raised on walking, so that the shortening appears to be greater than it really is. The real shortening varies from about a quarter of an inch to two inches. As the disease progresses, the muscles, especially the adductors, become shortened and offer considerable opposition to the restoration of the limb to its proper position. In this stage are included the cases of true dislocation without suppuration.

In the third stage suppuration is taking place. The changes in the joint and the position of the limb are similar to those in the second stage, though they are generally more marked, and abscesses or sinuses are also present. When, however, suppuration occurs early in the disease, the position of the limb may be more nearly that of the first stage than of the second. The abscesses may or may not communicate with the joint; generally they do so, but in some cases the osseous deposit is nearer the trochanter and does not open into the joint. A rectal examination should never be omitted when examining a case of hip-joint disease for abscess, as the inner surface of the acetabulum can easily be palpated and its condition on the two sides compared; if there is a pelvic abscess

due to acetabular disease, fullness can be detected by the finger in the rectum.

In the fourth stage the disease is retrogressive or has got well, but has left some deformity. Recovery from the disease is indicated by total disappearance of thickening in the neighbourhood of the joint, with a complete absence of pain on movement, and of rigidity of the surrounding muscles. The position of the limb is generally that of the third stage, *i.e.* flexion, adduction, and inward rotation, but this may be much modified by previous treatment.

DIFFERENTIAL DIAGNOSIS.—In the early stages of the affection, mistakes in diagnosis are not very uncommon. *Separation of the upper epiphysis of the femur* gives rise to signs which may easily be looked on as due to tuberculous hip-joint disease. Both conditions may follow an injury; the pain, limitation of movement and limping on walking occur in both affections. An X-ray photograph should be obtained whenever possible, in order to determine if the epiphysis has been separated. *Congenital dislocation of the hip* is another frequent source of error. In these cases, careful attention to the history, the absence of pain on movement and the fact that the head of the femur may be felt in an abnormal position, should suggest the possibility of this condition being present. An X-ray photograph is also a valuable help in establishing the diagnosis. *Disease of the lower lumbar vertebræ* or of the *sacro-iliac joint* may closely simulate hip disease. The situation of the pain, and the absence of pain on movement of the joint when the pelvis is fixed, and of any tenderness about the hip, will enable the diagnosis to be made in most cases.

PROGNOSIS.—Although of considerable gravity, hip-joint disease often gets well if suitable treatment is carefully carried out for a sufficient length of time. It is imperative, however, that the treatment should be continued for a much longer time than is generally the case. A few weeks' or months' treatment is totally insufficient in the great majority of cases. Two, three, and sometimes even six or seven years, are necessary to ensure complete recovery.

When the case is seen quite early and treatment is begun at once, recovery without shortening and with a considerable amount of mobility of the joint may ensue, but it must be borne in mind that movement is more likely to be obtained if the joint is kept rigidly fixed during the treatment. Recovery is by no means hopeless, even when the case is complicated by abscess, a very considerable proportion recovering with satisfactory joints if careful aseptic treatment be adopted. In fact, when it is possible to keep the case aseptic from first to last, the only way in which the disease threatens life is from the occurrence of tubercle elsewhere, especially in the lungs or the meninges of the brain.

TREATMENT.—This is partly general and partly local. The general treatment of tuberculous joint disease has already been referred

to (see p. 113), and we need here only discuss the local treatment of the various stages.

Treatment of the first stage.—Rest is most important, and should be enforced in all cases not only by applying suitable apparatus, but, in the first instance, by the maintenance of the horizontal position in bed. Whatever splint is employed, it is essential that the patient should not get up even on crutches, until all signs of acute mischief—especially pain and tenderness on pressure—have entirely disappeared, and the affection is well on the way to cure.

The first point of practical importance in determining the treatment for any given case in the early stage is to decide whether to employ rest and splints alone, or whether extension is also necessary. This will depend upon whether there is, or is not, spasm and rigidity of the muscles. When spasm of the muscles and starting pains in the limb are present, the bone is generally becoming affected; the inflamed osseous surfaces are pressed together as a result of the muscular contraction, and rapid absorption of the bones and shortening of the limb result. In these cases extension must be employed. It should be remembered, however, that the object of the extension is not to separate the ends of the bones—which would be impossible without using more weight than the patient could tolerate—but to overcome the tonic contraction of the muscles around the joint, and so prevent the bones being forcibly pressed together.

In applying extension in cases of hip-joint disease, the strapping should take its purchase from the thigh as well as from the leg; indeed, if much weight be required, it is well not to continue the plaster below the knee at all, so as to avoid pulling unduly upon the ligaments of that joint. In the first stage the extension should be made in the long axis of the body, but if the flexion is not easily overcome, it should be in the long axis of the limb (see Fig. 58). The weight employed will depend upon the age of the patient and the strength of the muscles. In a child, three pounds is sufficient to begin with, and this may be increased or diminished according to circumstances; should it not relieve the pain and overcome the spasm, additional weight must of course be employed. If the pain is relieved in the first instance and then returns, this may be due either to extension of the disease or to stretching of the diseased ligaments after the spasmodic contraction of the muscles has been overcome. In the former case the weight must be increased, in the latter it must be diminished. Under these circumstances it is well to try the effect of diminishing the weights in the first instance; if this fail they should be gradually increased. The extension should never be left off suddenly, but should be gradually diminished, otherwise the symptoms will be very likely to recur.

The trunk must also be kept steady by means of a folded sheet passed over the thorax and abdomen, with heavy sand-bags placed over it on each side of the body. If the patient is unruly and constantly trying to sit up, it will be advisable to apply a Liston's long splint (see Vol. II.

p. 370) to the sound side; if applied to the affected side, it would interfere with the extension. Counter-extension is provided for by raising the foot of the bed on blocks (see Fig. 59). It should be borne

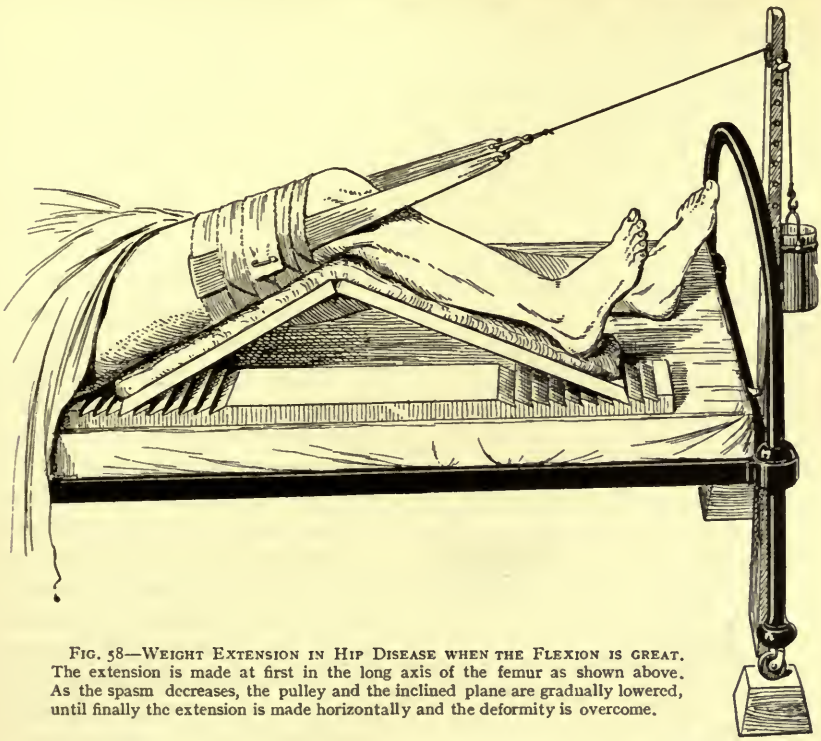


FIG. 58—WEIGHT EXTENSION IN HIP DISEASE WHEN THE FLEXION IS GREAT. The extension is made at first in the long axis of the femur as shown above. As the spasm decreases, the pulley and the inclined plane are gradually lowered, until finally the extension is made horizontally and the deformity is overcome.

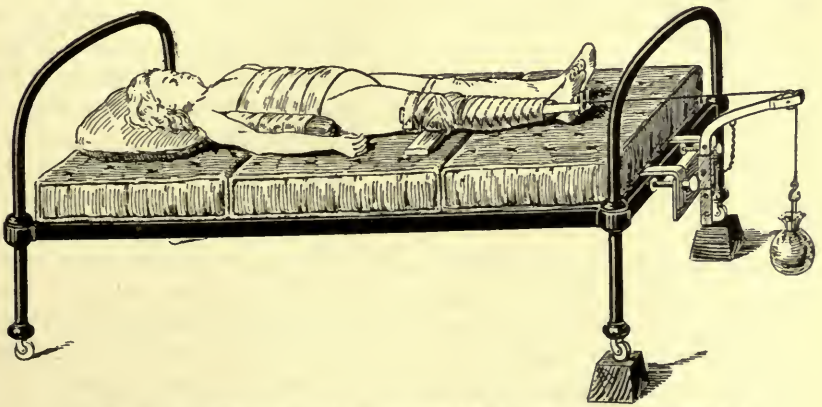


FIG. 59.—EXTENSION BY WEIGHT AND PULLEY FOR HIP DISEASE. The extension is made by the weight attached to the cord passing over the pulley fixed to the end of the bed. The limb is kept from rotating by means of the transverse bar of wood fixed behind the knee with plaster of Paris bandages; this is shown in more detail in Fig. 55. The trunk is kept horizontal by the sheet passed across the chest with a sand-bag rolled up in each end. Counter-extension is made by raising the foot of the bed on blocks.

in mind that the limb is apt to become rotated outwards unless special care is taken ; Fig. 55 shows an arrangement for this purpose.

When the case is very acute, it is well to employ a mattress divided into three parts ; the narrow central part is beneath the pelvis and is again divided into two lateral halves, so that one-half of it can be removed for nursing purposes without disturbing the patient.

In the first stage of the disease, there is often no marked pain or muscular contraction. This is especially the case in primary synovial disease, and here extension is not called for—at any rate, at first ; indeed, by stretching the ligaments it may do harm instead of good. The patient should be put to bed, and a Liston's long splint applied to the affected side, while sand-bags are placed along the other side of the body. Absolute rest in bed must be maintained for some time.

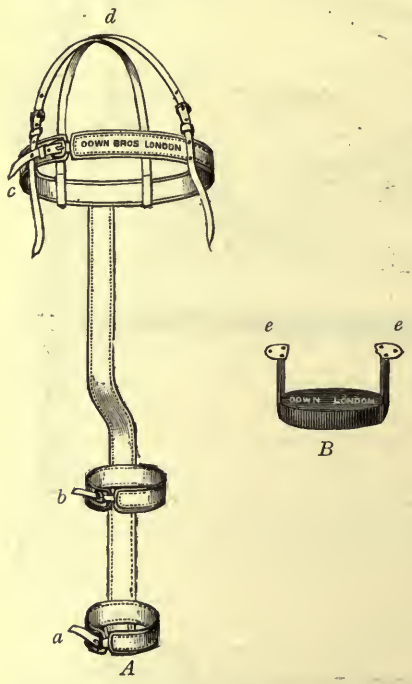


Fig. 60.—Thomas's Hip Splint. *A* shows the splint previous to use ; the wings, *a*, surround the leg just below the knee, while those at *b* enclose the thigh well above it. The stout metal band, *c*, encircles the chest, and the splint is kept in place partly by bandages and partly by the braces, *d*. *B* is the patten fastened to the boot on the sound side by the screw plates, *e*.

As improvement takes place, the time arrives (usually in three or four months) when the rigid confinement to bed can be given up and arrangements made by which the patient can be moved about and taken into the open air ; the joint, however, must still be kept fixed. Various forms of apparatus may be employed, the most useful at this stage being, in adults a single Thomas's splint, and in children a plaster of Paris casing, a double Thomas's splint, or a Phelps's box.

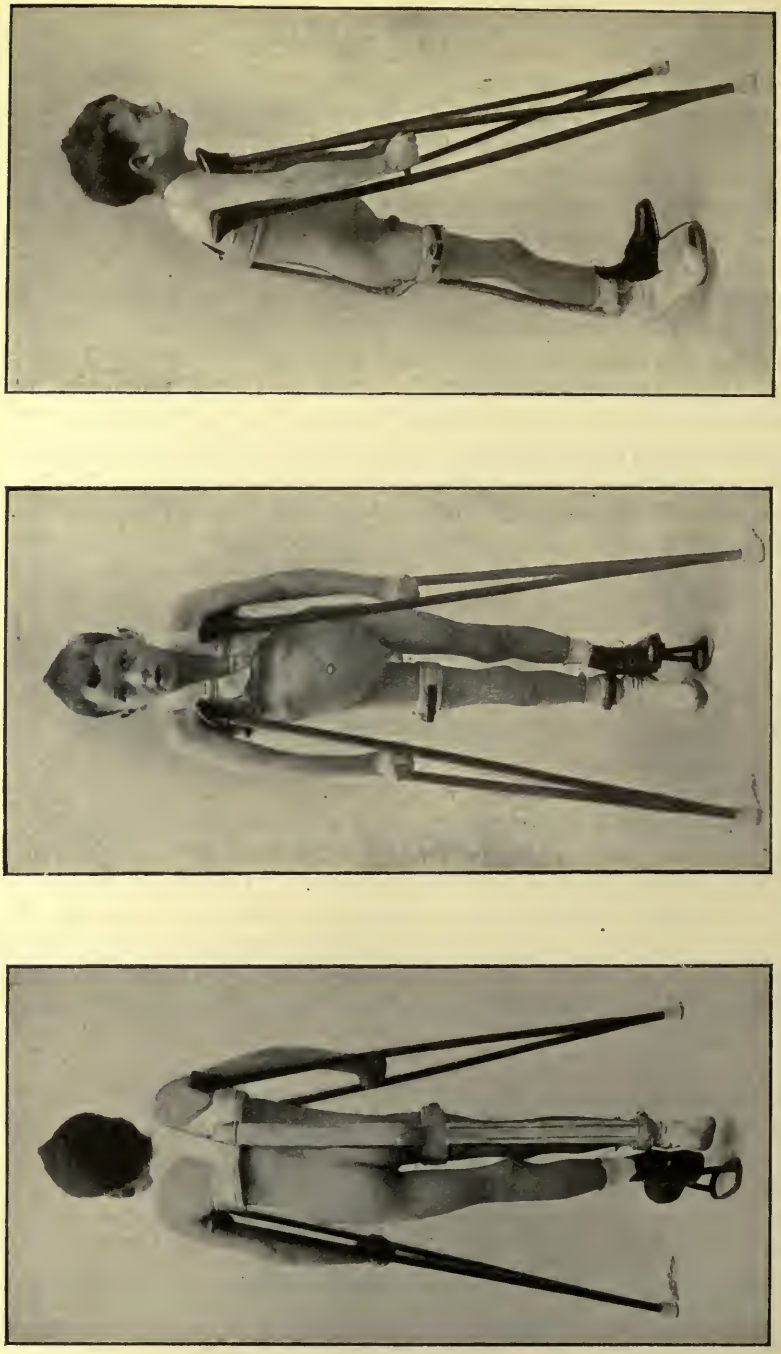
As *Thomas's hip splint* is used in all stages of the disease, and often very badly fitted, we may describe Thomas's own method here. The splint consists of a long, flat bar of malleable iron running down the back of the trunk and the affected extremity, from the axilla to just above the ankle. It runs vertically from the thorax down to the level of the hip-joint. It is there bent with its concavity forward to fit the buttock, and finally it is continued straight down behind the thigh and leg. The lower vertical portion is parallel to the upper, but lies on a plane somewhat anterior to it. The upper part of the bar is twisted a little, so that it lies flat against the side of the trunk, whilst the lower part runs down the middle of the limb behind (see Fig. 60, *A*). There are three

cross-pieces attached to the vertical bar and bent round to form wings on either side. The length of these wings is unequal on the two sides, the shorter ones being on the side corresponding to the affected limb. The upper wings encircle the thorax just below the axilla, the middle ones surround the middle of the thigh, whilst the lowest encircle the lower part of the calf. The splint is secured to the trunk by a broad bandage and by special shoulder braces, whilst the lower portion is fixed by bandages between the lower wings. It is also well to add a stout pelvic band, otherwise the pelvis may be moved to one side, and adduction or abduction may not be properly overcome.

Thomas's original directions for the application of this splint are as follows: '(1) The initial act should be to place the machine so far posteriorly that it is just out of sight behind the buttock when the patient is lying horizontal. (2) The machine should be pushed upwards until the upper wings are close to the patient's axillæ. (3) An assistant should grasp the patient's leg, together with the lower part of the main stem, to hinder the machine from slipping downwards while the operator is manipulating, that is to say, twisting it so as to make it fit properly. (4) The surgeon should proceed first to fit the wings which grasp the sound side of the trunk, thigh and leg, and afterwards the other wings are adjusted. (5) The shoulder braces are to be adjusted; afterwards the thigh and leg bandages.' When flexion is present at the time that the splint is applied, no attempt should be made to draw the leg forcibly into the straight position. It should be allowed to remain in the position which is comfortable to the patient; and in the course of a few days the weight of the limb itself, which is left unsupported behind the knee, will gradually bring the leg straight (see Fig. 61).

Sometimes there is considerable pain for a day or two after the splint has been applied; this is largely due to the weight of the limb, which is gradually producing extension at the hip-joint. If the pain be excessive, two or three pads may be placed behind the knee so as to take off the strain; these are gradually diminished in thickness so as to allow the limb to come down by degrees, which it will then do without pain. The patient should be encouraged to persevere with the splint in spite of the pain, which should cease when the limb has come into good position.

A very serious fault, frequently committed by instrument makers, is to mould the splint to fit the body of the patient accurately whilst the limb is in the position of deformity. Thus it is curved forward in the loin to correspond to the amount of lordosis; below this comes the concavity for the buttock, and then it is bent forward again to correspond to the flexion of the leg. The result is that by no possibility can the flexion be overcome, as the apparatus fixes the limb in the faulty position. If a good result is to be obtained, it is absolutely essential to overcome the flexion, and, when a Thomas's splint alone is employed, this must be applied as he himself recommended; namely, in the form of a straight



Back view. *Front view.* *Side view.*

FIG. 61.—THOMAS'S HIP SPLINT APPLIED. (*Photos supplied by Allen & Hanburys, Ltd.*)

bar simply curved forward where it lies over the buttock, the other parts of the apparatus being absolutely vertical.

The great objection to a single Thomas's splint is that the limb is not kept abducted, as is advisable in all these cases; indeed, unless great care is taken, adduction may actually take place. Hence it is well to have the splint bent outwards at the lower end of the curve for the buttock so as to produce as much abduction of the leg as possible, or, in bad cases, to apply a *double Thomas's splint.* The latter is not very convenient for adults, but in children it should always be used in the early stage of the treatment in preference to the single splint, as it will enable the patient to be carried about. This splint consists of a bar running up behind each buttock and leg, thence along each side of the spine, the two being connected by cross-pieces above and opposite the pelvis (see Fig. 62). The bars should diverge from each other, so that the lower extremities are slightly abducted when fixed to them (see Fig. 63). Here also a pelvic band is essential to prevent the patient moving the pelvis laterally.

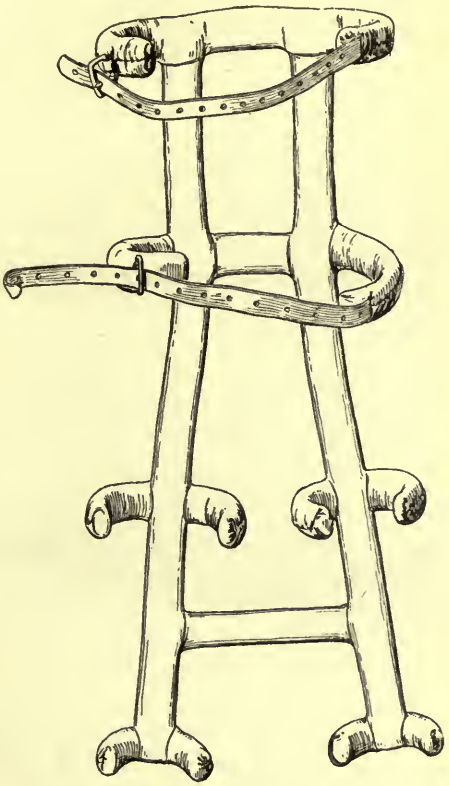


FIG. 62.—A DOUBLE THOMAS'S SPLINT FOR HIP DISEASE. The splint, which is made of malleable iron thickly padded with leather, is shown applied in the following figure. The leg-pieces diverge, so as to abduct the lower extremities.

In children at this stage the application of a *plaster of Paris casing* is very satisfactory. The limb should be abducted and the thigh and pelvis enveloped in plaster of Paris bandages, specially strengthened in front of, and behind the hip-joint. The plaster need not include the knee unless the case is a bad one, and should be renewed every three or four weeks. An excellent arrangement for the purpose of applying the plaster has been designed by Dr. Gallie, of Toronto (see Fig. 64). It consists of a board, with a raised wooden rest for the shoulders at the upper end, high enough to leave plenty of room between the body and the board for passing

the bandage. Below this is a central vertical slot in which moves an upright bar carrying two thin pieces of metal which lie behind the buttocks and support the pelvis. The plaster bandages are applied around the pelvis and thigh with the greatest ease; when they have set, the metal pelvic supports can be withdrawn without weakening the splint.

Another apparatus of great value in young children is *Phelps's box* which is more particularly referred to in connection with the treatment of spinal disease (see Fig. 65). The management of the child in this apparatus is described on p. 302. In it the patient can be kept lying

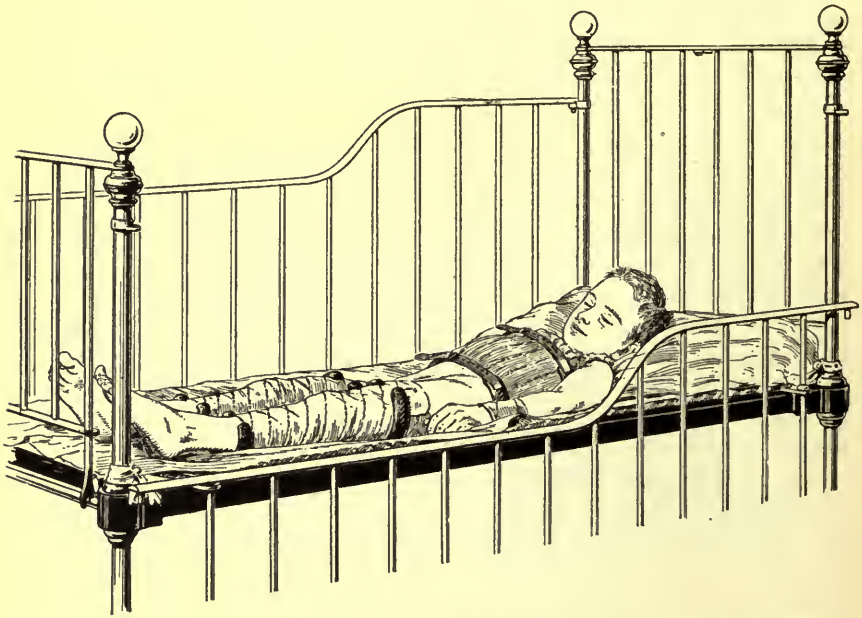


FIG. 63.—METHOD OF APPLICATION OF THE DOUBLE THOMAS'S SPLINT FOR HIP DISEASE. The limbs are fastened to the vertical bars with bandages and are encircled by the iron wings. Those surrounding the chest are fastened by buckles. There are no braces as in the single form of splint as of course the patient cannot walk.

flatter and more comfortably than in Thomas's splint, whilst the abduction is more efficient. If necessary, extension can be obtained by elastic tubing attached to the foot-pieces of the splint, counter-extension being made by fastening the trunk to the head of the splint (see Fig. 66), and the child can be carried out or wheeled about without disturbing him or interfering with the extension.

At a later period the patient is permitted to walk with the aid of crutches, wearing a Thomas's hip splint or a *Hessing's splint.* This latter has certain advantages over a Thomas's splint in that it gives a firmer support to the limb, and transmits the weight of the body direct to the

foot-piece. It is also less likely to become displaced when it has been put on (see Fig. 67).

The next stage is to permit the patient to leave off the splint and walk with crutches, swinging the leg freely, a 3- to 4-inch patten being attached to the sole of the boot of the sound limb, so that the foot of

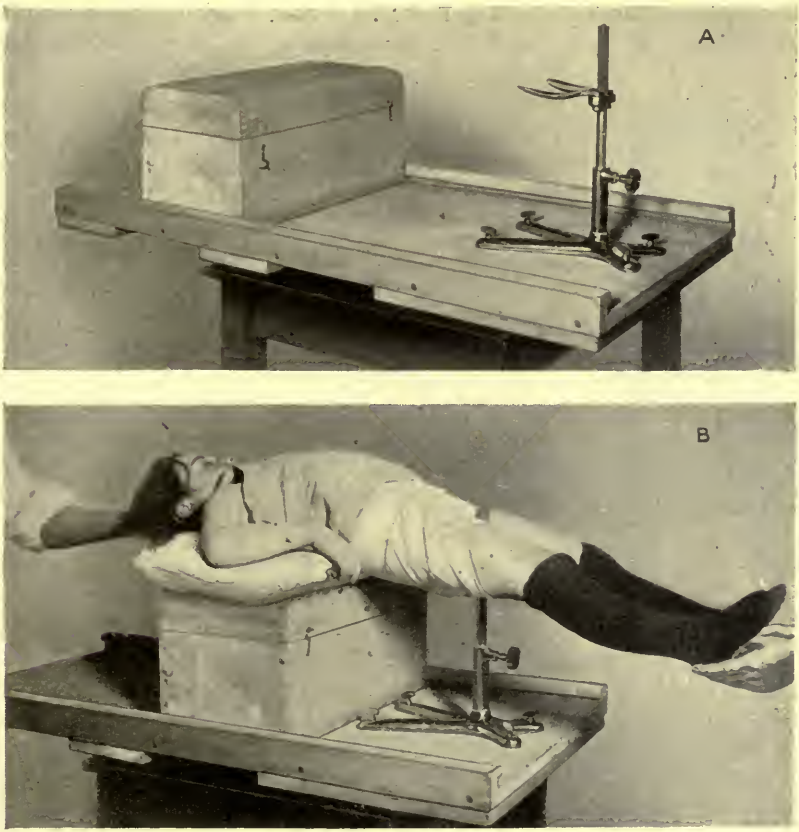


FIG. 64.—APPARATUS FOR THE APPLICATION OF A PLASTER OF PARIS SPICA. This is similar to that of Dr. Gallie, of Toronto. In A is seen the apparatus with a pelvic rest adjustable in height and consisting of two movable wings upon which the tubera ischii rest, and the box upon which the thorax is supported. This box slides backwards and forwards according to the length of the child. The apparatus is shown in use in B. (*From photographs by Mr. E. B. Clayton.*)

the affected side cannot be placed on the ground. The patten should be worn both in and out of the house.

Finally, if there is no pain or swelling in the region of the hip-joint after four to six months the patient may be allowed to bear weight on the limb and gradually begin to increase the range of movement in the joint. During this time massage is of value in keeping up the nutrition of the muscles and restoring their tone.

Operative interference is rarely required in the first stage of the disease, but when it is evident that there is a deposit in the neck of the femur, good results may sometimes be obtained by cutting down upon, and removing it before the joint has become infected. The difficulty in these cases is to make an exact diagnosis, but the chief point is that the neck of the bone and the great trochanter are thickened without any marked symptoms such as pain or interference with movement. No thickening will be found inside the pelvis on rectal examination, and practically none in the synovial membrane. A radiogram may be of considerable assistance. Under these circumstances we have cut down and removed tuberculous deposits from the interior of the neck of the femur, and have thus succeeded in curing the disease without any infection of the joint. When the disease is evidently in the substance of the neck of the femur, it may be readily got at by a vertical incision over the outer surface of the trochanter; when this is exposed, the compact tissue is cut away with a gouge, and then the cancellous bone is scraped out with a sharp spoon until the tuberculous deposit is exposed. This is scooped out and the soft bone removed until normal cancellous bone is reached. Care must be taken not to open the joint. The wound is sewn up without a drainage tube, and the cavity fills with blood-clot which ultimately undergoes organisation into bone.

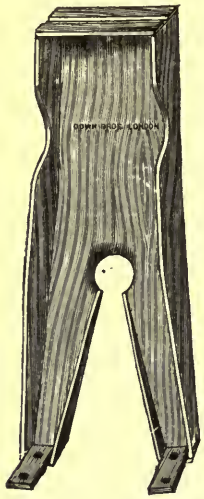


FIG. 65.—PHELPS'S BOX. The splint is here shown without the pads; in the next figure it is shown in use. The holes in the foot-pieces and the slit in the upper end of the splint, through which extension and counter-extension can be made if desired, are seen, as are also the hollows in the sides of the box over which the child's arms can lie.

Treatment of the second stage.—It is in this stage that extension is essential, because absorption of the neck of the femur is going on and the acetabulum is becoming enlarged, so that, unless means are taken to arrest the muscular spasm, the shortening will increase in spite of the most careful fixation of the joint. In this stage also the tendency to flexion, adduction, and rotation inwards must be overcome; suitable extension is usually able to do this. In the first instance the extension should be applied in the direction that the limb has already assumed (p. 167); by altering the direction gradually, the deformities can be quite corrected and the limb brought into the fully extended and moderately abducted position. The abducted position is of great importance for the following reason. The best result that can be hoped for in these cases is recovery with more or less complete anchylosis of the joint, and, should anchylosis occur with the limb parallel to the middle line, the functional shortening will be considerable. If, however, the limb be

abducted, the patient will have to tilt the pelvis towards that side when he desires to bring the sole of the foot flat upon the ground in walking, so that the apparent shortening becomes less than the real shortening, and thus the patient can get about with a thinner sole on the affected side than would otherwise be necessary. If extension alone is employed, it will be difficult to maintain this abduction; the patient involuntarily wriggles across the bed and so defeats all the attempts to remedy the adduction. Hence a Liston's long splint should be applied on the sound side and heavy sand-bags placed outside it. Shoulder

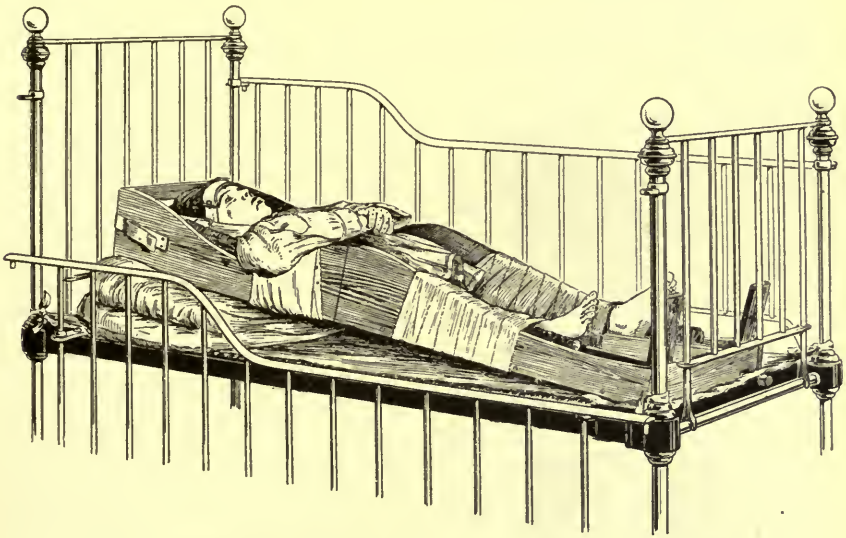


FIG. 66.—METHOD OF APPLICATION OF PHELPS'S BOX. The child lies upon suitable firm cushions made to fit the splint; other similar ones are inserted between the sides of the splint and the body. The legs are kept in their respective troughs by bandages; the thorax is encircled by a broad towel or folded sheet over the splint. The sketch above shows the box arranged for a case of spinal caries; extension is applied to the head, which is fastened to the end of the splint by a headstall, and the child's weight allowed to tell upon it by raising that end of the splint. For hip disease, if desired, extension can be made by combining weight and pulley extension of the lower limb with the above; the cord bearing the weight passes from the stirrup through holes in the foot of the splint.

straps attached to the bed, or a broad sheet passed across the chest and wrapped round heavy sand-bags on each side should be used to prevent the patient raising the body from the mattress. It is also advisable to place fracture boards beneath the mattress, and the foot of the bed or of the cot should be raised on blocks six to nine inches high.

After the limb has been got into good position, and the muscular spasm has subsided, a plaster of Paris or a Thomas's splint may be fitted; the double Thomas's splint should be employed in children, as the single one is quite ineffectual in obtaining sufficient abduction. The apparatus should be worn for a year or two after the disease has come to

a standstill, otherwise muscular contraction may recur and the deformity be reproduced. A great advantage of the double Thomas's splint is that the patient can be moved out of doors and can get the benefit of the fresh air. Until the disease has become entirely quiescent, however, it is not advisable to allow him to get about on crutches. When this stage is reached a single Thomas's or a Hessing's splint should be employed.

Sometimes the contraction of the adductors may be so marked that it is advisable in the first instance to perform tenotomy of the adductors close to their origin from the pubes. It is, however, very important that no violence should be used after the tenotomy in order to restore the limb to its proper position, otherwise aggravation of the disease is almost certain to occur. Gentle steady traction will bring the limb out to a considerable extent, and then further abduction may be obtained in a short time by suitable arrangement of the extension apparatus.

Fig. 67.—Hoefficke's Extension Splint for Hip-joint Disease.

The question of operation often comes up for decision in the second stage of hip disease, the particular form being excision of the hip, with as complete removal of the diseased structures around as possible; arthrectomy of the hip-joint is unsatisfactory, as thorough removal of the disease by this operation is almost impossible. Formerly surgeons were in favour of operation at this stage, and they claimed that, by an early and complete removal of the disease before suppuration has occurred, the trouble is cut short and the danger of subsequent constitutional infection is avoided. Of late years, however, whether it is that the bacilli are becoming less virulent or that improved hygienic conditions are increasing the resisting power of the patients, it has been found that a large proportion of cases recover under expectant treatment and with a better limb than is obtained by excision. The functional result after excision is not at all good, because in walking the limb moves up and down over the side of the pelvis and there is a great want of stability, the gait closely resembling that of congenital dislocation. On the other

hand, a patient with a stiff hip-joint has a firm and very satisfactory support, provided the limb is in good position. Further, in children, excision often interferes to a very marked extent with the growth of the limb.

Apart from the question of the functional result it is very doubtful whether excision really cuts short the disease or prevents subsequent general infection. Complete removal of the disease is hardly possible in the case of the hip-joint. It is a particularly difficult matter to take away the posterior part of the synovial membrane, and the surgeon often has to content himself with scraping this after he has removed the head of the bone. Moreover, it is by no means certain that an early excision does really avoid dissemination of the tuberculous disease. A considerable number of cases have been recorded in which tuberculous meningitis has followed so directly after an excision of the hip that there can hardly be any doubt that it was caused by the operative procedure. Local recurrence also is by no means avoided ; indeed the divided bone often becomes infected, and tuberculous osteitis or osteo-myelitis occurs. Hence we cannot agree that early excision is indicated either on the ground of a rapid cure of the disease or on that of avoiding dissemination of the tubercle, whilst the functional result is certainly not good.

Nevertheless there are still cases in which excision at this stage of the disease is the proper procedure. Such are (1) cases in which the disease progresses in spite of careful expectant treatment ; that is to say, those in which the tenderness does not subside, the fullness in the groin increases, the starting pains at night continue, and the disease is evidently active ; and (2) cases in which it is evident that there is primary acetabular disease—this is shown particularly by thickening of the tissues on the inner surface of the acetabulum, which can be felt *per rectum*. In these cases the head of the bone must be removed, if the disease does not show early signs of recovery, in order to obtain sufficiently free access to the joint to enable the surgeon to deal with the acetabular deposit.

Treatment of the third stage.—The characteristic of this stage is the presence either of unopened abscesses, or of sinuses. The deformity is very similar to that already described in the previous stage. While the local treatment as regards splints and extension is the same as in the second stage, the operative treatment depends on whether the abscess is unopened, or whether septic sinuses are present.

When there is an unopened abscess.—Operative treatment is necessary under these circumstances, because the cases in which a chronic abscess becomes absorbed are so rare that a cure cannot reasonably be looked for, if it is left alone. The point for decision is, whether the abscess shall be aspirated or opened, or whether steps shall be taken to remove the primary disease by excision of the joint. The answer will depend upon the circumstances of the individual case. When the abscess has originated

outside the pelvis, it is well in the first instance to be content with the treatment of the abscess and to defer the question of excision to a later period. When, on the other hand, the abscess has originated on the pelvic side of the acetabulum, the joint must be excised and the acetabulum perforated so as to evacuate the pus and prevent it from burrowing downwards, for, if it bursts about the perineum, sepsis is certain to occur.

When it is decided to treat the abscess alone, the methods to be followed are either aspiration and injection, or an open operation in which as much of the wall is removed as possible. The details of these methods have already been fully given in Vol. I. p. 235. As a general method, especially where there is a risk of sepsis, repeated aspiration as carried out by Calvé and Gauvain (*Lancet*, March 5, 1910) should be employed. The other method of treating abscesses has, however, the advantage that the disease is more thoroughly dealt with, and the surgeon has the opportunity of examining the joint and of removing any sequestrum or tuberculous deposit in the bone which may be present. When the abscess has been got rid of, the condition often improves and the treatment becomes that of the second stage.

When, on the other hand, the abscess originates within the pelvis it is a clear indication that the acetabulum is diseased; this is usually due to a primary osseous deposit in the acetabulum, although sometimes the disease of the bone is secondary. Excision of the head of the femur is necessary here to allow free access to the acetabulum and the evacuation of the abscess. If the abscess has tracked into the iliac fossa it is advisable to begin by making a small incision into it at some point easy of access—generally in this case about the anterior superior iliac spine—scraping it out as thoroughly as possible, injecting iodoform and glycerine, and stitching up the wound. Excision of the head of the femur should then be performed through the anterior incision, and when the head of the bone has been removed, special attention must be directed to the acetabulum so as to remove any osseous deposit, and to establish a communication with the interior of the pelvis by gouging away the bone until the abscess can be thoroughly evacuated. After injecting more iodoform and glycerine the excision wound is also closed and the after-treatment of excision (see p. 185) carried out.

When there are septic sinuses.—When septic sinuses are present, the conditions are altogether different, and in a good many cases excision is advisable. When the position of the limb is good and the patient's general health is satisfactory, and when there are only one or two sinuses, an attempt may, however, be made to bring about a cure of the disease by proper fixation of the limb and the establishment of good drainage.

The best method of fixing the joint is to apply a plaster of Paris spica, leaving suitable openings for dressing the sinuses. The plaster casing should be strengthened both in front of and behind the hip,

either by strips of metal incorporated in the bandage or by strands of tow thoroughly impregnated with plaster. Above, it should extend as high as the ribs ; below, it should reach to the upper part of the calf, so as to fix the knee-joint as well as the hip, and it should be applied with the limb in a position of abduction. When the sinuses are so situated that it is difficult to apply the bandage without covering them in, metal bars bent outwards opposite the wound may be incorporated with the bandage on each side, so as to provide a firm splint, and at the same time to allow proper access to the wound.

The methods of dealing with the septic tuberculous sinuses are fully considered on p. 128. *When there is much suppuration*, steps must be taken to secure efficient drainage. For this purpose it may be necessary to open up existing sinuses or to establish fresh openings, inserting large-sized drainage tubes down to the bottom of the wound or passing tubes through from one opening to the other ; packing with gauze should not be employed. When two sinuses have been made to communicate, and a tube has been passed through from one to the other, a long loop of silk should be fastened to one end of the tubes. When it is desired to wash the tube it can be pulled out and then readily re-introduced by traction on the string. After cleansing the tube it is well to dust it with iodoform before it is put back. These sinuses should not be syringed out with an antiseptic solution, which irritate the wound without disinfecting it. After about three weeks the tube may be cut in two and gradually shortened as the sinus closes.

When the tubes are first introduced they should not be disturbed for about a week, otherwise there may be great difficulty in re-inserting them. At the end of a week each tube may then be withdrawn, cleaned, powdered with iodoform, and replaced. In all cases the tubes should be employed as long as possible, and, when it is found that the large tube will not go down to the bottom of the sinus, one of smaller calibre must be substituted for it. In any case it is well to substitute a fresh tube for the old one every few days, as granulation tissue grows through the holes in it and blocks its lumen ; in the fresh tube the holes will be in a different position, and this difficulty is thus easily avoided.

When the amount of discharge is small, Bier's cups may be applied and citrate of potash administered, with the view of promoting the flow of serum containing antibodies. In some cases remarkable benefit follows the use of bismuth injections (see Vol. II.).

Vaccines prepared from the organisms present in the sinus may be employed, and injections of tuberculin may be beneficial.

In a certain number of cases the sinuses may heal and the disease may be cured ; but when there are a number of sinuses, and when sepsis is severe, the attempt as a rule fails and the question of excision of the joint will arise ; in most of these cases it should be done unless the patient's general condition prohibits it. In performing the operation,

the sinuses should first be thoroughly scraped and then sponged with pure carbolic acid, so as to render the wound as aseptic as possible. After the excision the cavity left should also be sponged out with undiluted carbolic acid. For the operation of excision, see p. 182.

When the disease has extended on to the pelvis, and when there is much suppuration and the patient is going downhill, amputation of the limb has been advocated so as to obtain free access to the disease in the pelvis. When the amputation is performed (or subsequently if the patient is collapsed), the disease in the pelvis must be dealt with freely.

Treatment of the fourth stage.—This includes the cases in which recovery has taken place or is progressing satisfactorily, but in which the limb is in bad position ; the main aim of the treatment is therefore to remedy the deformity. The usual deformities met with are flexion, adduction, and rotation inwards. When there is great flexion, the patient is either unable to put the foot to the ground, or can only do so by producing extreme lordosis. When the adduction is marked, he finds it necessary to tilt the pelvis upwards on the affected side before the leg can be brought parallel with its fellow, and this produces marked scoliosis, whilst the practical shortening of the limb is greatly increased. In either case the functional disability is serious.

In the cases in which there is still some movement in the joint, the deformity may be overcome by *dividing any contracted bands or tendons*, particularly the adductors, and by careful employment of force to stretch the adhesions, followed up by extension (see p. 167). The limb should ultimately be brought into the position of abduction, while the rotation and flexion are corrected. The reason for preferring the abducted position is given on p. 174. A certain amount of scoliosis must, of course, result from this abducted position ; but, if the patient be strong, it will not be more than is necessary to compensate for the shortening.

In the majority of cases, however, the anchylosis is so firm that to overcome the deformity by these means alone it would require an amount of force that might light up the disease afresh. Various operative measures must therefore be considered, the principal being excision of the joint, removal of a wedge of bone from the region of the trochanter so as to enable the limb to come straight, or simple division of the femur below the trochanters. When the disease has passed off completely, Murphy's *arthroplasty* (see p. 153) may be employed.

Of the various operations the most satisfactory, in the majority of cases, are removal of a wedge of bone or osteotomy of the upper part of the femur. Excision of the joint is not to be recommended for the reasons already given (see p. 176). Sometimes however it may be called for when the deformity is very marked, as it may be impossible to get the limb straight by other measures ; when excision is done, prolonged after-treatment is necessary in order to get a stable joint.

When it is determined to remedy the deformity by *the removal of a*

wedge of bone, it is best to do this in the neighbourhood of the junction of the neck with the trochanter; this leaves a large surface for union, and is in quite an accessible region (see Fig. 68). The shape and the size of the wedge will depend upon the exact nature of the deformity. If there is mainly adduction, the base of the wedge must be directed outwards and upwards; if there is much inward rotation its base must be backwards.

The bone is reached by an incision very closely resembling that for the anterior operation of excision of the hip (see Fig. 69); it should be four or five inches in length. The incision is deepened, the muscles are pulled aside, and the junction of the neck of the femur with the trochanter is exposed, no structures of importance being divided. The wedge is best removed by means of a chisel and hammer, and the amount of bone to be taken away must be accurately gauged. When the limb is brought into position, it will generally be found that the adductors require division, and this may be done close to their origin from the pubes; any other tense bands should be similarly treated.

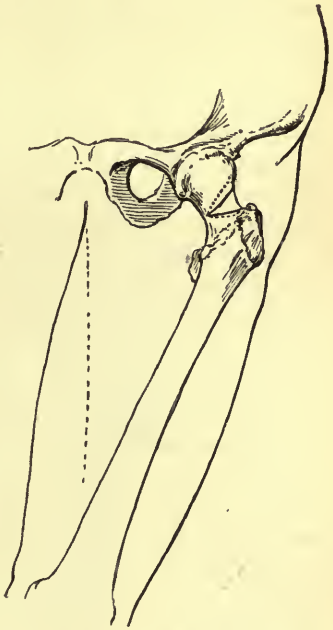


Fig. 68.—Excision of a Wedge from the Neck of the Femur in old Hip Disease. The wedge which is excised through the incision seen in Fig. 69, is made with its base upwards and outwards for the deformity here shown, viz. flexion, adduction, and inward rotation. The wedge also requires to be made wider behind than in front, as shown by the dotted lines.

After the limb has been brought into position, extension should be employed in the direction that the limb is intended finally to occupy—a weight of three or four pounds being generally sufficient. Besides this, the arrangement figured on p. 159 for preventing rotation should be used. A Liston's long splint should be fastened to the sound side, so as to prevent the patient from sitting up, and a divided mattress (see p. 167) is of great value.

The patient should be kept in this position until union has occurred, which will generally be in about six weeks, after which he may be fitted with a Thomas's splint, bent to correspond to the amount of abduction present; he may then get about on crutches. In about three months from this time he may be provided with a high boot on the affected side and allowed to walk without crutches.

In the other procedure the femur is *sawn across just below the trochanters*, and the limb is placed in its proper position. Some surgeons aim at a false joint; others try to get anchylosis in good position. The latter seems the preferable course.

When the deformity is very great, and when it is evidently impossible to remedy it by the above methods, and particularly when the disease is still active, *excision of the joint* will probably provide a better result. When, however, the disease has been quiescent for some years, Murphy's *arthroplasty* may advantageously take the place of any of the three procedures to which we have been referring (see p. 153).

At this stage of the disease cases are sometimes met with in which both hip-joints have been affected, and the adduction has caused the legs to cross one another, and to produce the so-called '*scissor-leg deformity*.' This is a most distressing condition, and something must be done to remedy it. The best treatment in recent cases is to excise the joint on one side so as to get a movable joint, and thus to enable the patient to sit down, whilst on the other side a wedge should be removed or a sub-trochanteric osteotomy performed. It will be advisable not to operate on both sides at the same time.

If both hip-joints are excised, the patient is in a condition similar to that of congenital dislocation of both hips, and will probably have most serious locomotive troubles, whereas if one leg be firm and in good position and the joint on the other side be excised, the ultimate result will probably be very satisfactory. In cases of longer standing, Murphy's arthroplasty may take the place of excision.

Excision of the Hip-joint.—The indications for excision of the hip in cases of tuberculous disease have already been given (p. 177). In all cases, removal of the bone must be combined with free removal of the diseased synovial membrane. The operation may be performed in various ways, of which we shall describe three: by an anterior, an external, or a posterior incision. Each of these has its own special merits and may be adopted under different circumstances.

1. *By an anterior incision.*—The anterior incision is the one in common use, and is the most satisfactory method for children. It is especially adapted for cases of medium severity in which the disease does not extend far out along the neck of the femur. The incision commences just below the anterior superior iliac spine, and runs downwards and slightly inwards for about four inches, so as to open up the interval between the tensor fasciæ femoris externally and the sartorius internally (see Fig. 69). After the skin and deep fascia have been divided, the septum between the tensor and the sartorius comes into view, and these muscles are separated and pulled well apart by large retractors; the cellular tissue lying between the deeper muscles is then divided, in doing which a fairly large branch of the external circumflex artery is usually cut across. As the incision is deepened, the capsule of the joint is reached and opened. The neck of the bone is then divided in the line of the external wound with a fine saw (see Fig. 70), and the head of the bone seized with lion forceps; it can usually be removed without any

difficulty owing to the enlargement of the acetabulum and the destruction of the ligamentum teres.

This brings the surgeon to the most important part of the operation, namely, the identification and removal of the diseased synovial membrane. In order to do this, the wound is fully retracted, the outer surface of the capsule is defined at the point where it has been incised, and the tissues

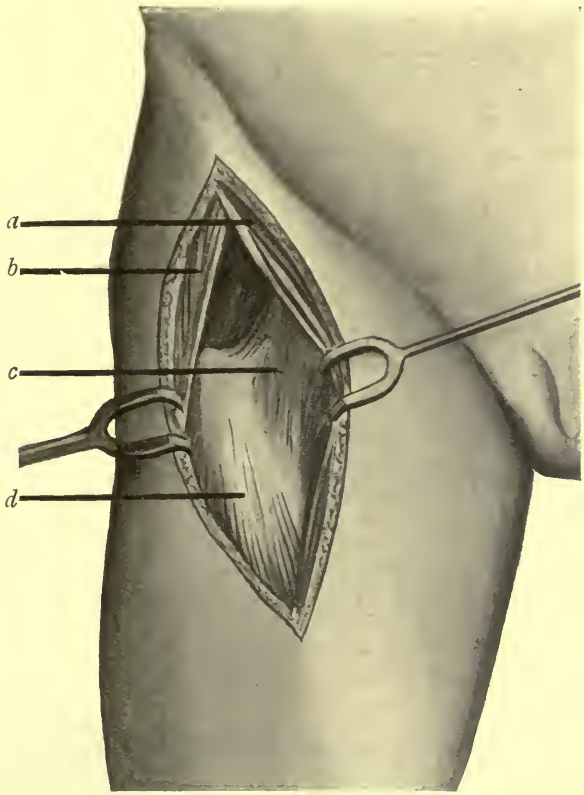
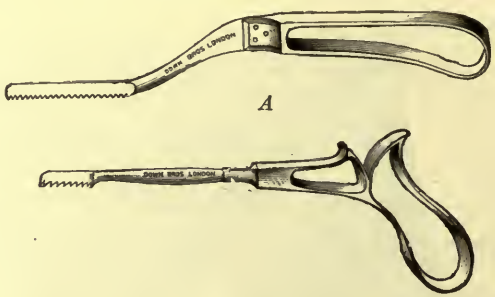


FIG. 69.—INCISION FOR EXPOSURE OF THE NECK OF THE FEMUR. *a*, Sartorius; *b*, tensor fasciæ femoris; *c*, capsule of the hip-joint; *d*, quadriceps.

in front of it are separated by the finger and a suitable blunt dissector, and raised from it until the margin of the acetabulum is reached. The anterior part of the capsule is freed in this manner as far as possible upwards and downwards, and it may then be clipped away almost entire. When the soft parts are retracted, there is a good view of the interior of the joint, and the acetabulum can be dealt with. The remains of the ligamentum teres are cleared out, and if there is any destruction of the cartilage covering the acetabulum or any tuberculous deposit in

the bone, the whole surface of the acetabular cavity should be thoroughly scraped with a flushing curette (see Fig. 71).

The next, and perhaps the most difficult, part of the operation consists in defining and removing the posterior portion of the capsule. If the patient is bearing the operation well, by far the best way of doing this is to make an incision behind the trochanter extending upwards and back-



A

B

Fig. 70.—Saws for Division of the Femur. *A* is the form most useful for sub-trochanteric division, while *B* is more suited for division of the neck of the femur, where the width of the bone to be divided is less. Both forms should be blunt-ended, cross-cut, and very stout, so as to ensure rapid cutting and to minimise the chance of breaking the saw *in situ*.

wards from its posterior border in the direction of the fibres of the gluteus maximus muscle, which are separated by the handle of the knife; the dissection is then gradually deepened until the posterior portion of the capsule is reached. This may now be separated from the structures behind it by means of one finger introduced through the posterior wound, aided by another introduced through the anterior incision as a guide,

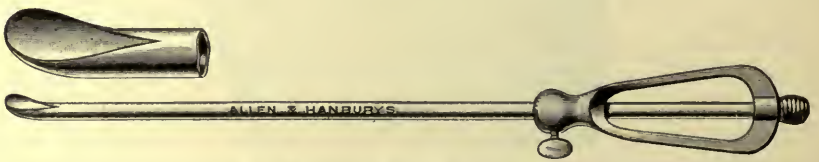


Fig. 71.—Flushing Curette. The handle of the curette is provided with a thumb-screw so that it can be moved along the instrument, and give greater purchase if required. In the small upper figure the sharp end of the curette is shown full size.

and a considerable portion of the capsule may thus be clipped away. It is, however, practically impossible to remove the entire structure, and the portion remaining must be cut away with curved scissors and systematically scraped with a sharp flushing curette (see Fig. 71) through which a weak sublimate solution (1 in 6000) is kept running.

After the bleeding has been arrested, the posterior wound is first sutured accurately and then about an ounce of iodoform and glycerine emulsion (see p. 118) is introduced through the anterior incision, and the

wound stitched up entirely without any drainage. The limb is brought into a position of moderate abduction. The tendons of the adductors, if necessary, may be divided by a tenotomy knife close to their origin from the pubes.

When, after making the anterior incision and removing the head of the bone and the anterior portion of the capsule, the surgeon finds that the patient's condition is such as to contra-indicate a prolonged operation, he must confine himself to removing as much of the posterior part of the capsule as possible through the anterior wound by means of scissors and a sharp flushing curette. This, however, is a far inferior method to the one described, and should only be adopted when circumstances forbid the employment of the other.

After-treatment.—When the patient is put back to bed, extension should be applied, a weight of about three or four pounds being used for a child. The limb is placed in the abducted position, and rotation prevented by means of the apparatus shown in Fig. 55. A Liston's long splint should also be applied to the sound side from the axilla to beyond the toes, so as to prevent the patient from sitting up. The mattress is divided into three parts, so that the central portion can be removed for nursing purposes without any disturbance of the limb.

The extension and fixation of the limb should be kept up for about six weeks ; at the end of that time a Thomas's hip splint (see p. 168) may be employed. This should be bent well outwards opposite the joint so as to keep the limb in the abducted position ; the splint should be provided with a pelvic band. In young children, who are difficult to keep quiet, either a double Thomas's splint (see p. 171) or a Phelps's box (see p. 172) will be better than the single Thomas's splint. The patient need not be kept in bed after six weeks or so ; he may be allowed to get about in a single Thomas's splint with crutches and a high boot on the sound foot or a Hessing's splint may be used. We very strongly advise that the patient should not be allowed to bear any weight on the limb for at least six or eight months after the operation. If this line of treatment is carried out, the consolidation of the structures in the neighbourhood of the joint will give a much firmer joint than is otherwise obtainable. It is very seldom that anything like bony anchylosis occurs, but if a movable joint is desired, this may be assured by performing passive movement of the hip through a limited range twice a week after the wound has healed.

2. *By an external incision.*—When the disease extends far out along the neck of the femur, and especially when there are several sinuses, a freer and better opening may be obtained by an incision over the outer surface of the trochanter, commencing about two inches above its upper border and running vertically downwards for four or five inches (see Fig. 72). The knife should be carried through the glutei muscles directly down to the bone, and the trochanter itself is cut into. This structure is

usually cartilaginous in young subjects, and the epiphyseal portion may be divided in two with the knife. These portions retain their muscular connections above and are still connected with the periosteum of the femur below. They are pulled aside, and access is at once gained to the neck of the femur. In adults, or in those in whom ossification of the trochanter has taken place, this structure may be sawn off and turned up with the muscles attached to it.

The neck of the femur is now sawn through with an Adams's osteotomy saw (see Fig. 70), outside the limits of the disease—usually on a level with the trochanter—the saw being directed obliquely downwards and forwards. The head and neck of the bone are then seized with lion forceps and gradually extracted. In these cases the removal of the head and neck of the bone in one piece is very difficult if the ligamentum teres is intact, but, when the latter structure is destroyed, there is no trouble. The manœuvre is much aided by incising the capsular ligament freely, when the admission of air into the joint facilitates the removal of the head. Should it be difficult to take the latter away in one piece, there is no objection to chiselling it out of the acetabulum.

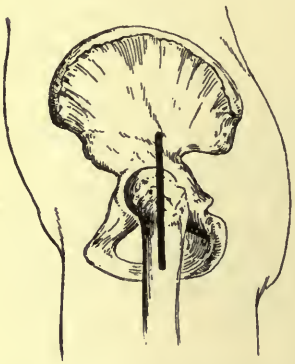


FIG. 72.—EXCISION OF THE HIP BY AN EXTERNAL INCISION. The limb should be somewhat flexed and rotated inwards.

The subsequent steps are similar to those recommended for the anterior operation. In this method there is much better access to the posterior part of the capsule, so that a second incision is unnecessary, but in children the damage to the epiphyseal line of the trochanter may interfere with the growth of the limb. Hence this method should seldom be employed.

3. *By a posterior incision.*—In bad cases, especially in adults, or when there is dislocation of the head of the bone on to the dorsum ilii, a curved incision passing behind the trochanter is very useful and provides excellent drainage. The patient is rolled over on to the sound side, the thigh is semiflexed and rotated a little inwards, and an incision is made, commencing about an inch and a half above the centre of the top of the trochanter and passing downwards and forwards, until it reaches the junction of the base of the trochanter and the shaft of the bone (see Fig. 73). As this is deepened, the glutei muscles are separated in the line of their fibres and the posterior surface of the neck of the bone is easily exposed by dividing the muscles attached to the great trochanter. The saw is now applied to the bone just above the trochanter, and the head and neck of the femur are removed.

By this operation the whole of the interior of the joint is very freely exposed and can be accurately examined. The thorough removal of

the disease is perhaps more easy by this method than by any other. It is, however, open to the serious objection that the glutei are considerably damaged and the functional result is therefore not likely to be so good; it gives excellent drainage, however, and should be employed by preference in cases in which numerous septic sinuses are present.

Septic sinuses should be dissected out or scraped, and undiluted carbolic acid applied to them; finally the whole wound should be thoroughly sponged with the same substance before the sutures are introduced. When there is widespread sepsis and a number of sinuses, it is well to leave the wound open and to pack it with cyanide gauze impregnated with iodoform until granulation is well advanced. The packing should be renewed daily for about three weeks, when it should be dispensed with and the wound allowed to close.

When excision is employed after the disease has become quiescent, the

FIG. 73.—EXCISION OF THE HIP BY A POSTERIOR INCISION. The patient lies upon the sound side with the affected joint flexed and rotated inwards.

operation is only done for the deformity, and removal of the head of the bone is all that is required; it is not necessary to dissect out the synovial membrane. The object of the operation in these cases is to get rid of the head of the bone so as to obtain a movable joint. Here the anterior incision is the best, and after the neck has been sawn through, the head of the bone must be chiselled out of the acetabular cavity; it is impossible to pull it out after division of the neck on account of the bony anchylosis. In these cases, however, Murphy's operation (p. 153) will probably replace excision of the hip when the only object is to obtain a movable joint.

OSTEO-ARTHRITIS.

This is one of the most common diseases of the hip in old people. The hip-joint is one of the most frequent seats of monarticular osteo-arthritis, and probably the condition known as *malum coxæ senile*, in which there are marked atrophic changes in the cartilage and bone, and which so

frequently follows injury in old people, is merely a form of this disease. The affection in the hip is associated with much greater pain than in other joints, and this does not necessarily accompany movement, but may be very marked while the patient is lying in bed; it is, however, generally increased by movement.

There is usually considerable fixation of the joint, which is somewhat flexed, adducted and rotated inwards. The head of the femur undergoes softening and absorption, and the angle which the head and neck of the bone form with the shaft is considerably altered, so that it may be a right angle or even a somewhat acute one. This gives rise to shortening of the limb, which is not due to enlargement of the acetabulum or to dislocation, but to absorption and the altered position of the head and neck of the bone. The trochanter will therefore be often above Nélaton's line in advanced cases. There is a marked tendency to the formation of osteophytes around the hip, and the patient may suffer from severe pain in addition to that attributable to the trouble in the joint; this pain may be due to pressure upon the sciatic nerve by these osteophytic outgrowths, or to adhesion of the nerve to the capsule.

TREATMENT.—This is fully discussed on p. 143, and there is little further to be said. It may, however, be occasionally necessary to consider the question of operation, especially in cases in which the sciatic or obturator nerves are pressed upon by osteophytes, or have become adherent to the capsule of the joint. Under these circumstances it may be advisable to cut down and either free the nerve or remove the osteophytic growths which press upon it. The operations for exposing these nerves have already been described (see Vol. II. p. 142). The nerves, after being freed, should be stretched, and any osteophytic outgrowths defined and as far as possible removed. Great improvement frequently follows the operation.

The surgeon may sometimes be tempted to excise the joint; the procedure, however, is not to be recommended. The operation is difficult on account of the distortion of the neck of the femur and the presence of osteophytes around it, and it is accompanied by considerable shock. Besides this, the functional result in adults and old people is extremely unsatisfactory, while the limitation of movement and the pain are likely to recur owing to the formation of fresh osteophytes. If operation is desirable Murphy's procedure (p. 153) will be preferable to excision; it would, however, be limited to young subjects and to cases in which the hip is the only joint affected.

CHARCOT'S DISEASE.

The hip is frequently the seat of Charcot's disease, and in this situation atrophic changes only are found as a rule. There is rapid atrophy of the head and neck of the bone, with destruction of the joint, and early dislocation.

TREATMENT.—The treatment is mainly directed to fixing the joint and enabling the patient to get about. In the earlier stages he should, if possible, be taken off his feet entirely, and confined either to bed or to a couch; at the same time, matters should be so arranged that he is able to get out in the air, and for this purpose he may have a Bath chair. When the acuter symptoms have subsided, a Hessing's splint may be employed, and the patient allowed to walk about.

HYSTERICAL HIP.

Hysterical joint disease is very common in the hip and is generally marked by muscular contraction and the assumption of vicious attitudes. The trouble often occurs after some injury, and is distinguished from hip-joint disease by the diffuseness of the pain and its superficial character. There is an entire absence of any of the signs of disease of the joint, such as thickening around it. In the early stages also, the limb can be moved without any difficulty under an anæsthetic, and no grating can be felt.

TREATMENT.—The treatment has been fully discussed (see p.137), and little more need be added here. In the later stages true shortening of the muscles may occur, and it may be necessary to perform tenotomy, after which the limb must be kept in position by extension apparatus or splints. The muscles that usually require division are the adductors, which should be divided on the inner side of the thigh just below their origin from the ramus of the pubes; the tensor fasciæ femoris may also be shortened. Sometimes the rectus may be contracted and it is then best to make an incision between the inner border of the tensor fasciæ femoris and the sartorius, close to the anterior superior spine of the ilium, and then, separating these muscles, to define the tendon of the rectus and divide it.

CHAPTER XX.

DISEASES OF THE KNEE-JOINT.

INFLAMMATORY AFFECTIONS.

ACUTE SYNOVITIS.

THIS is one of the commonest affections of the knee-joint and generally occurs after sprains. It may also be associated with rheumatism, although the true rheumatic inflammation of joints affects the fibrous capsule rather than the synovial membrane. It may also occur without any assignable cause.

The symptoms vary with the acuteness of the inflammation, and consist essentially in effusion of fluid into the joint, and a varying amount of pain which is increased on moving the limb. The joint usually assumes the semi-flexed position, the fluid effused is coagulable, the synovial membrane is congested and infiltrated with leucocytes, and, in the more acute cases, its surface may be covered with a layer of fibrin. Adhesions of one part of the capsule to another often occur. At first these adhesions are simply fibrinous; but, if the part be kept at rest, organisation may occur later on, ending in the formation of fibrous tissue and true adhesions, which may be so extensive as to end in complete obliteration of the affected portion of the joint cavity. Adhesions only occur after the fluid effusion has become absorbed or has been removed; as long as fluid is present, the synovial cavity is distended and its surfaces are separated from each other.

TREATMENT.—This largely depends on the acuteness of the inflammation and the character of the effusion. When much fibrin is poured out and the inflammation is acute, there is great probability of adhesions forming afterwards, and the treatment must be mainly directed to their prevention. In synovitis occurring in connection with slight sprains, there is little tendency to adhesion; and the trouble will subside quickly if elastic pressure, either by means of an elastic bandage or a

large mass of wool and an ordinary bandage, is applied to the joint. The patient may be allowed to walk and massage should be employed daily.

When, however, the inflammatory attack is more acute, the indications are, firstly, to subdue the inflammation as rapidly as possible; and, secondly, to prevent adhesions forming in the joint afterwards. *Rest and elevation of the limb* are the first essentials. The patient should be confined to bed, with the limb upon a suitable splint and somewhat elevated. The knee should be kept as straight as possible so long as the position does not cause pain; it will generally be necessary to allow a little flexion at first, as the fully extended position is almost intolerable if there is much distension. The best apparatus is a MacIntyre's splint slightly bent at the knee and suitably padded, or a trough of Gooch's splinting with a considerable amount of padding behind the knee in the first instance; this can be gradually reduced as the swelling subsides, until finally the limb is brought straight.

Amongst local applications, *hot fomentations* are probably most satisfactory; they may be applied in the following manner so as to avoid constantly lifting the limb out of the splint on account of the padding becoming wet. After the splint has been padded, but before it is put on, a broad piece of mackintosh is placed over the padding opposite the popliteal space, sufficiently long to fold around the limb, and reaching from about the middle of the thigh to the middle of the leg. The limb is now placed upon the splint, which is fastened on by means of straps or bandages, leaving the knee uncovered; the mackintosh is then turned aside, the fomentations laid in place over the front of the knee, and the mackintosh folded over them. A large mass of wool is put on over all and secured by a bandage. Hot fomentations are, on the whole, better and more soothing than ice-bags or the evaporating lotions so commonly employed. They should be changed every two or three hours or as soon as they get cold.

If the acuteness of the symptoms does not subside, *aspiration* of the joint, repeated more than once if necessary, may be employed; this relieves the tension in the joint and thus at once diminishes the inflammation and pain. The aspiration will also show whether the fluid is purulent or not. Sometimes the effusion is so thick that it will not run through the needle; hence it is well to use a large-sized needle or cannula. On account of the severity of the pain it is often advisable to give the patient an anæsthetic when performing the aspiration.

In some cases beginning without any injury, the symptoms are most acute, the temperature high, and the pain so severe that the case is apparently one of infective arthritis; and yet on opening the joint there is no pus but simply coagulated lymph, and the most careful examination by the microscope and by cultivation fails to reveal any micro-organisms. Under such circumstances the symptoms are often so acute

and the pain so severe, that it may be necessary to make free incisions into the joint to allow the effusion to escape. If the incisions are sufficiently free and are left open, drainage need not be employed; the synovial membrane is so inflamed and sensitive that the presence of a drainage tube may cause intense pain and retard recovery.

In ordinary cases of simple acute synovitis the attack soon subsides under treatment by rest and fomentations, and the fluid will have disappeared in a week or ten days. As soon as this has occurred, it is necessary to take steps to prevent the formation of fibrous adhesions, and therefore gentle massage and passive movements should be begun as soon as possible; the patella should be moved freely in all directions, and the knee gently flexed. Unless these manœuvres are followed by an increase of the effusion, the movements may be gradually increased and the massage may also be more vigorous. This treatment should be continued for about a week, when, in the absence of any bad symptom, the patient may be allowed to walk, at first wearing a firm starch and cotton-wool bandage or an elastic knee-cap, and later without any apparatus at all.

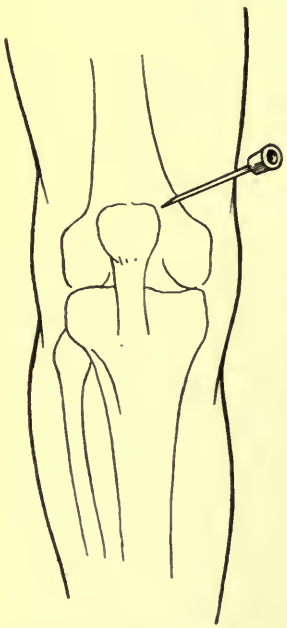


FIG. 74.—ASPIRATION OF THE KNEE-JOINT. The diagram shows the best spot at which to puncture the joint and the direction in which the needle is to be introduced.

The common mistake made in treating acute synovitis of joints is to keep the limb too long upon a splint. It is not unusual to find the limb kept up for six to eight weeks without any attempt at passive movement, and this allows the formation of firm fibrous adhesions which may have to be broken down under an anæsthetic before massage and passive movements can do any good. The reason why the limb is kept in splints so long is, that the attempts at movement may cause great pain; this pain is, however, due to stretching the young adhesions, and quickly passes off as they are torn through. Hence the mere occurrence of pain should not deter the surgeon from employing early passive movement, the main symptom indicating that movement is injurious being recurrence of the effusion.

When the limb has been kept on a splint for too long a time, massage and passive movement may be tried at first; but, as a rule, it will be necessary to break down the adhesions under an anæsthetic before any progress can be made. In doing this the rules recommended for the treatment of adhesions (see p. 155) should be followed.

CHRONIC SYNOVITIS.

Chronic synovitis of the knee-joint is not uncommon, and may either follow an injury or may appear without any obvious cause. Sometimes the effusion is extreme, when the case is spoken of as 'hydrops articuli'; in this condition the capsule may become enormously distended with fluid and, if allowed to go on, this may lead to very serious disability of the limb, on account of the stretching of the ligaments and consequent looseness and deformity of the joint.

TREATMENT.—What has already been said relative to the treatment of chronic synovitis in general applies closely to that condition in the knee (see p. 105); indeed our previous remarks had reference mainly to the knee, and we need not therefore go further into the matter here.

PAPILLARY SYNOVITIS.

In speaking of diseases of joints in general we referred to the occurrence of papillary outgrowths from the synovial membrane due to hypertrophy of the synovial fringes; these are generally most numerous in the neighbourhood of the articular cartilages, but may sometimes cover the entire synovial membrane, and may or may not be associated with rheumatoid changes in the bones (see Fig. 75). The condition affects various joints, but is most frequently found in the knee, where it may give rise to acute symptoms. The long villous processes float about in the joint, keep up considerable chronic synovitis with effusion, and frequently become nipped between the articular ends, so that the patient has sudden pain and sometimes locking of the joint with increase of the effusion.

TREATMENT.—The condition is unaffected by baths, massage, and the other measures usually employed for rheumatoid arthritis. As far as our experience goes, the best method of treatment is to remove the affected portions of the synovial membrane. If this operation is not feasible, the injection of irritant fluids into the joint cavity may be tried with the view of causing adhesion of the villi to the capsule.

Excision of the hypertrophied synovial membrane.—When the affection is limited to one or two patches, the result is most satisfactory; it is only necessary to remove the portion actually affected, after which persistent massage and passive movement will entirely restore the functions of the joint. When, however, the whole synovial membrane is involved and requires removal, the subsequent mobility of the joint may be impaired; at any rate, prolonged treatment is necessary to prevent stiffness from contraction of the capsule, where the synovial membrane has been cut away. In some cases, however, even a certain amount of stiffness is preferable to the great pain and complete disability from which the patient suffers, and we strongly recommend that this method should

be employed when a fair trial of other plans has failed to cure these cases. The steps of the operation have been already given (see p. 109).

Irritant injections.—Injection of irritating fluids into the joint with the view of soldering down the papillæ has been tried, but is by no means certain in its action. The joint has been flushed out with various irritating fluids, such as 1 in 2000 sublimate solution, 1 in 40 carbolic acid lotion, or two per cent. formalin in glycerine. Some fluid is left in the joint and the limb placed on a splint for a few days till the inflammation subsides. Passive and active movements should then be employed to prevent stiffness of the joint. This method cannot be recommended in preference to excision of the villous patches.

ACUTE SUPPURATIVE ARTHRITIS.

Acute suppurative arthritis is not uncommon in the knee, and, when occurring as the result of a wound or from acute epiphysitis, complete destruction of the joint and subsequent bony anchylosis is very likely to take place, should the patient survive. It is one of the commonest lesions in cases of pyæmia, but there, curiously enough, the destruction of the joint is often slight. It may also occur as a result of infection by the pneumococcus or streptococcus; in these cases it is not uncommon to find that the few patients who recover do so with a fairly movable joint.

TREATMENT.—This has already been fully gone into, and directions given for opening and draining the knee-joint (see p. 95). Great care must be taken that the tibia is not allowed to become displaced backwards or to rotate outwards, and therefore the limb must be placed on an efficient splint which will not interfere with the drainage. It is always well to attempt to save the limb, and amputation should not be resorted to unless the case is so bad that it is obviously hopeless to try to retain it, or unless the symptoms do not decidedly abate within three days from the establishment of efficient drainage. The use of a vaccine of the organism present may also be employed, but the value of vaccines in these acute septic cases is doubtful.

Fig. 76 shows the various recesses and bursal cavities in connection with this joint and will serve to point out the regions in which drainage must be provided.

If the serious symptoms continue in spite of free incision and drainage, and amputation is called for, this should be done through the lower third of the thigh. The medulla must be carefully examined at the point of section and, should signs of osteo-myelitis be found, a further portion of the bone is removed. Excision has been practised in cases of acute septic arthritis, but it is not at all satisfactory. It opens up the cancellous ends of the bones and exposes them to infection, and acute osteo-myelitis not infrequently results and the case terminates fatally.

FIG. 75.—PAPILLARY SYNOVITIS OR LIPOMA ARBORESCENS. The supra-patellar pouch has been opened, the patella turned down, and the distended synovial membrane spread out. The articular cartilage is normal.

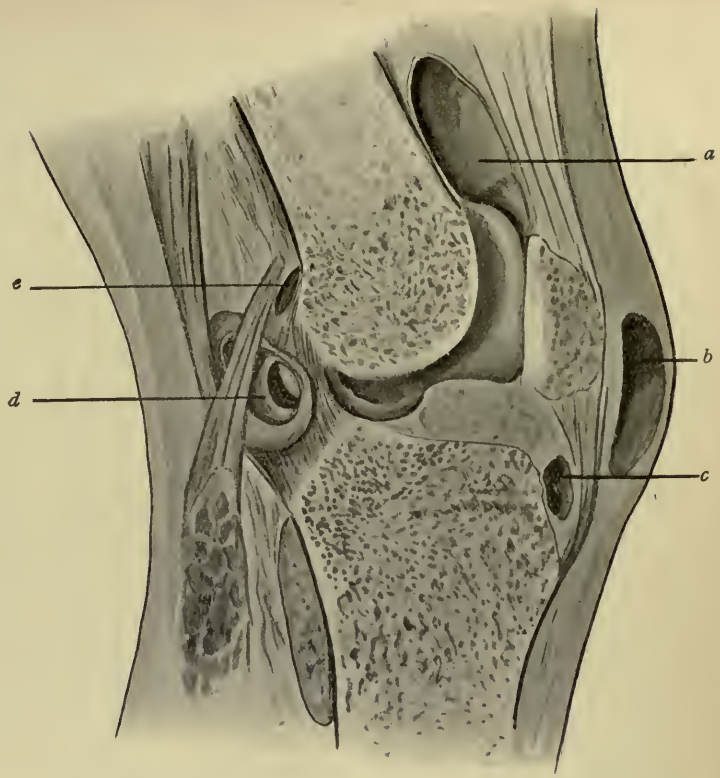


FIG. 76.—THE BURSÆ IN THE IMMEDIATE NEIGHBOURHOOD OF THE KNEE-JOINT. A consideration of these will show the difficulty of securing efficient drainage of the joint. *a*, Supra-patellar pouch; *b*, pre-patellar bursa; *c*, bursa beneath ligamentum patellæ; *d*, bursa beneath inner head of the gastrocnemius; *e*, bursa between the latter muscle and the semi-membranosus tendon.

In our opinion the choice of procedure lies between free drainage with irrigation, and amputation.

When the disease is not due to pyæmia and occurs without a wound, the epiphyses of the femur and the tibia and also the patella should be examined for signs of acute osteo-myelitis; should this disease be present and an attempt be made to save the limb, the medulla must be thoroughly opened up and any dead bone or collections of pus evacuated.

GONOCOCCAL ARTHRITIS.

This condition has already been fully discussed (see p. 99) and, as the knee is the joint in which the trouble most frequently occurs, the remarks made there are particularly applicable to this joint and need not be repeated. It is important to bear in mind the great tendency to stiffness after gonococcal arthritis, and therefore passive movements must be begun as soon as the acute symptoms have passed off.

SYPHILITIC AFFECTIONS.

The knee is the joint most frequently affected both in the secondary and tertiary stages. What has already been said with regard to the treatment of the various forms of syphilis of joints (see p. 131) may be taken as applying to the particular joint under notice.

TUBERCULOUS DISEASE.

This affection is more common in adults than in children, and may commence either in the synovial membrane or in the bone, probably more frequently in the latter. As age advances, the proportion of primary bone cases with sequestra (as compared with soft caseating deposits) increases very markedly. The osseous deposits especially affect the epiphyses of the bones; sometimes they occur in the shaft of the bone outside the epiphyseal line, but this is rare, though it is sometimes the case in the tibia. In the femur the internal condyle is the most common seat of the primary deposit. The patella is rarely affected primarily. In the synovial membrane localised tuberculous deposits, particularly in the form of pedunculated masses hanging into the joint, are sometimes seen, but most commonly the disease in the synovial membrane is diffuse.

Apart from the localised deposits referred to above it is convenient to consider the clinical history of the ordinary cases in which the disease is more or less diffuse as being divided, from the point of view of treatment, into five stages according to the symptoms and local conditions present.

In the first stage the synovial membrane is thickened throughout, though the thickening may be greater at one spot than at another; the result is a general elastic swelling of the knee, sometimes very marked. This thickening is most readily made out in the supra-patellar pouch at the point of reflection of the synovial membrane, where it will be found to be especially thick and to roll under the finger; there is no enlargement of the bone and usually but little pain. The mobility of the joint is in some cases quite good, but generally there is some restriction of movement and more or less flexion. The thigh muscles, especially the anterior group, waste very rapidly.

In the second stage the disease has spread from the synovial membrane to the ligaments, the cartilages, and the articular surfaces; this condition may result from extension of the primary synovial disease or from sudden rupture of an osseous deposit into the joint. Under the latter circumstances the symptoms become suddenly acute, and were formerly described under the name of 'ulceration of cartilage.' In this stage there is much pain on movement and on pressing the bones together, owing to the osteitis of their articular ends. The ligaments are unduly loose and the joint can be moved laterally, whilst there is tonic spasm of the hamstring muscles, so that the joint becomes flexed; as the disease progresses, the ligaments become softened and allow the leg to be pulled backwards and rotated outwards. The degree of thickening of the synovial membrane at this stage depends upon the acuteness of the disease, and upon whether it was a case of primary disease of the synovial membrane. When the disease begins in the synovial membrane the enlargement of the joint is generally very marked, but when it is secondary to rupture of an osseous deposit the thickening may be comparatively slight, and there may be a considerable amount of fluid in the joint.

In the third stage abscesses are also present. These abscesses may form in the most superficial portions of the synovial membrane and may then find their way externally without opening into the joint. Hence it does not necessarily follow that a probe will pass into the cavity of the joint when there is a sinus in connection with knee-joint disease, and therefore in probing these sinuses the greatest care must always be taken not to employ force, otherwise a communication with the joint, not previously present, may be established. In other cases, however, the abscess in the synovial membrane communicates both with the joint and the exterior, whilst in others again the suppuration begins within the joint and finally the pus makes its way through the capsule and the skin over it.

In this stage there is generally increased synovial thickening; there may also be severe starting pains at night, whilst the laxity of the joint increases, and flexion and rotation outwards of the leg are more marked. As the flexion goes on, the tibia becomes drawn up behind

the femur, so that the limb cannot be brought straight even under an anæsthetic.

In the fourth stage recovery is taking place, and a considerable degree of anchylosis will be met with, which may be fibrous or bony, according to the amount of destruction that has taken place in the articular cartilages and the bones; generally it is fibrous or only in part bony.

In the fifth stage the symptoms have entirely subsided, but, either because there has been no treatment or because it has been inefficient, deformity has resulted. The knee is flexed up to or beyond a right angle, the leg is rotated outwards and the head of the tibia drawn up behind the femur, so that it is impossible to bring the leg straight; indeed if this is attempted forcibly, true dislocation backwards will be produced.

FIG. 77.—INCISION FOR EXPOSURE AND REMOVAL OF A TUBERCULOUS DEPOSIT IN THE INNER CONDYLE OF THE FEMUR.

TREATMENT.—We have already pointed out that if localised deposits are present, either in bone or synovial membrane, they should be removed at once before general infection of the joint has occurred, and we have indicated the ordinary seats of these deposits. Nothing more need be said, therefore, under these headings. We may pass on to the consideration of the treatment of diffuse disease of the joint, and it will be most convenient to describe in detail the treatment of each of the clinical stages above referred to.

Treatment of the first stage.—When the synovial thickening is not very marked, and there is no great pain or interference with movement, the seriousness of the condition is apt to be overlooked, and the patient allowed to get about and move the joint freely. Parents are often most averse to fixation of the joint under these circumstances. It must never be forgotten, however, that the chances of securing a good result are best at this stage; if a cure can be obtained, it is probable that considerable movement will be retained; indeed, not uncommonly, the movement of the joint is completely restored if treatment is carried out strictly and for a sufficient length of time.

The great indication at this period is *absolute rest* to the joint. The patient must be confined to bed in the horizontal position, with the leg elevated and the joint fixed by some suitable apparatus. Well-moulded, closely-fitting leather, poroplastic or Croft's plaster of Paris *splints* (see Vol. II.) are the best. It is most essential that the patient should be kept recumbent until improvement is well advanced, because any attempt to

move about on crutches, or even to sit up in bed, is accompanied by contraction of the muscles of the thigh and this keeps up a state of unrest in the joint. In a child the recumbent position may be enforced by carrying a sheet across the trunk and placing heavy sand-bags over it on each side of the body.

Pressure is often of considerable value at this stage of the treatment and is usually combined with Scott's dressing, which is also to a certain extent a counter-irritant. This is made by spreading the compound mercurial ointment fairly thickly upon lint, which is then cut into strips and wrapped firmly around the joint. Outside this, ordinary strapping is applied smoothly and firmly so as to exercise pressure. A more satisfactory method is to spread the ointment on chamois leather, which is then cut into strips and applied in an imbricated fashion as already described (see p. 117). The limb is fixed upon a suitable splint and the patient kept at rest as before. The Scott's dressing requires changing at least once a week, otherwise the skin may become excoriated; should this happen, the dressing must be abandoned, and pressure by means of a cotton-wool and starch bandage (see p. 118) substituted for it.

In pure synovial disease *extension* is quite unnecessary; indeed it would be hurtful in most cases, as has already been pointed out in connection with disease of the hip. It is only of benefit at this stage when flexion has occurred and it is applied then with the view of overcoming the deformity; three or four pounds are usually sufficient. When the flexion is slight, it is usually found that a Thomas's splint will suffice, the weight of the limb alone gradually bringing the knee straight.

Should the synovial thickening remain unaffected or actually increase in spite of complete rest, good hygienic conditions and pressure, some more active measures will be required; of these, perhaps, the best is *injection of iodoform and glycerine emulsion* into the joint. This should be prepared and used as directed on p. 118. The injection gives rise to a certain amount of swelling and perhaps slight pain for a few hours afterwards, both of which gradually pass off; the injection may be repeated about once a week. In some cases we have found very marked improvement follow this treatment. Another plan used in the early stage is *Bier's congestive method.* This has already been described (see p. 119) and may be advantageously combined with the iodoform injections.

If, after two or three months of this treatment, the condition is improving or at any rate not extending, arrangements may be made to enable the patient to move about. The best splints for this purpose are Thomas's knee splint and Hessing's splint. Of these, Thomas's splint (see Fig. 78) is probably the best in the first instance, but it is well also to apply a light silicate casing around the knee; if the Thomas's knee splint is used alone it does not seem to fix the leg sufficiently, as

it does not grasp the leg well. The combination of the two methods overcomes this difficulty.

Thomas's knee splint consists of a groin ring, with lateral rods running down the inner and outer sides of the limb, attached at the bottom to the boot, and with three broad leather bands behind to support the limb. The groin ring is ovoid in shape, the narrowest part being on the outer side, the inner part, which rests on the tuber ischii, being thickly padded. This ring lies obliquely in the fold of the groin, the inner

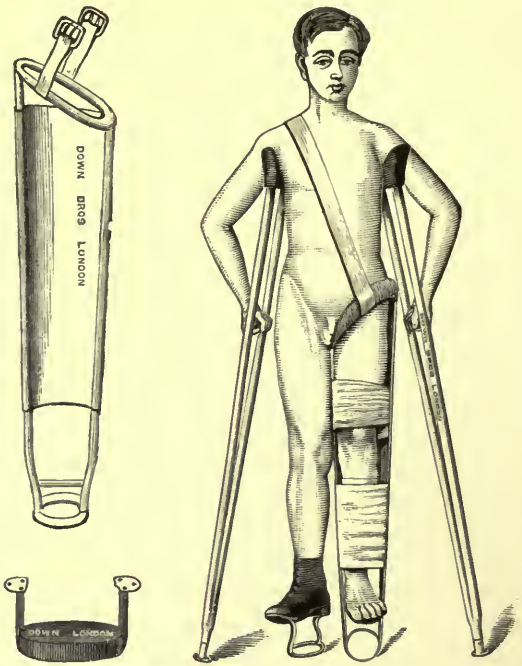


FIG. 78.—THOMAS'S KNEE SPLINT. As the weight of the body is borne on the oval ring which supports the pelvis, no pressure is allowed to fall upon the knee. On the left-hand side is a sketch of the splint, and the patten for the sound limb, before application.

vertical rod being attached to it at an angle of 120°, the angle at the outer side varying with the shape of the limb. Thomas employed two splints—one for walking and one for rest in bed. In the bed splint the lateral rods are attached at the longest diameters of the ovoid ring; in the walking splint the inner rod is attached farther back. The foot is enclosed in a boot which is cut away in a V-shaped manner behind, and the lateral rods are bent at right angles and passed into holes in the heel. The posterior leather bands are three in number: one about the middle of the thigh, one behind the knee, and one behind the lower part of the leg. The splint is fixed to the leg by two broad straps passing in front, one above and

one below the knee. If flexion is present, these straps are employed to overcome it. If there is a tendency to knock-knee, the thigh is pulled outwards by a band attached to the outer rod, while the inner rod is bent inwards so as not to press on the internal condyle. The knee should be kept slightly flexed with a pad behind it, partly because, if it becomes stiff, this position is more useful than when it is absolutely straight, and partly also because the posterior ligament is apt to stretch and the knee becomes over-extended if the pad is not employed.

A point of some importance at this stage is whether the patient should be allowed to get about on crutches, wearing the splint, or whether he should be merely wheeled about in the recumbent position until the disease has advanced farther towards recovery; in our opinion the latter course is preferable. The dependent position interferes with the return circulation in the limb and with its nutrition. As the condition of the joint improves, however, crutches and a thick sole on the sound side may be provided and the patient allowed to walk about. When this stage is reached, Hessing's splint is a much more comfortable and satisfactory arrangement, but it is unfortunately much more expensive and, therefore, only within reach of the well-to-do.

The question of operative treatment in the first stage of the disease will very seldom arise, except in a few instances in which there is great pain and the disease is steadily progressing in spite of careful treatment. The various operations are fully discussed under the treatment of the third stage (p. 203).

Treatment of the second stage.—Here the affection is no longer confined to the synovial membrane, but is attacking the cartilages and the bone, and the main symptoms are those produced by the osteitis of the ends of the bones. Its characteristic features are great increase in the pain, and fixation of the joint from muscular contraction. There is also intense pain on the slightest movement, and starting pains at night. This stage of the disease may come on gradually from extension of the disease of the synovial membrane, or suddenly from rupture of an osseous deposit into the joint.

The treatment in this stage may be either expectant or operative; the former does not, however, offer the same prospects of success as in the preceding stage. Nevertheless, in children especially, it is advisable to make a trial of it so long as the condition improves, or at any rate does not become worse.

Expectant Treatment.—As a rule, extension is required to overcome the pressure of the bony surfaces against each other and to control the starting pains at night. The weight employed will depend upon the strength of the muscles and can be gauged by the amount of relief obtained. In children, three or four pounds may be used to begin with, and may be increased if necessary; in adults from six to eight pounds are

generally called for at first, and this may also have to be increased. With the extension it is necessary to combine fixation of the limb, whilst injections of iodoform emulsion into the joint and the administration of tuberculin subcutaneously may be useful.

Operative Treatment.—When operative treatment is called for on account of the continuance of the intense pain or extension of the disease, either arthrectomy or excision will be employed.

In children arthrectomy is the operation of choice (see p. 204). In performing the operation special care must be taken in inspecting the bones so as not to overlook a primary osseous deposit. Should the cartilage be much destroyed and pitted, it is well not only to remove it completely, but also to shave off a thin layer of the bone beneath. This may be done with a knife, and not more than a quarter of an inch in depth need be taken. Under no circumstances should the ends of the bones be scraped, as this is very likely to force tuberculous tissue into the cancellous spaces and so facilitate the spread of the disease. *In adults* the chances of recovery are not good when the destructive changes have reached this stage, and the results of *excision* in adults are so excellent and are obtained so quickly and with such little risk that there seems no valid reason why excision should be delayed when it becomes evident that the ends of the bones are being destroyed. The best that can be hoped for from expectant treatment is a stiff joint, and this will often require years of rest, while the patient will never be secure against a recurrence of the disease, and if the anchylosis which results is fibrous the limb may be a painful one, especially if it is twisted or wrenched. On the other hand, a successful excision removes the disease, cures the patient within a short time, and generally leaves him with an absolutely firm limb, without risk of recurrence and without liability to sprains. The chief objection to excision is that, as it is performed nowadays, the operation takes a long time and is accompanied by considerable shock and loss of blood ; hence it should not be undertaken lightly in weakly patients, in those suffering from tuberculous disease elsewhere—particularly in the lung—or in those with renal disease. For the majority of these patients the choice must lie between continuance of the expectant treatment and amputation. When, however, the patient is vigorous and able to stand an excision, it seems more reasonable to resort to it when the disease has arrived at this stage than to continue the expectant treatment indefinitely. The operation is described on p. 208.

Treatment of the third stage.—Here, in addition to the destructive changes in the synovial membrane, the cartilage and the bone, which have already been referred to, there are unopened abscesses or sinuses, usually septic. The treatment will vary according as the abscesses are unopened or not, and also according as the patient is a child or an adult.

When there are unopened abscesses.—The treatment will depend

upon the age of the patient, the condition of the joint, the extent of the disease, and the amount of suppuration.

In children when the abscess is single and the condition is not advanced, the treatment should first be directed to the cure of the abscess. As has already been pointed out, abscesses may be treated by aspiration of the contents and the injection of iodoform emulsion into the cavity; excision of the abscess wall; incision, with removal of as much of the wall as possible; and incision and scraping of the abscess wall followed by immediate irrigation and the injection of iodoform emulsion, and suture of the wound. In the majority of cases, aspiration should be employed in the first instance, but when the abscess is small and over one side of the joint—for example, over the inner condyle—it may be possible to dissect it out entire. When the abscesses are multiple and extensive, it will probably be necessary to employ one of the other methods. Both in children and in adults, however, the abscess should be treated first, and its size reduced before proceeding to further operative measures. If this is not done, the pus is very likely to infect the cut surfaces of the bone after excision or arthrectomy and thus to lead to recurrence of the tuberculous disease. An additional argument in favour of this line of treatment is that removal of the abscess, simultaneously with the performance of excision or arthrectomy, makes the operation much longer and more severe.

Operative Treatment.—The adoption of further operative measures at this stage will depend on the severity of the disease and on the age of the patient.

When the joint is much disorganised and the disease progressive or affecting the patient's health, operation will be indicated. When the patient is an adult, much time—months or even years—may be saved, and a better functional result obtained, by *excision* than by perseverance in expectant treatment. At this stage there is no hope of a movable joint being obtained, and a firmer and better union will result from excision. In children a considerably longer time may be devoted to expectant treatment, and when operation is necessary *arthrectomy* should be performed if possible.

Amputation at the junction of the lower with the middle third of the femur is the best procedure in adults when the abscesses are numerous or large, when the joint is unduly movable—indicating marked destruction of the ligaments—or when the pain is great and the patient much emaciated and suffering from phthisis or tuberculosis elsewhere. In cutting the flaps care should be taken not to open the abscesses and thus soil the wound with tuberculous material.

By an *arthrectomy* we understand the removal of the whole of the diseased tissues of the joint, leaving intact as much of the healthy structures as possible, and not dividing the bones on set lines as is done in excision. It is most important to bear in mind that the

diseased structures should be removed by clean cutting and not by scraping. The latter is a most unsatisfactory procedure; the tubercles in the synovial membrane are generally embedded in firm fibrous tissue and cannot be removed thoroughly by scraping, and moreover the scraping may force bacilli into the blood and lymphatic vessels.

Arthrectomy.—A large number of incisions have been recommended, but the one we advise is H-shaped and consists of a vertical incision on each side of the patella, connected at a later stage in the operation by a transverse one across the centre of that bone (see Fig. 79). The vertical incisions should reach from the upper limit of the supra-patellar pouch to below the articular surface of the tibia, and should be about an inch from the edge of the patella. They are deepened until the quadriceps extensor is exposed; this is then separated and partially divided in the lines of the vertical incision, until the fibrous capsule of the joint is seen covered by fat and loose cellular tissue.

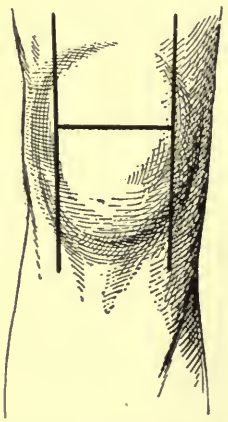


FIG. 79. — INCISIONS FOR ARTHRECTOMY OF THE KNEE. The longitudinal incisions should be very free.

The next step is to divide the fibrous capsule, taking care not to cut into the synovial membrane. The handle of the knife or a blunt dissector is introduced between the fibrous capsule and the synovial membrane, and these are separated from each other, first of all in the supra-patellar region. Should, however, the disease be advanced and the fibrous capsule obviously implicated in parts, it is best to take it away as well. The separation of the synovial membrane from the capsule is effected first between the two incisions, and is then continued upwards and on each side until the reflection of the synovial membrane is reached, and then downwards over the condyles of the femur, and also behind the ligamentum patellæ. In this way the whole anterior part of the synovial membrane is separated from the capsule. The supra-patellar pouch of synovial membrane is now pulled down and its posterior surface separated from the femur. The soft parts are well retracted and the synovial membrane is cut through at its attachment around the articular surface of the patella; this allows the finger to be introduced into the joint, and further facilitates the pulling downwards of the supra-patellar pouch and its separation from the front of the femur. When this has been done, the membrane is detached from the articular surface of the femur all around as far as can be reached, and from the head of the tibia below. The division is carried as far backwards as possible on either side beneath the lateral ligaments, and then the whole of the anterior portion of the synovial membrane can be lifted

out; a thin slice of the articular cartilage should be shaved off with the knife, so as to insure that the whole of the synovial membrane is removed.

The next step is to wash out the joint with 1 in 8000 sublimate solution so as to remove all the pus. When this has been done, a transverse incision is made over the patella and the bone sawn across, the cut surfaces of the bone being immediately covered with a piece of gauze soaked in 1 in 2000 sublimate solution, and the two flaps thrown upwards and downwards. The cartilage covering the patella is examined and, if it shows any appearance of being affected, a thin layer is shaved off.

The knee is now fully flexed, and the semilunar cartilages are removed, all the synovial membrane around the articular edges being most carefully pared away. The crucial ligaments and the structures in the intercondyloid notch are then examined and cleaned. At this stage of the disease it will generally be found that the ligaments are intact, although they are often covered with pulpy synovial membrane. Great care must be taken to remove every portion of synovial membrane from the intercondyloid notch.

The synovial membrane at the side of the joint should next be attacked, and in most cases it will be necessary to divide the lateral ligaments, after having effected separation between them and the synovial membrane with a blunt instrument. When this has been done, the whole of the lateral portion of the synovial membrane on each side can be removed entire by pulling the soft tissues aside and detaching the synovial membrane from the articular edges of the femur and the tibia.

The last point is the method of dealing with the posterior part of the synovial membrane. In many cases this can be removed without dividing the crucial ligaments, which it is well to leave intact if it is desired to obtain a movable joint afterwards. As a rule, it is easy to separate the synovial membrane in the popliteal space by means of the finger and a blunt instrument, and, after fully flexing the knee, to pass the finger across from side to side and upwards and downwards behind the synovial membrane. When this has been done, all that remains is to detach that structure from its attachment to the articular cartilage. When no tourniquet has been applied, the popliteal artery can be felt pulsating behind the finger and forms a useful guide in the manipulations.

The articular surfaces must now be systematically examined, and wherever there is any greyness, roughness, or vascularity of the cartilage, its surface should be shaved off with a sharp knife and any pits in it carefully cut out; if there be a hole in the cartilage leading down to the bone, this should be scooped out, first with a knife and afterwards with a gouge.

The bleeding is finally arrested and the divided ligaments sutured. If

the crucial ligaments have been divided, as will generally be the case, they should be united by one or two catgut stitches ; the lateral ligaments should be similarly treated. A hole is drilled in each half of the patella, through which a silver wire is passed to unite the two fragments ; this is exactly similar to the operation for fracture of the patella (see Vol. II. p. 399). The wound is now sewn up without any drainage, antiseptic dressings are applied, and the limb is placed upon a suitable splint.

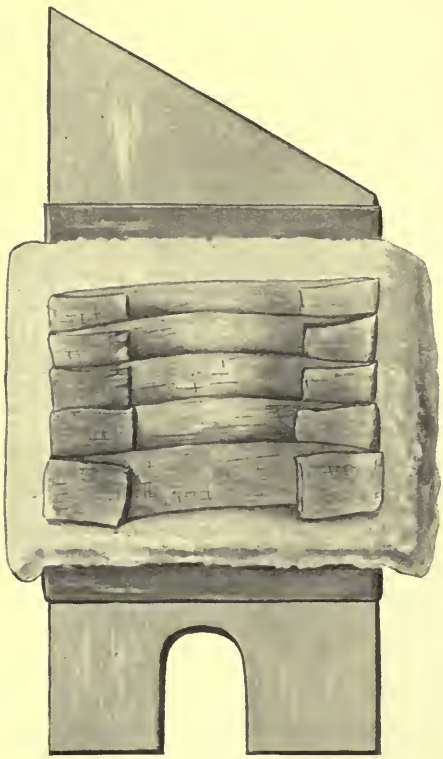


Fig. 80.—Splint arranged for Dressing an Arthrectomy of the Knee. The layers of mackintosh, wool, and gauze are shown in position.

If possible, the operation should be carried out without using a tourniquet. It is much easier to distinguish the exact limits of the tuberculous tissue when the surface bleeds freely, and there is probably more blood lost when a tourniquet is used than when the operation is done without it, owing to the free bleeding which follows its removal. When no tourniquet is employed there is no vascular paralysis, and, while the vessels bleed freely when divided, they can be clamped and tied at once, and therefore the surface is practically dry by the time the operation is finished. Moreover, the pulsation of the popliteal artery is a valuable guide when separating the posterior part of the capsule.

The best *splint* for these cases is a trough of Gooch's splinting cut out below to receive the heel, bevelled away above to follow the gluteal fold (see Fig. 80), and covered with a folded sheet over which is a large piece of mackintosh. Upon the mackintosh is placed a thick sheet of salicylic wool, whilst superficial to this, opposite the region that the knee will occupy, is laid a series of broad strips of sterilised cyanide gauze overlapping each other well —much as in a many-tailed bandage—so that, when the limb is laid flat upon the splint, these strips can be folded up one after the other around the knee. The leg is slightly raised upon a pillow.

After-treatment.—As a rule there is no need to disturb the limb for dressing. It may be left in the splint for six weeks, when the stitches are

removed and a silicate bandage or some similar immovable apparatus is applied. In most cases, especially when the crucial and lateral ligaments have been divided, it is best not to try to obtain a movable joint; if movement be aimed at after arthrectomy, union of the ligaments and shortening of the capsule do not occur satisfactorily, and there is a marked tendency for the knee to become flexed. In fact, the great difficulty

Fig. 81.—Hoefftcke's Knee Splint. The splint can be arranged with varying degrees of extension. The left-hand figure shows the powerful metal spring which acts as a strong extending force, and is useful when there is much flexion to be overcome. The right-hand figure shows the same splint arranged with elastic extension, and is most useful when there is only slight flexion to be overcome.

in the after-treatment is this tendency to flexion, so that in a large number of cases it is advisable that the patient should wear a splint —either a Thomas's splint or a moulded leather splint—for months or even years. There is no doubt that the tendency to flexion is greater after arthrectomy than after excision, though in young subjects even the latter operation may be followed by the same trouble.

When the ligaments have not been entirely destroyed in the operation, but have been stitched together afterwards, a Hessing's splint (see Fig. 81)

permitting movement in the joint may be used after about six weeks, but it must be kept on for a very long time.

The results of complete arthrectomy in pure synovial disease are extremely satisfactory. The disease is cut short and the patient is quickly restored to health ; the only trouble is the tendency to flexion referred to above. In adults, however, when a firm limb is desired excision is much more satisfactory than arthrectomy, because strong bony anchylosis is obtained. And in adults the question of the epiphyseal line which negatives excision in children does not arise.

Excision.—During the operation it is well to avoid the use of a tourniquet for the reasons mentioned under arthrectomy. The best incision is one with its convexity downwards, commencing over the centre of the lateral aspect of the joint, running down to the lower part of the tubercle of the tibia, and then curving upwards to a corresponding point on the opposite side (see Fig. 82). The flap thus marked out is turned up, so as to expose the whole of the capsule of the joint.

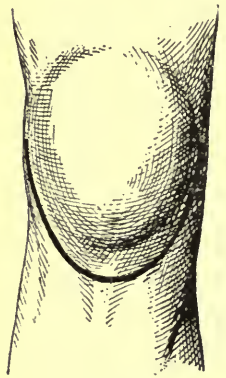


Fig. 82.—Incision for Excision of the Knee. The lowest point of the incision should reach the lower part of the tubercle of the tibia.

The first question that arises is whether the patella should be removed or not. In most cases it is well to take it away, and the only real objection to this is that the divided extensor may contract adhesions to the lower end of the femur rather than to the tibia, and there will not then be such good leverage as if the patella were left. This can easily be prevented by peeling off the periosteum from the anterior surface of the patella, and thus shelling the bone out of the quadriceps tendon instead of dividing the latter transversely above the bone. The best way to do this is to have the skin flap held well out of the way, and to make a vertical median incision through the quadriceps from the top of the supra-patellar pouch down to the tubercle of the tibia. This incision is very carefully deepened above the patella until the muscular fibres are cut through, when the handle of the knife can be sunk between the muscle, and the capsule and the two structures separated from one another. The periosteum over the patella is then turned off to either side with a raspatory, and the ligamentum patellæ is split longitudinally.

The muscle is now raised from the capsule of the joint on each side until the whole of the supra-patellar pouch and its lateral prolongations have been exposed. The steps of this procedure are identical with that for arthrectomy (see p. 204). The margin of the quadriceps tendon is defined below, and then the supra-patellar pouch and the whole of the anterior portion of the synovial membrane are removed, including

the patella and the fatty pads below it. The knee is fully flexed, the lateral ligaments are divided, and the synovial membrane over each side of the joint is taken away. If it should be necessary in order to obtain freer access to the joint, the tendon of the quadriceps may now be divided transversely, the two ends being stitched together at the end of the operation. After the crucial ligaments have been divided and the knee fully flexed, the end of the femur is protruded and its articular surface removed. In doing this the limb is held horizontal, and the bone sawn vertically at the upper limit of the articular cartilage on the front of the femur. The line of bone section should be at right angles to the long axis of the limb and not to that of the femur. As the posterior surface of the femur is reached, care must be taken to see that the structures in the popliteal space are kept out of the way and protected by a spatula if necessary.

When the end of the femur has been removed, the posterior part of the capsule is easily separated and removed, in the manner already described for arthrectomy (see p. 205), and the head of the tibia is then protruded through the wound and its articular surface sawn off. In doing this the knee must be flexed, the foot being placed flat upon the table so that the leg is vertical; the saw is applied at right angles to the long axis of the tibia, and about half an inch of the upper end is removed.

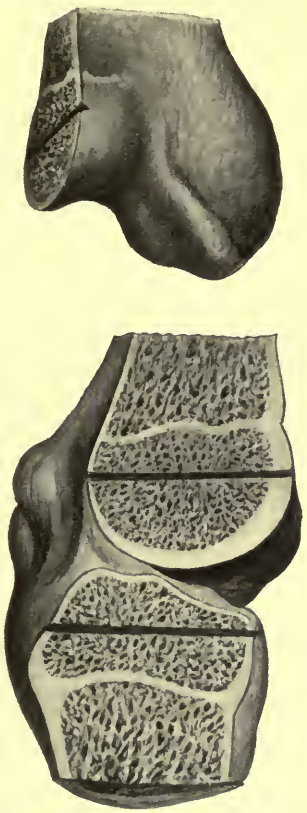


FIG. 83.—RELATION OF THE EPIPHYSEAL CARTILAGE TO THE BONE SECTION IN EXCISION OF THE KNEE. The lower figure is a lateral view, showing the epiphyseal cartilage as a white line and the saw-cut as a dark one. The upper figure is a front view of the same femur, and illustrates the relation of the bone section to the edge of the articular cartilage in front. It will be seen how easy it is to encroach unduly upon the line of growth when sawing the bone. (*Holmes's System of Surgery.*)

The wound is now examined to see that none of the capsule nor any osseous deposits are left behind. Any portions of articular cartilage which have been left are carefully clipped away; any projecting edges of the bones are removed with bone pliers, and any tuberculous deposits present in the cut surfaces of the bones are scooped out, together with a portion of the healthy bone around.

The bleeding is arrested and the wound stitched up, but before doing this it is well to fix the femur to the tibia by wires or plates; this is

not essential, but it keeps the limb in position and prevents any antero-posterior dislocation of the bony surfaces. It must be remembered that the divided surface of the tibia is much broader than that of the femur, and if the anterior margins of the two bones are brought into apposition, the posterior surface of the tibia will project markedly into the popliteal space, and, when the limb is placed upon the splint, serious pressure may be exerted upon the popliteal artery, and gangrene of the limb may result. The posterior margins of the bones should therefore be accurately adapted, and it is with the view of insuring this that fixation of the bones is advisable. Some trouble may be caused by the extreme softness of the bone, which allows the wires or plates to become loose, and therefore great care must be taken to fix the limb firmly with splints.

As a rule, it is well to introduce a drainage tube at the outer edge of the incision, the rest of which is sewn up by a continuous suture; the limb is placed upon a Gooch's splint prepared in the way recommended for arthrectomy (see p. 206).

After-treatment.—When a drainage tube has been used, the dressing must be changed next day, and about the third day the tube may be removed. Before changing the dressing, it is well to have a fresh splint prepared in a similar manner to the original one. The splint is then opened and the front of the knee dressed; while this is being done, an assistant must fix the thigh to prevent starting of the limb, while another similarly fixes the leg. It is well at the first dressing to keep the limb in contact with the splint by opening and dressing one side at a time whilst the limb is pressed against the other. The splint is then elevated, the inclined plane or pillow upon which it is resting is removed, and one assistant grasps the thigh and another the leg, whilst the surgeon grasps the limb on either side of the knee; the splint is then allowed to drop away from the limb, the posterior part of which is thoroughly washed with 1 in 20 carbolic acid solution, and afterwards with 1 in 2000 sublimate. The fresh splint, with the dressing already arranged, is put in place beneath the limb and gradually raised until the surgeon and the assistants can remove their hands and leave the limb lying upon it. The strips of gauze and wool are then wrapped around the knee and the fresh splint fixed on by bandages. At the end of three weeks this splint may be left off, and the limb put up in plaster of Paris or some similar immovable apparatus.

In three months after the operation, union is usually firm enough for the patient to get about. Massage will then be required to restore the circulation and improve the nutrition of the muscles. The tendency to flexion must be borne in mind, and therefore a moulded leather splint or some similar apparatus should be worn during the day for some months or even years.

When septic sinuses are present.—The presence of sepsis is a very

serious complication, and the chances of recovery are by no means good. In children these sinuses will sometimes heal if the limb is thoroughly immobilised and the patient placed under good hygienic conditions. At the same time healing is rare, and the patient is very apt to go downhill, especially if there be much pain. Apart from fixation and good hygienic conditions, the main point is to try to get the sinuses aseptic and provide free drainage. The treatment of these sinuses has been fully discussed in Vol. II. p. 457. If these methods fail, operation must be resorted to.

The operations are arthrectomy or (very occasionally) amputation in children, and excision or amputation in adults. The crucial point in these cases is the presence of sepsis, and special efforts must be made to eradicate it, especially if arthrectomy or excision is to be done. At the commencement of the operation the sinuses should be carefully scraped, after the skin has been thoroughly purified, and a piece of sponge soaked in undiluted carbolic acid should be introduced into each sinus and left there. The orifice of each sinus should then be included in an elliptical incision and its track dissected out. Should the sinuses lie in the line of the ordinary incision they will, of course, be removed during the deepening of the wound. After the synovial membrane has been taken away, it is well to sponge the entire wound with undiluted carbolic acid, which is allowed to act for about five minutes and is then washed away with 1 in 2000 sublimate solution. No symptoms of carbolic acid poisoning need be feared. Drainage tubes must be used.

When the general condition is bad, *amputation* through the lower third of the thigh is the best treatment, especially in adults; the patient recovers at once, there is much less shock, and little fear of recurrence.

Treatment of the fourth stage.—When recovery is taking place with anchylosis of the joint in a faulty position, the treatment consists essentially in rectifying the deformity. If the union is fibrous and comparatively slight, *continued extension* may be tried with the view of bringing the limb straight, but this is rarely successful, because the adhesions in the joint are generally accompanied by marked shrinking of the ligaments and shortening of the muscles in the neighbourhood. If extension is to be employed, it is well to divide these structures in the first instance, and the weight should be gradually increased. In the great majority of cases, however, some more extensive operation will be necessary.

In a child.—In children, when there is only fibrous anchylosis and the disease is still active, *arthrectomy* should be performed if extension fails to bring the limb into proper position. This allows free access to the various ligaments about the joint, which can be divided and the limb brought into proper position. When no active disease is present, and the union is too firm for extension to have any

effect, the best treatment is to allow the child to get about and to have the limb well massaged; when growth is nearly complete—at from sixteen to eighteen years of age—the case can be treated as described below. To interfere by operation in the case of children is to incur the risk of destroying the epiphyseal line, with consequent imperfect growth of the limb.

In adults the usual plan is to remove a wedge from the bone, so planned as to bring the limb into proper position and then to fix the bones together by plates or wires, so as to obtain bony union. We have

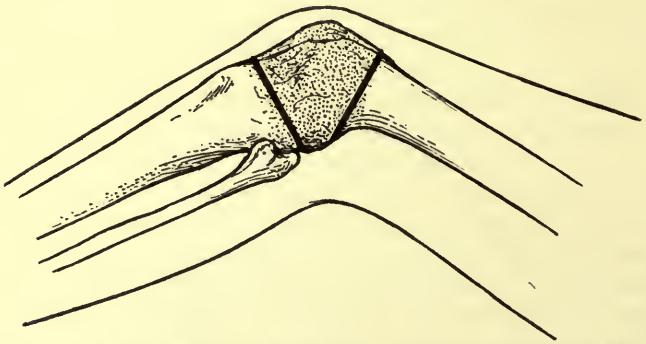


FIG. 84.—CUNEIFORM EXCISION OF THE KNEE FOR ANCHYLOSIS WITH DEFORMITY. The thick lines show where the bone will require to be divided in order to get the limb straight. From this it is obvious that the region of the epiphyseal line must necessarily be encroached upon.

already referred to Murphy's arthroplasty (see p. 153), which offers a promising alternative to the older plan.

RHEUMATOID ARTHRITIS.

This affection is common in the knee. The characteristic deformities are flexion and outward rotation of the leg, and there is sometimes a certain amount of genu valgum. The symptoms have already been described (see p. 142).

TREATMENT.—There is very little to add to what has already been said in discussing the treatment of the disease in general (see p. 143). Special care should be taken to remove any septic focus, such as pyorrhœa alveolaris.

Operative interference, such as gouging or drilling the condyles of the femur for excessive pain, or removal of osteophytes in the rare instances in which they interfere mechanically with the movements of the limb, may be called for. Excision is also of value in cases in which there is great pain and disability.

In speaking of the treatment of osteo-arthritis in general, we referred to the question of excision of joints in the monarticular form of the disease.

This procedure is more particularly suited for the joints of the upper extremity ; when the knee is affected, it is of more doubtful value, mainly because of the risk of the other knee becoming attacked later. When one knee is stiff, extra strain is thrown upon the opposite side, and after excision for rheumatoid arthritis it is not uncommon to find that the disease appears in other joints subjected to extra strain. How far this should contra-indicate the performance of excision of the knee must be judged of by the circumstances of each individual case. When the patient suffers greatly, and the other joints are free from any sign of the disease, it is better to be relieved of pain and to take the risk of the disease developing elsewhere. This risk may, to some extent, be avoided if the possibility of its occurrence is borne in mind and the patient is instructed to lead a more or less invalid life, and on no account to overstrain the other joints.

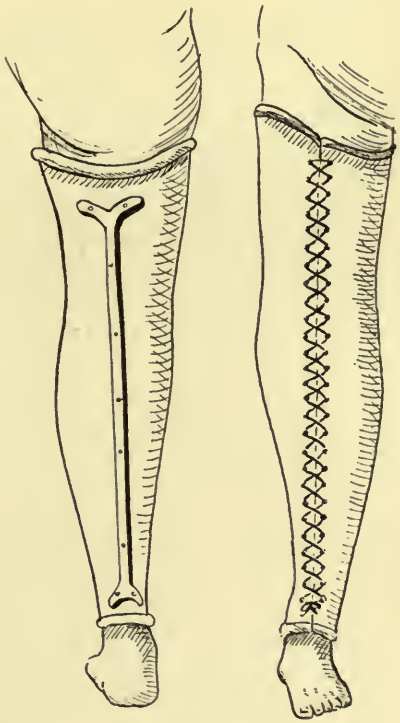


FIG. 85.—MOULDED KNEE SPLINT. The patient's weight may be borne upon the tuber ischii, so that no pressure is exerted on the articular surfaces, if the metal bar is prolonged down into the heel of the boot.

CHARCOT'S DISEASE.

The knee is frequently affected by this disease ; the general principles of treatment have been already laid down (see p. 136). The special points with regard to the knee are to aim at obtaining as much consolidation of the joint as possible, and, as the form of Charcot's disease which is accompanied by osteophytic outgrowth is not uncommon in this joint, it is sometimes possible by prolonged fixation to obtain sufficient rigidity to enable the patient to get about. Hessing's splint is well adapted for these cases, and enables the patient to walk comfortably, while favouring consolidation of the joint in good position. A less expensive and very useful splint may be made of leather ; it should reach from the groin to the ankle, and be strengthened by a longitudinal metal band, running the whole length of its posterior surface (see Fig. 85). If necessary, this band may be made to fit into a socket in the heel of the patient's boot.

HYSTERICAL CONDITIONS.

These must be treated similarly to hysterical joint disease elsewhere (see p. 137). When true contracture occurs, it may be necessary to divide the hamstring tendons. The majority of these may be divided subcutaneously where they are most prominent, but the biceps tendon should be divided through an open incision; if the operation is done subcutaneously, the external popliteal nerve runs a risk of being injured.

HÆMOPHILIA.

Effusion of blood into the knee is not at all uncommon in hæmophilic patients, the joint swelling up suddenly and becoming distended with blood after a slight injury or without any injury at all.

TREATMENT.—The limb should be placed at rest on a splint in the elevated position, the patient being recumbent, and an ice-bag or evaporating lotions (see Vol. I. p. 8) should be applied. The general treatment of hæmophilia is unsatisfactory, but it is well to administer lactate of calcium in ten-grain doses in the hope of increasing the coagulability of the blood. Normal horse serum may also be used for the same purpose. Massage and aspiration should be avoided on account of the risk of increasing the bleeding. Passive movement must be very cautiously resorted to after the effusion has disappeared. When frequent effusion occurs into joints, osteo-arthritic changes are very likely to take place.

INTERNAL DERANGEMENT OF THE KNEE-JOINT.

The knee is especially liable to the various forms of disability formerly classed under the term 'internal derangements of the knee-joint.' These may be subdivided into two main groups: (1) Actual loose bodies—the so-called loose cartilages (see p. 149); and (2) villous fringes in the joint (see p. 107), detachment of the ligamenta alaria, or injuries to the semilunar cartilages (see p. 68).

LOOSE CARTILAGES.

These are not uncommon in the knee joint, and their symptoms have already been described (see p. 149). The patient frequently identifies the loose body slipping about in the joint, but, whether this is so or not, the symptoms will usually lead to an accurate diagnosis.

TREATMENT.—The only treatment possible is to remove the loose body. It is, however, extremely unsatisfactory to open a joint like the knee, in which there are so many recesses, however certain one may be that a loose body is present, unless it can actually be felt. It is quite easy for the cartilage to slip away into some recess and to

escape detection, even after the joint has been freely opened. In all these cases, therefore, it is well to delay the operation, if possible, until the surgeon has been able to satisfy himself as to the presence of a loose body.

Should he succeed in feeling it, it will usually be met with on one side of the supra-patellar pouch, and an attempt may be made to retain it there by winding gauze firmly round the joint below it and putting the limb on a splint while preparations are being made for operation.

The loose body is extracted by making an incision directly over it, arresting all the hæmorrhage from the superficial structures before the capsule is divided, and then opening the latter freely and removing the body as already described (see p. 150). When the body has been merely fixed by an assistant's fingers previous to operation, it is well to thrust a stout needle into it before the skin incision is made, otherwise it is extremely liable to slip away when the capsule is opened, as the assistant's fingers must necessarily be removed then.

Should the body escape into the recesses of the joint notwithstanding these precautions, or should it be deemed advisable to open the articulation without previously fixing the cartilage, and should the introduction of the finger through the opening fail to detect it, it may often be brought into reach by freely flushing the joint with sterilised normal saline solution, or by flexing and extending the joint sharply several times. After the loose body has been removed, all bleeding is arrested, the capsule is sutured with fine catgut and the external wound sewn up.

In former days this operation was a very dangerous one, and all sorts of expedients were resorted to in order to avoid opening the joint directly. Nowadays, with perfect asepsis there is no risk at all.

PAPILLARY SYNOVITIS.

This form of internal derangement of the joint has already been fully described (see p. 107).

DETACHMENT OF THE LIGAMENTA ALARIA.

This condition is not at all uncommon. One or both of the ligamenta alaria may be torn away from their attachments to the intercondyloid notch and hang into the joint, where they may be caught between the ends of the bones, and give rise to all the symptoms of a loose semilunar cartilage. The possibility of this should always be borne in mind when the patient has symptoms of internal derangement; under these circumstances it is, of course, justifiable to open the joint for examination.

TREATMENT.—The best method is to make a vertical incision along the inner side of the patella downwards as far as the head of the tibia, and then to curve it backwards just below the joint. This flap is

turned backwards and the capsule exposed. After the bleeding has been arrested the capsule is incised, and the opening held apart so as to expose the interior of the joint, the knee being flexed sufficiently for this purpose. The synovial membrane is then examined to see if any villous outgrowths are present, and the finger is passed into the recesses of the joint, particularly above the patella, to search for any loose body. Finally, the ligamenta alaria are examined ; should they be loose, the free ends will probably be thickened from the constant irritation, and they should be cut off close to the fatty pad and removed. The wound is then closed in the usual manner (*vide supra*) ; no splint is necessary. The after-treatment is the same as in the preceding cases. The patient does perfectly well without one or both of these ligaments.

INJURY TO THE SEMILUNAR CARTILAGES.

This is the commonest form of internal derangement of the knee-joint. One or both cartilages may be injured, the one usually affected being the internal. The accident follows some sudden strain, more especially rotation at the knee-joint, the internal semilunar cartilage being damaged by violent external rotation of the leg, whilst the external is injured by violent internal rotation. The accident most commonly occurs whilst playing football or lawn-tennis, or doing anything in which the leg is planted firmly upon the ground and the body is twisted violently round upon it. This condition has been fully described on pp. 107 *et seq.*

CHAPTER XXI.

DISEASES OF THE ANKLE-JOINT AND TARSUS.

VERY little need be said concerning the non-tuberculous affections of these joints; their treatment has already been fully described in speaking of these diseases in general.

ACUTE ARTHRITIS OF THE ANKLE-JOINT.

This may be either suppurative—when it is most commonly either of pyæmic origin or is secondary to osteo-myelitis—or it may be non-suppurative, when it either results from an injury such as a sprain, or is associated with some general disease such as rheumatism, gout, or gonorrhœa; the ankle and tarsus are common seats of gonococcal disease, and acute flat foot is very often due to this infection.

TREATMENT.—*When there is no suppuration in the ankle-joint,* the joint should be placed at rest in the first instance. It is important to remember that there is a constant tendency to pointing of the toes when the ankle-joint is fixed, and this must be carefully guarded against, as it is very difficult to overcome afterwards. The foot must be kept at right angles to the leg. Perhaps the best splints are lateral splints of poroplastic, or plaster of Paris (Croft's). As soon after the subsidence of the acute symptoms as possible massage and passive movements should be commenced.

When there is suppuration in the ankle-joint.—The presence of pus will be shown by increasing distension of the joint, great pain, œdema and severe febrile symptoms. Incisions must be made on each side of the extensor tendons over the front of the joint, and, if possible, behind also. It is a point of great importance to avoid wounding the tendon sheaths, otherwise a disastrous suppurative teno-synovitis may be set up. When efficient drainage has been provided, the case is treated on the lines already laid down for suppuration of joints (see p. 94). Care must be taken to keep the foot at right angles to the leg.

The *after-treatment* will be similar to that just described. When the case does not do well, amputation through the leg may be necessary.

ACUTE OSTEO-MYELITIS OF THE OS CALCIS.

The commonest seat of acute osteo-myelitis in the foot is the os calcis: the disease here generally gives rise to an abscess which fortunately finds its way externally rather than into the neighbouring joints. In this bone it usually takes the form of acute epiphysitis, so that the principal focus of disease is situated in the immediate neighbourhood of the posterior epiphyseal line, and necrosis may occur in that situation. Sometimes, when there is necrosis of the entire os calcis, the calcaneo-astragaloid or calcaneo-cuboid articulation may become affected.

TREATMENT.—The risk of the inflammation spreading to the tarsal joints is a reason for early operation. The bone should be exposed by a curved incision, with its convexity backwards over the inner or outer aspect of the heel, the periosteum incised, the compact bone chiselled through, and the interior gouged freely out, so as to afford exit for the pus. This treatment is the best when the disease is seen in the early stages and is limited to the bone. In the later stages excision of the bone may be performed, provision being made for free drainage.

When the disease has spread to the neighbouring joints, particularly the calcaneo-cuboid, it may be best to amputate. This, as a rule, should be done through the lower third of the leg, as it is impossible to perform a Syme's operation without infecting the flaps.

When the inflammation implicates the ankle-joint, and the symptoms do not abate in spite of free drainage and constant irrigation, amputation is called for and should be performed not lower than the middle of the leg.

RHEUMATOID ARTHRITIS.

This affection has already been fully described (see p. 141). It is not uncommon in the ankle and tarsus, and the pain may be so great as to incapacitate the patient completely.

In the case of the ankle-joint, the question of excision of the astragalus will arise. The decision will depend to some extent upon whether the ankle is the only joint affected or whether several are attacked. Should the disease be confined to one ankle it is quite justifiable to relieve the patient's pain and enable him to get about by removal of the astragalus and any osteophytes that may be present. Should this be undesirable, the weight of the limb may be taken off the foot by the use of a peg-leg (see Fig. 86).

CHARCOT'S DISEASE.

This disease occurs not uncommonly in the ankle-joint, which becomes much disorganised, especially if the patient continues to walk about.

While the active destructive stage is going on, the patient should be confined to a couch or only allowed to go about on crutches, with the affected limb supported by a sling from the neck. In some months a

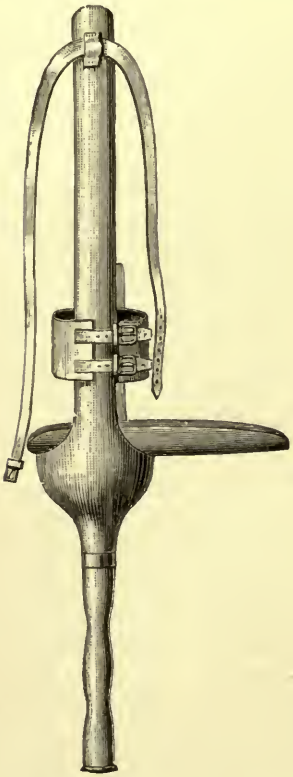


FIG. 86.—A PEG-LEG. The transverse rest is for the reception of the bent knee. The lower strap buckles the apparatus round the thigh, the upper one goes round the waist.

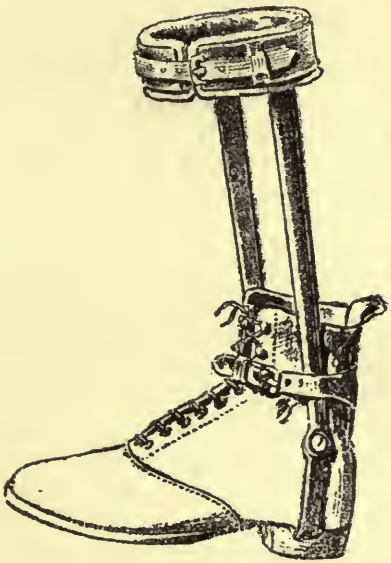


FIG. 87.—BOOT FOR USE IN CHARCOT'S DISEASE OF THE ANKLE-JOINT. The band to which the leg-irons are fastened should encircle the limb on a level with the tubercle of the tibia.

certain amount of consolidation may occur, and it may then be possible to allow the patient to walk, wearing a suitable boot (see Fig. 87), provided with lateral irons and a hinge at the ankle-joint, so as to allow the ordinary movements of the joint without the possibility of lateral bending. A more efficient, but also a more expensive, splint is Hessing's (Fig. 176), which takes the weight of the body off the joint.

When the ankle is the only joint affected and the patient is completely

crippled, and when at the same time there is no marked ataxia, amputation either at or just above the ankle-joint may be quite justifiable and will enable the patient to get about better.

SYPHILITIC AFFECTIONS.

Syphilitic disease of the tarsal bones is not at all uncommon, and the various forms of joint syphilis already referred to (see Chap. XIV.) may be met with in the ankle-joint.

Thickenings of the tarsal bones are not uncommon in hereditary syphilis; these are due to periostitis and may lead to considerable interference with the movements of the joints. The treatment offers no points of difference from that already described (see p. 131).

ANCHYLOSIS OF THE ANKLE-JOINT.

This condition, which is the result of disease in the joint or an injury, is a very crippling deformity, and causes great disability in walking.

TREATMENT.—The best results are obtained by excision of the astragalus (see p. 222). If it is necessary to remove any part of the adjacent bones, the raw surfaces should be covered by a flap of soft tissues, taken from the fasciæ of the leg or foot, so as to prevent union taking place between the bones (see 153).

TUBERCULOUS DISEASE.

Tuberculous disease of the ankle, the tarsus, and the metatarsus is relatively more common during adolescence than at any other period of life. The parts most frequently affected are those upon which most strain is thrown in the transmission of the weight of the body, namely, the ankle-joint itself, the astragalus (more particularly its head), the os calcis, and the base of the first metatarsal bone.

As in other joints, the disease may commence primarily either in the synovial membrane or in the bone; in the ankle it is more often primary in the synovial membrane, whilst in the tarsus it is more common in the bone. Of the tarsal bones, the os calcis is the one most frequently affected; next in order come the first metatarsal, then the astragalus, and finally the scaphoid and internal cuneiform. It is important to note that in tuberculous disease of the tarsus nearly all the bones are the seat of rarefying osteitis and are consequently much softer than usual.

TUBERCULOUS DISEASE OF THE ANKLE-JOINT.

In cases of *primary synovial disease*, the principal swelling is in front of the ankle-joint on either side of the tendons; there is also some swelling on either side of the tendo Achillis. As the disease advances, the whole joint becomes swollen and spindle-shaped.

When the disease is *primary in the bone* its most frequent seat is in the astragalus; after this come the malleoli, particularly the inner one, and when the malleoli are affected there is enlargement of the bone in addition to the general swelling of the joint.

When the astragalus is primarily affected there may be no marked enlargement of the joint in the early stages, and it may be difficult to diagnose the disease; the X-rays, however, may help in the diagnosis. The deposit may be in the substance of the bone and make its way to the surface outside the joint, but in the majority of cases the deposit occurs beneath the articular cartilage and soon opens either into the ankle-joint or the astragalo-scaphoid joint.

If the disease is left untreated, the toes gradually become pointed; while, as the result of the softening of the ligaments, there may be lateral deviation of the foot, particularly to the outer side. When abscesses occur, they usually point on the antero-lateral aspects of the joint. A common complication is tuberculous disease of the extensor tendon sheaths and of those passing behind the internal malleolus.

TREATMENT.—As in the case of other joints, we may distinguish various stages of the disease from the point of view of treatment. These are: (1) primary osseous deposits; (2) synovial thickening; (3) joint disease complicated by abscesses or sinuses; (4) recovery with deformity.

1. Of primary osseous deposits.—If these can be diagnosed and are accessible they should be removed at once, and in some cases the joint may be saved. Should the deposit be in the base of either malleolus, it may be reached through an incision over the enlarged bone, and scooped out with a sharp spoon. Unless there are signs of advanced disease of the joint as well, the removal of the bone deposit will suffice in the first instance, and the joint trouble may be treated by the expectant measures described below.

When the deposit occurs in the astragalus, that bone must be removed in order to obtain a cure. Unfortunately these cases are seldom diagnosed until the synovial membrane of the ankle-joint has become widely involved, when arthrectomy combined with removal of the astragalus (see p. 222) should be performed.

2. Of synovial thickening.—When the disease in the ankle-joint is primarily synovial or when a deposit in one of the bones has been removed and the synovial thickening left, the case should be treated on lines similar to that recommended for other joints, the first essential being rest in the recumbent position, combined with fixation of the joint. Most cases of disease of the ankle-joint result in anchylosis if they get well, and therefore the limb must be kept in the position in which it will be most useful afterwards; this will be at, or slightly less than, a right angle to the leg. The thing to avoid is pointing of the toes, as it is most essential to comfort in walking that the heel should reach the ground and

support the weight; when the toes are pointed, the whole weight is thrown on the heads of the metatarsal bones. Care must also be taken to see that there is no lateral deviation of the foot.

The best arrangement is to fix the limb in Croft's lateral splints extending from the knee to the roots of the toes (see Vol. II. p. 266). The patient should be kept recumbent, with the limb slightly elevated, until the disease is well advanced towards cure; afterwards he may be allowed to get about on crutches, the best arrangement being to fit him with a peg-leg (see Fig. 86) so that the weight is supported upon the knee instead of the ankle. He may then get about with the aid of a crutch or a stick.

In addition, other methods for the treatment of tuberculous joints may be employed, such as the injection of iodoform emulsion (which is readily effected in front of the internal malleolus) and Bier's method of passive congestion (see Vol. I. p. 13).

In children, however, arthrectomy should be performed comparatively early unless rapid improvement follows these methods. Tuberculous disease of the ankle is often very obstinate, and is not infrequently associated with tuberculous meningitis or phthisis, while the functional result after recovery without operation is not so good as when arthrectomy has been performed, a stiff ankle being a great drawback. Hence we do not think that expectant treatment should be persevered with for any length of time, unless marked improvement is taking place. This is contrary to what we advise in the case of other joints such as the hip, but the functional result after arthrectomy combined with excision of the astragalus is so good and the disease is so effectually got rid of, that early operation is desirable, especially in children.

Arthrectomy.—Arthrectomy of the ankle-joint may be performed in various ways, but either temporary resection of the malleoli or removal of the astragalus is essential in order to obtain free access to the posterior part of the joint; some surgeons prefer one, some the other procedure. Our own opinion is that the best result, both from the point of view of complete removal of the disease and the functional result afterwards, is obtained by combining excision of the astragalus with the arthrectomy. The division of the malleoli does not seem to be so satisfactory, as the difficulty of obtaining access to the back of the joint is not entirely overcome, and, moreover, the area of cartilage and bone which has to be examined, and from which the tuberculous disease may have to be removed, is not so accessible; any disease left behind is apt to infect the cut surfaces of the malleoli, whilst their union afterwards may not be quite accurate and deformity may consequently occur. Further than this, the astragalus is very commonly the primary seat of disease, and small sub-cartilaginous deposits may be overlooked if the bone is left behind; lastly, division of the malleoli in young children may interfere with the epiphyseal line. On the other hand, removal of

the astragalus gives admirable access to the whole of the joint, and by removing it the surgeon can make quite sure of taking away all the diseased synovial membrane, and, at the same time, removing any deposits in the bones. The functional result is excellent, a freely movable joint being practically always obtained. We shall, therefore, only describe this method.

Many incisions have been employed. We generally use a longitudinal incision in front of each malleolus, extending from about two inches above the joint to the centre of the lateral aspect of the foot (see Fig. 88). The inner incision commences just over the anterior border of the tibia, runs down in front of the internal malleolus and curves somewhat inwards on the foot towards the internal cuneiform bone. On the outer side of the limb, the incision runs in front of the external malleolus, forwards on to the foot, curving slightly towards the base of the fourth

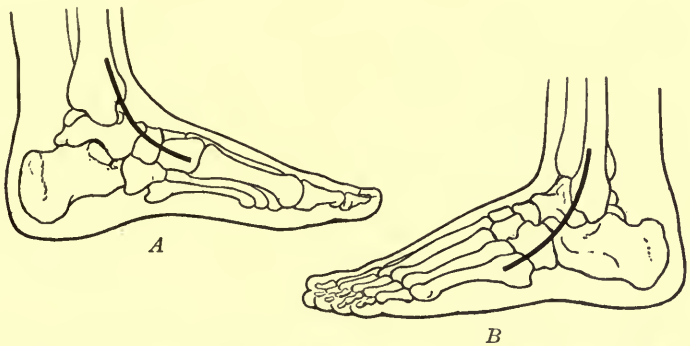


Fig. 88.—Incisions for Excision of the Astragalus. *A* is the incision on the inner side, *B* that on the outer.

metatarsal bone. These incisions are deepened until the capsule of the ankle-joint is exposed. The soft parts are carefully raised from the front of the joint with a periosteum detacher, which is gradually insinuated from one wound to the other, between the capsule and the parts over it. Then, by pushing the periosteum detacher forcibly upwards and downwards, the whole of the soft parts, containing the tendons and the anterior tibial vessels and nerves, can be lifted up so as to expose the entire anterior portion of the capsule from its connection with the tibia above to the astragalus below.

The soft parts are then similarly separated backwards from each incision, and raised from the malleoli. The entire anterior and antero-lateral areas of the capsule are thus separated from the structures over them, and the attachments of the former to the lower end of the tibia, the malleoli, and the tarsus may be cut through with a knife or scissors, and the anterior part of the synovial membrane removed in one piece, the edges of the articular cartilage being shaved away with a knife.

The lateral ligaments are now divided, and the next step in the operation is to remove the astragalus. The inner incision is fully retracted, the astragalo-scaphoid articulation defined and its ligaments divided. The lateral connections of the astragalus with the os calcis are severed, and then it is easy, by everting the foot and pushing up the astragalus, to insinuate the knife beneath the bone and divide the calcaneo-astragaloid ligament. The astragalus is now only held at its posterior part by the sheath of the flexor longus hallucis which runs in a groove in the bone; this is cleared and the astragalus is removed. The astragalus may be so softened that it breaks up and may have to be removed piecemeal; this should be avoided if possible.

The interior of the joint can now be thoroughly inspected. The remains of the synovial membrane over the lateral and posterior aspects of the joint are gradually detached from the tissues superficial to them with a blunt dissector and the finger, and are divided at their attachment to the tibia and fibula. The tendon of the flexor longus hallucis gives rise to some difficulty, but by pulling the foot downwards from the leg it can be seen and avoided.

When the entire synovial membrane has been removed, the lower ends of the tibia and fibula should be protruded through either wound and methodically examined and any suspicious parts taken away (see Fig. 89). In all cases, the edge of the cartilage, to which the synovial membrane was attached, should be shaved off cleanly with a knife. Any soft or loose portions of cartilage should be removed, and the surface of the bone beneath them gouged. Should there be any pits or depressions in the cartilage, they should be enlarged and bone deposits looked for.

After the joint has been cleared out, the parts are replaced in position, the joint is filled with iodoform and glycerine emulsion, and the wound stitched up without a drainage tube. Cyanide dressings are applied, with which may be incorporated perforated block-tin or wire-netting splints (see p. 87); outside these a large mass of sterilised salicylic wool is put on.

After-treatment.—The dressings should be changed in a week, when the wound will probably have healed, and the stitches may be removed. The limb may now be put up in plaster of Paris, taking care to keep the foot strictly in its normal position. The plaster casing is kept on for about six weeks, when it should be removed and an apparatus such as Hessing's splint should be applied, with the object of permitting movements at the joint, but preventing lateral displacement and also keeping the foot off the ground. The patient should not be allowed to bear weight on the sole until six or eight months have elapsed from the time of the operation.

The chief trouble after arthrectomy of the ankle-joint is the tendency to lateral deviation of the foot—particularly inversion—and this must be carefully guarded against by the use of apparatus until the parts

have become quite firm. For some months the patient must wear a suitable boot provided with leg-irons to prevent lateral displacement (see Fig. 90).

In adults, arthrectomy performed in this manner, combined with removal of the astragalus, is better than the ordinary excision, because it gives a good movable joint, whereas the latter leaves the articulation stiff; nothing impedes locomotion more than a stiff ankle.

FIG. 89.—EXPOSURE OF THE ENDS OF THE TIBIA AND FIBULA IN ARTHRECTOMY OF THE ANKLE. When the astragalus has been removed, the ends of the bones can readily be protruded through either of the lateral incisions.

3. When abscesses or sinuses are present, operation is generally called for; it is very seldom that treatment of the abscess without further operation will suffice. When, however, there is a single abscess it will be well to aspirate or wash out the abscess in the first instance; then, if further operation becomes necessary, it will be less extensive and more satisfactory. If arthrectomy is performed while the abscess is still present, extra large incisions will be required, and it is very likely that tuberculous material will be left behind. Arthrectomy may be performed as soon as the abscess has healed or has diminished in size.

The presence of sinuses does not necessarily contra-indicate arthrectomy, as they may be scraped out and sponged with undiluted carbolic acid before proceeding to the operation, and may then be included in the incisions and dissected out entire. The steps of the operation are exactly similar to those already described, but it is well, before sewing up the wound, to sponge it out freely with undiluted carbolic acid and insert a drainage tube. The best position for drainage is on the inner side of the tendo Achillis, and the opening may be made by thrusting a pair of forceps through from the wound, making them project beneath the skin just at the inner border of the tendo Achillis and cutting down upon them in that situation ; the forceps are then pushed through, the blades expanded, and a drainage tube of suitable size seized and pulled back into the joint. If there is no suppuration the drainage tube may be left out after five or six days.

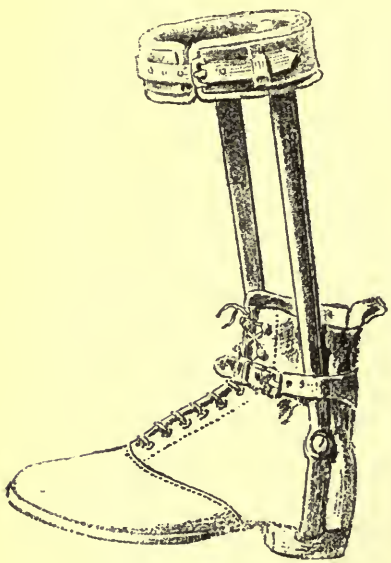


FIG. 90.—BOOT FOR USE AFTER ARTHRECTOMY OF THE ANKLE-JOINT.

While arthrectomy is the ordinary operation in these cases, *amputation* may be advisable in adults when abscesses or sinuses are present or the disease is extensive.

When amputation is called for in disease of the ankle-joint, the choice of the operation requires consideration. At one time Syme's amputation was the one most usually employed ; indeed Syme introduced it for these cases. It is, however, extremely difficult to remove all the diseased synovial membrane in this operation, and hence recurrence very commonly takes place in the stump, often necessitating a further amputation. We are therefore of opinion that Syme's amputation is only advisable in cases in which the disease is not extensive, and that in bad cases it is best to amputate three or four inches above the ankle-joint (see Vol. II. p. 542).

4. Recovery with deformity.—The deformity generally takes the form of pointed toes, and the treatment will depend upon whether or not there is bony anchylosis ; if bony anchylosis is present, the proper treatment is excision of the astragalus, whereby the position of the foot is at once rectified and a movable joint is obtained. This may be a difficult matter, and the astragalus may have to be chiselled out and removed piecemeal. When this has been done, a flap of fascia should be

interposed between the cut surfaces so as to prevent bony union. If necessary, tenotomy of the tendo Achillis must also be performed.

On the other hand, if bony anchylosis is not present, it may be possible to obtain a rectification of the position by dividing the tendo Achillis and the shortened posterior ligaments of the joint, and by the subsequent use of gentle massage and passive movement. It is important to remember, however, that the disease is not really cured, and therefore any violent wrenching may light it up afresh.

TUBERCULOUS DISEASE OF THE OS CALCIS.

The osseous deposit here may be either soft and caseous, or it may take the form of a tuberculous sequestrum; it is usually situated in the neighbourhood of the epiphyseal line, and often towards the upper part. In the latter case the disease frequently spreads to the calcaneo-astragaloid joint. The disease may also commence as a tuberculous periostitis, when it is quickly followed by the formation of an abscess.

There is generally dull pain in the heel and enlargement of the bone, with fullness later on about the calcaneo-astragaloid joint; sometimes, however, the deposit makes its way through the shell of the bone to one side—most commonly the outer—and gives rise to an external abscess.

TREATMENT.—This will depend upon the stage at which the disease has arrived. When there is no external abscess and no distinct evidence of disease of the calcaneo-astragaloid joint, *palliative measures* may be employed for a time; these will consist in immobilisation of the foot in plaster of Paris, and the usual hygienic measures suitable for tuberculous joint disease in general (see p. 113).

It is best, however, to advise early *operative interference* in most of these cases, the object being to remove the osseous deposit before it has spread beyond the limits of the bone. The position of the incision will be determined by the situation of the primary deposit. This may be shown in a radiogram, and is generally indicated by thickening of the bone. When the bone is uniformly thickened, it is best to make the incision at the upper part near the calcaneo-astragaloid articulation.

When there is no abscess.—Should there be no definite indication as to the seat of the deposit, the bone may be reached from the inner side, over which a curved incision should be made with its convexity upwards. This incision should not go far enough forward to endanger the plantar vessels and nerves. The flap is dissected downwards so as to expose the inner surface of the bone, which is then chiselled away until the cancellous tissue is reached; the osseous deposit is often met with at once, but if not, the cancellous tissue is cleared out with a sharp flushing curette, especially towards the upper and back part of the bone. If cheesy material is exposed, it should be scooped out until healthy bone is reached everywhere. The cavity is then filled up with iodoform emulsion

(see p. 118), and the wound stitched up without a drainage tube. Blood-clot fills up the cavity and becomes organised. Should serum accumulate it can be let out by introducing a pair of sterilised sinus forceps between the stitches.

After-treatment.—The foot should be encased in a large mass of dressing and firmly bandaged; it should be fixed by lateral splints. When the wound has healed and the parts are sound, a large mass of wool should be put around the ankle and fixed on firmly with a silicate bandage, so as to exercise a certain amount of compression. The patient should not be allowed to hang the foot down for at least eight weeks after the operation, otherwise the vitality of the organising blood-clot within the bone will be endangered. Should a sinus form and fail to heal, the scraping may be repeated after a time; the second operation will often succeed in curing the disease. If the sinus still refuses to heal, excision of the os calcis will be necessary.

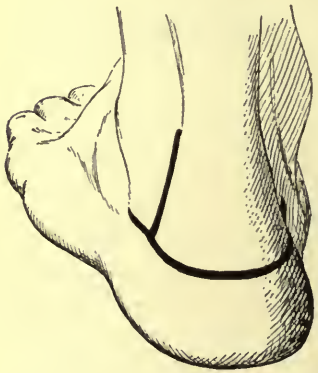


Fig. 91.—Incision for Excision of the Os Calcis. The incision should run a full finger's breadth above the sole. The vertical incision along the outer border of the tendo Achillis is only occasionally required.

When an abscess or sinuses are present.—*When there is an abscess* over the bone it should be dissected out, or at any rate cleared out as thoroughly as possible, and the bone deposit removed as described above.

When septic sinuses are present and lead into the interior of the bone, they may be treated in a similar manner; the sinus is swabbed out with undiluted carbolic acid, included in the incision, and removed entire. The interior of the bone is then gouged out and sponged with the undiluted acid. The cavity should be left open and packed with gauze. When granulation is complete, this packing may be stopped and only superficial dressings applied.

Excision of the Os Calcis.—When, however, the disease has lasted for a long time, and has resisted the treatment just described, when several sinuses are present, or when there is evidence of infection of neighbouring joints, such as the calcaneo-astragaloid or calcaneo-cuboid, excision of the os calcis will be necessary.

A very convenient incision for removal of the os calcis, is one which commences a finger's breadth above the sole, just behind the base of the fifth metatarsal, and is carried horizontally backwards around the heel and along the inner side of the bone for an inch and a half (see Fig. 91). It must not be carried too far forwards on the inner side, otherwise there is a risk of damaging the vessels and other structures below the internal malleolus. The incision should at first go through the skin and fascia

only. It is sometimes useful to add to the horizontal incision a vertical one, just in front of, and parallel to, the outer border of the tendo Achillis running upwards for about two inches. By this means three flaps are formed, which are dissected off the bone, care being taken to avoid the tendons of the peronei muscles behind the external malleolus. As soon as these have been defined, the incision is carried down to the bone throughout the rest of its extent, and the soft structures, if not diseased, are peeled off with a periosteum detacher. The tendo Achillis is divided just at its point of attachment to the bone, or the periosteum, with the tendon attached to it, may be peeled off, so as to allow it to retain its connection with the flaps; this, of course, should only be done when the posterior part of the bone is free from disease.

If the flaps are well retracted, the greater part of the bone can now be cleared, and the whole of the upper surface exposed as far as the calcaneo-astragaloid articulation. The only parts of the bone not well exposed are the calcaneo-cuboid joint and the sustentaculum tali. The middle fasciculus of the external lateral ligament of the ankle is next divided, when, by pressing the bone downwards and inwards, the articulation between it and the astragalus is seen, and the calcaneo-astragaloid ligament can be divided. The calcaneo-cuboid joint is exposed by turning forward the structures at the anterior end of the outer incision; in dividing the ligaments, the knife must be kept close to the bone.

The portion of the bone that gives most trouble is the sustentaculum tali; in freeing it, the greatest care must be taken to keep the edge of the knife well against the bone, and to employ the periosteum detacher as much as possible, so as to avoid damage to the important structures in its immediate neighbourhood. After dividing the connections between the astragalus and the os calcis and opening the calcaneo-cuboid articulation, it is generally possible to expose the structures retaining the bone by using the latter as a lever, and then to turn them off the sustentaculum tali without damage. The tendon of the tibialis posticus must be carefully raised from its groove with a raspatory.

After the bone has been removed and the bleeding arrested, the wound must be examined for diseased synovial membrane in the neighbourhood of the calcaneo-astragaloid or the calcaneo-cuboid joints; and, if any is found, it must be removed. Sometimes the cartilage on the under surface of the astragalus is diseased; and, if so, it must be removed, along with a thin layer of the lower surface of the bone. Any sinuses present must be excised, if possible, or at any rate carefully scraped and sponged out with undiluted carbolic acid.

As a rule, it is best to stitch up the wound after inserting a drainage tube at the most dependent spot. It is always advisable to employ drainage in these cases, because a large cavity is left in which serum is

otherwise very apt to collect; while, in cases in which there are septic sinuses, suppuration is very likely to occur.

After-treatment.—After the wound has been stitched up, and the usual dressings applied, it is well to employ an anterior splint, so as to avoid pressure upon the tissues over the heel. The best arrangement is an anterior suspension splint (see Fig. 92). A flat bar of malleable iron is moulded to the leg from the tubercle of the tibia to well beyond the toes, the foot, meanwhile, being kept at a right angle. The iron is fixed to the leg and the anterior part of the foot by a water-glass or plaster of Paris bandage, the region of the heel being left free for dressings. The bar is furnished with hooks by which it may be suspended from a cradle. The drainage tube should be kept in for about ten days; when the wound

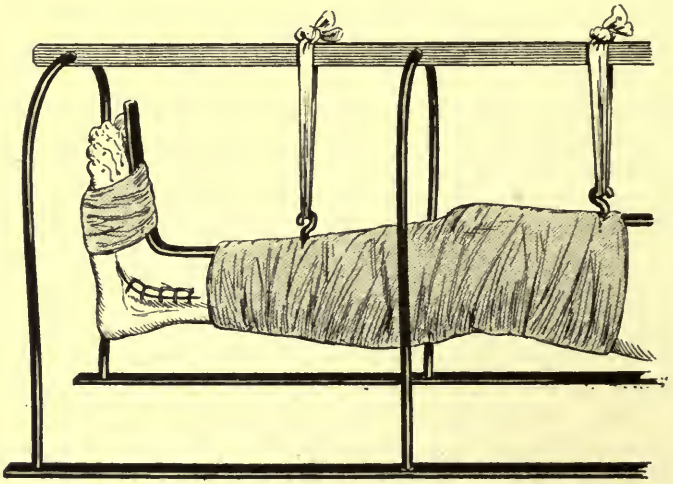


FIG. 92.—ANTERIOR SUSPENSION BAR APPLIED AFTER ARTHRECTOMY OF THE ANKLE. The wound is shown exposed without any dressings and without the sling which should support the heel. The splint is fixed to the limb by plaster of Paris bandages and suspended from a cradle. This gives sufficient fixation to the joint and at the same time allows dressings to be properly applied. It is a very useful splint for excision of the os calcis.

has healed, the limb should be put up in plaster of Paris, with the foot strictly at right angles. The patient should not be allowed to walk, or to hang the limb down, for two or three months after the operation.

Results.—The results of this operation are very satisfactory; patients are able to walk with comfort and without limping by merely placing a small pad of felt, wool, or india-rubber inside the boot, to supply the deficiency left by the removal of the os calcis. As a matter of fact, a considerable amount of new tissue, sometimes actual bone, forms; and the depression of the heel is not nearly so great as one would expect after removal of so large a bone. In most cases a pad about half an inch thick will be sufficient to compensate for the loss.

TUBERCULOUS DISEASE OF THE FIRST METATARSAL.

The disease usually begins in the interior of the base of the bone, and the pus may gradually find its way outwards, on the inner or anterior aspect of the bone, or it may open into the articulation between it and the internal cuneiform, and infect the synovial membrane of that joint.

TREATMENT.—*When the disease remains limited to the interior of the bone,* the best treatment is to remove the proximal half of the metatarsal bone, cutting it through beyond the tuberculous focus. In this way the disease is cured at once, and the risk of infection of the tarsal joints, which is always present if palliative treatment is adopted, is avoided. The functional result is excellent, as the remaining portion of the bone does not get drawn up very much.

The operation is easily done through an incision in the long axis of the bone a little to the inner side of the extensor tendon; this incision should extend nearly to the metatarso-phalangeal joint below, and well over the internal cuneiform above (see Fig. 93). The periosteum and soft tissues are detached from the bone; the anterior and internal ligaments connecting it with the internal cuneiform are divided, the bone partially sawn across beyond the disease, and the division completed with cutting-pliers. The divided end of the bone is then seized, and pulled inwards and the ligaments between it and the cuneiform on the outer side, and the connections between the first and second metatarsal bones are divided.

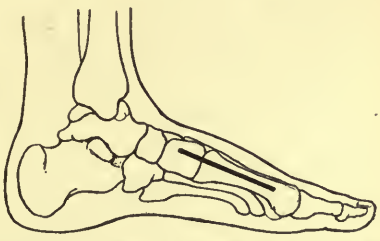


FIG. 93.—INCISION FOR REMOVAL OF A TUBERCULOUS DEPOSIT FROM THE BASE OF THE FIRST METATARSAL BONE.

After the bone has been removed, the cut surfaces must be examined to see if they are healthy, and any diseased synovial membrane about the internal cuneiform should be completely removed. When a healthy surface is obtained everywhere, the wound is stitched up without a drainage tube and cyanide dressings are applied. The wound fills with blood-clot which organises, and after two or three months the patient may be allowed to walk. In the meantime, the foot should be encased in plaster of Paris as soon as the wound has healed, care being taken to see that the affected metatarsal bone is parallel to its fellow.

When the tarsal joints have become affected from extension of the disease to the synovial membrane, the treatment is that of diffuse disease of the tarsus (*vide infra*), although in a few cases in which the disease is limited to the immediate neighbourhood of the metatarsal bone it may suffice in the first instance to remove the proximal end of the bone

and as much of the synovial membrane as possible. If the infection of the synovial membrane has not extended far, this may stop the generalised disease of the tarsus which is so very grave.

TUBERCULOUS DISEASE OF OTHER TARSAL BONES.

Besides the bones already considered, the astragalus, the cuboid, the scaphoid, and the internal cuneiform are not uncommonly attacked. We have already dealt fully with disease of the astragalus in connection with tuberculous disease of the ankle-joint, of which it is frequently the primary cause (see p. 220).

When the patient is young and there is disease of one of the tarsal bones or disease limited to one part of the tarsus, operative treatment is preferable to expectant methods. Under the latter, the disease almost inevitably spreads to the various tarsal joints and is very grave. Tarsal disease is particularly resistant to expectant treatment and is very commonly associated with internal tuberculosis; therefore no time should be wasted in expectant treatment when the disease is limited to one bone or to one portion of the tarsus.

The removal of individual tarsal bones does not really damage the usefulness of the foot. The scaphoid, the cuboid, or the internal cuneiform may be removed, and after a year or two it will be difficult to say that any bone has been taken away. We would therefore strongly advise operative procedures, in all cases in which there is disease limited to one tarsal bone or to a portion of the tarsus. These will consist in removal of the affected tarsal bone, or, if the disease has spread into the surrounding joints, of the section of the tarsus (bones and synovial membrane) which is affected.

Excision of individual bones.—The internal cuneiform may be removed by a longitudinal incision made directly over its inner side and carried down to the bone; the soft parts are dissected up, and the ligaments divided upon the dorsal and inner aspects. The bone is then seized with forceps, the toes are forcibly pulled outwards and the ligaments on the outer and posterior aspect divided with a long narrow knife; by twisting the bone, the plantar ligaments can also be cut and the bone removed. *The scaphoid* is removed by a similar incision directly over the bone, extending well above and below its limits so as to facilitate retraction of the parts.

After the affected bone has been removed, the wound should be stitched up without a drainage tube unless sinuses have been present; before this is done, a little iodoform emulsion should be left in. Healing by first intention will take place, after which the foot may be put up in a water-glass or plaster of Paris bandage. The patient is not allowed to walk for two or three months.

DIFFUSE TUBERCULOUS DISEASE OF THE TARSUS.

Removal of individual bones alone will not meet the requirements of these cases. In the first instance, expectant treatment consisting of rest, tuberculin injections, the injection of iodoform (see p. 118), or Bier's treatment may be tried for a short time, but it must be remembered that this form of disease is very grave and is likely to be followed by internal complications; expectant treatment must therefore not be persisted in too long.

The choice of operative procedures lies between partial tarsectomy, complete tarsectomy, or amputation, and the decision will be influenced by the virulence of the disease, the general condition of the patient, and the presence or absence of tuberculosis elsewhere.

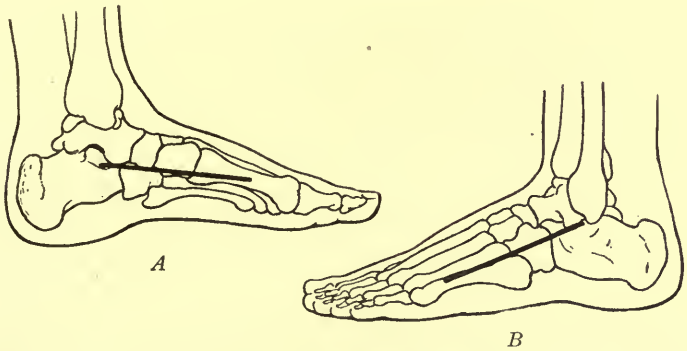


FIG. 94.—INCISIONS FOR PARTIAL TARSECTOMY IN TUBERCULOUS DISEASE OF THE TARSUS. *A* is the incision on the inner, *B* that on the outer side. By varying the length of the incisions, as much or as little of the tarsus as may be desired can be removed.

Partial Tarsectomy.—When the disease is limited to the bones and joints in front of the transverse tarsal articulation, the best procedure is to remove the affected bones in one mass by a partial tarsectomy. This is done by lateral incisions which preserve the tendons, vessels, and nerves. Two long incisions are made, one on each side of the foot just above the sole, extending on the inner side from the front of the sustentaculum tali to the centre of the first metatarsal, and on the outer side from just below and in front of the external malleolus to the centre of the fifth metatarsal bone (see Fig. 94). These incisions should be carried down to the bones at once. The tibialis anticus and the peroneus longus tendons may be divided, as they must inevitably be separated from their points of attachment during the operation.

All the tissues down to the bone are now raised from the front of the foot in a manner similar to that described for arthrectomy of the ankle (see p. 222), so that the fingers can be made to meet between

the two incisions. The structures on the plantar surface should also be separated from the tarsus, and, in doing this, one must bear in mind the arch formed by the tarsal bones, and should keep close to the bones. In this way all the soft structures are separated from the bony skeleton of the foot throughout the whole extent of the incisions, leaving the entire synovial membrane intact and in connection with the joints. This is quite easy to do on the dorsum of the foot, as the surgeon can see what he is doing, but it is more difficult in the sole.

The next step is to apply a long narrow saw, or Gigli's wire saw, transversely across the bases of the metatarsal bones, about an inch behind the level of the base of the first metatarsal. The saw is then applied transversely across the tarsus opposite the neck of the astragalus and divides it and the corresponding portion of the os calcis. Whilst this is being done, the soft parts must be protected and held out of the way by suitable spatulæ. After the bones have been divided, a few touches of the knife allow the whole bony mass, together with the synovial membrane and other diseased structures, to be taken away in one piece without infecting the wound.

After-treatment.—The wound is stitched up and a drainage tube is inserted if there is much oozing. The limb should be placed upon a back splint with a foot-piece at right angles, and the weight of the toes will keep the metatarsal bones in contact with the os calcis and astragalus. In arranging the padding, particular care must be taken to bring the foot into proper position and to keep the bones in contact. As healing takes place, the muscles contract and the tendons, which at first are much too long, gradually become shortened and finally act very well.

Results.—As a consequence of this operation the foot is considerably shortened, but the functional result is good, and is much better than that obtained by amputation, as the ankle-joint is preserved.

A similar operation may sometimes be performed, even when sinuses are present, if care is taken to deal with them in the manner already recommended (see p. 225). When, however, there are numerous sinuses or when abscesses are present, and the patient is an adult, Syme's amputation at the ankle-joint is much the best practice. In some cases a sub-astragaloid amputation may be done and gives an excellent result. When the ankle-joint is also involved in the disease, amputation through the lower third of the leg should be performed.

CHAPTER XXII.

DISEASES OF THE SHOULDER-JOINT.

INFLAMMATORY AFFECTIONS.

SYNOVITIS with effusion, whether acute or chronic, is comparatively rare in the shoulder-joint, and the condition may be readily overlooked if the distension of the capsule is only slight. When it is considerable, the swelling is most marked beneath the anterior edge of the deltoid, and the upper arm is slightly abducted and somewhat internally rotated; fluctuation may sometimes be felt in the axilla.

The treatment follows lines similar to those already described for acute and chronic synovitis (see Chap. XII.), and presents no points of special interest.

It may be well, however, to draw attention to the stiff and painful shoulder-joints which not uncommonly follow injuries in elderly people. After a fall on the hand or shoulder in an elderly patient, it is very common to find that the joint becomes stiff. There is limitation of movements—especially of abduction—accompanied by severe pain. As a rule there is no evidence of effusion into the joint, and no creaking. The deltoid is often atrophied. An X-ray photograph generally shows no gross changes in the bones.

The symptoms may begin immediately after the injury or some days later. The majority of patients are getting on in years. The affection is very intractable; in some cases, permanent disability remains, others recover partially or completely, but only after a long course of treatment. The treatment consists in active and passive movements, massage, and hot-air baths. Injections of fibrolysin appear to be beneficial in some cases.

ACUTE SUPPURATION occurs as a result of penetrating wounds or as a complication of acute epiphysitis of the upper end of the humerus; in the latter case the joint is often affected.

The treatment is identical with that for similar affections elsewhere (see p. 94). The incisions for draining the joint will be found on p. 98.

TUBERCULOUS DISEASE.

Tuberculous disease of the shoulder-joint is not uncommon and is mainly met with in adult life, being most frequent between the ages of twenty and thirty. As in the other joints, the disease may be primary either in the synovial membrane or in the bone, more commonly the latter.

The primary osseous deposits occur most frequently in the great tuberosity of the humerus, and much less commonly in the neck of the scapula. In some cases the acromion process may be the primary seat of the mischief, but when this bone is affected it is usually secondary to tuberculous disease of the deltoid bursa. When the deposit reaches the surface of the bone, it is not uncommon for the deltoid bursa to be infected, with the result that a soft fluctuating swelling forms beneath the muscle often containing rice-like bodies, which manifest themselves by their peculiar creaking sensation on manipulation.

In the early stages of the disease there is increased fullness about the shoulder, with swelling in the axilla, and considerable limitation of movement of the arm, which is held in an abducted position and rotated inwards. In the later stages there is very marked pain on movement, the arm being kept rigidly applied to the side and rotated inwards; later still, abscesses form and point in front of or behind the deltoid. It is not uncommon to find an abscess travelling along the bicipital groove and coming to the surface beneath the skin about the centre of the front of the arm. In other cases it may open into the axilla, and sometimes about the lower limit of the posterior border of the deltoid.

TREATMENT.—The same general rules must guide the surgeon in the treatment of tuberculous disease of this joint as in the case of tuberculous joint disease elsewhere. There are, however, certain special points which may be referred to.

Expectant treatment.—Recovery from the disease in this situation is practically always followed by stiffness of the joint, which is a great disability to the patient. Moreover, unless very special care be taken to prevent it, and often in spite of such care, stiffness will occur with the arm in such a position that the limb is rendered very useless; that is to say, it is rotated inwards and closely applied to the side. If expectant treatment is to be employed, the limb should be abducted to about 45°, and kept midway between extreme inward and outward rotation, that is to say with the forearm looking almost directly forwards. Abduction can be secured by a large wedge-shaped pad in the axilla with the base downwards (see Fig. 95), whilst the forearm should be flexed to a right angle. The elbow may be fixed by a plaster of Paris casing or a moulded splint; if desired, the shoulder may be left uncovered so that local applications, may be made to it.

Extension has also been used in cases in which there are severe starting pains at night. If this is to be employed, the patient should be confined to bed, the trunk fixed with sand-bags, counter-extension made by a broad bandage passed around the thorax, and a weight applied by means of a stirrup fixed upon the upper arm, which is kept in the position recommended above (see Fig. 96). In most cases, however, in which the pain is so great as to call for extension, operation is desirable.

When there are abscesses in connection with the joint, the question of operation becomes urgent. It is best to treat the abscess first, so as to cure or reduce it in size. The same remark applies to tuberculous disease of the deltoid bursa.

Operative treatment.—We have not laid stress upon expectant methods, because we are of opinion that early excision is of great value in tuberculous disease of the shoulder, especially as it is essentially a disease of adult life. In children, it is true, we should advise that operative interference be delayed as long as possible, as arthrectomy of the shoulder-joint is neither an easy nor a satisfactory operation; but in adults, in whom the growth of the limb has ceased, the question of excision will arise early in the course of the disease. By it the progress of the disease is cut short, and the patient is given a movable arm which, though weaker than its fellow, is still greatly superior to an anchylosed joint, especially when the limb is in bad position.

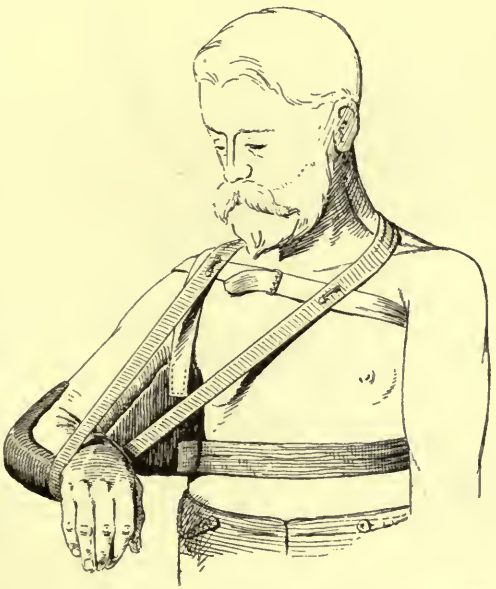


FIG. 95.—APPARATUS FOR USE IN TUBERCULOUS DISEASE OF THE SHOULDER-JOINT. The wedge-shaped cushion is fixed in position by the straps shown in the figure. The arm-splint is made of moulded gutta-percha or poroplastic material.

There is a further reason for advocating early operation, in that shoulder-joint disease is very frequently associated with or followed by disease of the lungs; the exact connection between the two is difficult to understand, but it certainly is a clinical fact that a large number of patients with disease of the shoulder-joint suffer also from phthisis, and, in a very considerable proportion, the latter affection only sets in after the joint

disease has lasted for some time. Hence excision, which secures a useful movable joint after a short convalescence, eradication of the disease, and diminished danger of deposit of tubercle elsewhere, is distinctly preferable to expectant methods, which demand a long time, leave the patient subject to risks of infection elsewhere, and at the best give a stiff joint which is of comparatively little use.

Excision of the Shoulder-joint.—We recommend the following method. The patient should lie upon his back with a firm pillow or sand-bag beneath the affected shoulder, which is drawn well to the side of the table. The arm should be slightly abducted and rotated outwards. The surgeon stands on the outer side of the joint and makes an incision about four inches in length, commencing just external to the tip of the coracoid process, and extending downwards and outwards parallel to the anterior border of the deltoid (see Fig. 97). It is well to curve the incision outwards at the lower end and to detach a portion of the insertion of the deltoid. In this way the region of the joint can be exposed much more freely than is possible by simply retracting a straight incision. The divided fibres of the deltoid can be stitched together afterwards (see Vol. II. p. 63).

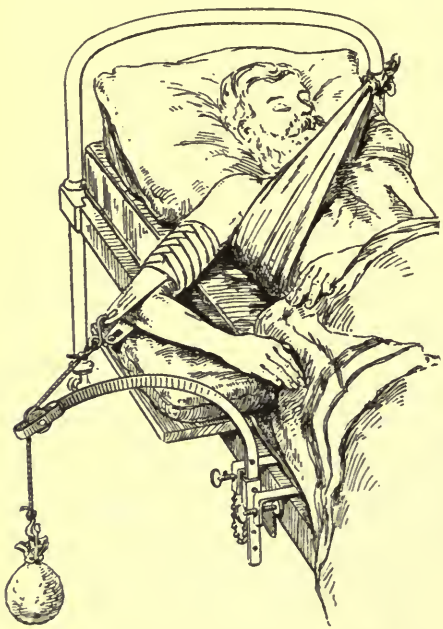


FIG. 96.—WEIGHT EXTENSION APPLIED FOR TUBERCULOUS SHOULDER-JOINT DISEASE. The extension is made with the arm in the abducted position. In the figure above, however, the arm is rotated too much inwards. The forearm should be raised almost into the vertical position by using a thick wedge cushion, with its base beneath the hand; it will then correspond to the position of the limb seen in the preceding figure.

The dissection is carried down to the thickened capsule at the upper part of the incision, and the tendon of the long head of the biceps must be looked for; it is brought into view if the arm is rotated slightly outwards. The biceps tendon should be freed from its sheath, and pulled inwards if it is healthy; if, however, the disease extends down the bicipital groove it must be dissected out. The finger is then passed beneath the deltoid muscle, which is pulled forcibly outwards. Should the deltoid bursa be affected, it must be removed, the arm being fully abducted and the deltoid muscle everted. The front part of the capsule is defined and isolated from the structures lying over it, and the

portion thus separated clipped away with scissors. The arm is now carried backwards so as to hang over the table, and the muscles attached to the tuberosities are divided sufficiently to enable the head of the bone to be protruded (see Fig. 98). In most cases enough bone can be removed without complete division of the rotators, as a bone section about the level of the anatomical neck or just below it usually suffices. If, however, there is a deposit in the greater tuberosity, that structure must either be removed or the deposit must be gouged out.

After the head of the bone has been removed, the glenoid cavity is sawn off, the amount of bone removed depending on the extent of the disease present. The remains of the capsule must now be clipped away with scissors, and a careful examination of the whole area is made to see that all tuberculous material has been removed. It is important to leave the attachment of the rotators intact if this can be done safely; this permits rotation of the arm, whereas after the old operation, in which the rotators were completely cut across and the bone was sawn on a level with the surgical neck, the resulting limb was often very useless, rotation being always imperfect, and indeed sometimes absent altogether.

FIG. 97.—INCISION FOR EXCISION OF THE SHOULDER-JOINT.

To prevent the stiffness which is so liable to follow excision, a layer of fascia taken from the upper arm should be placed over the divided surface of the humerus, and sutured to the periosteum (see p. 153).

A drainage tube should be inserted at the lower angle of the wound, as a considerable cavity is left which may become distended with blood and serum; this tube may be taken out as a rule in three days. A large wedge-shaped pad should be placed in the axilla so as to prevent displacement inwards of the upper end of the bone. It is well also to place a firm pad over the front of the joint, because the upper end of the bone is apt to be drawn forwards. The wedge-shaped pad should be carried down as far as the elbow, and the forearm should be supported in a wrist-sling. The hand should not be bound to the side, but the limb

should be put up with the forearm looking forward in the position already recommended on p. 236. Middeldorpf's splint (see Vol. II. p. 324) is very suitable.

When there is already actual anchylosis of the joint, the head of the bone must be removed *in situ* at the level of the anatomical neck with a chisel of suitable breadth, the soft parts on the inner and posterior aspects

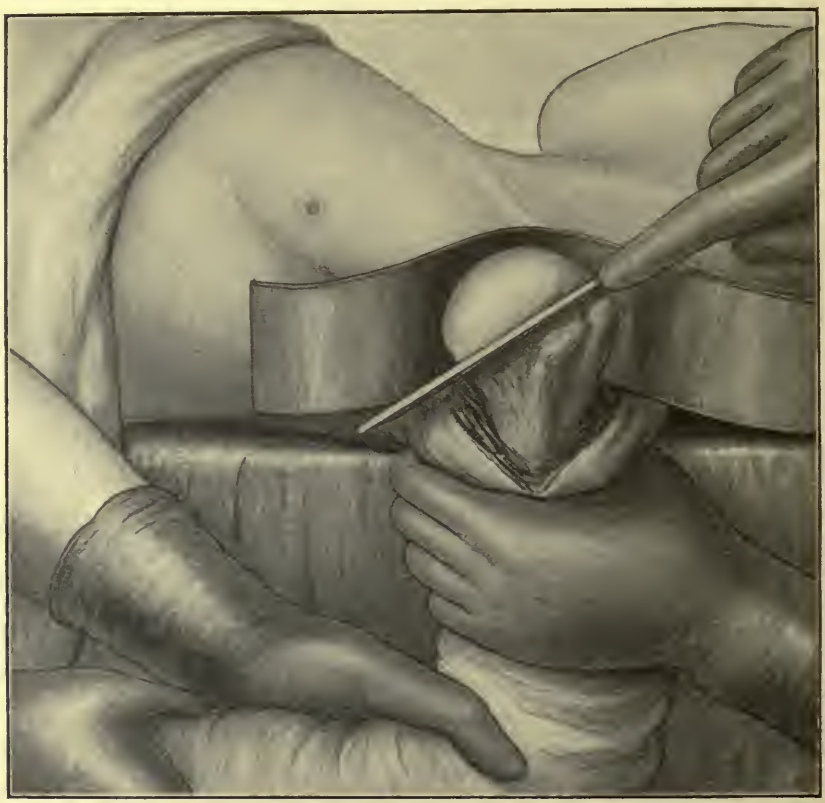


FIG. 98.—REMOVAL OF THE HEAD OF THE HUMERUS IN EXCISION OF THE SHOULDER. The assistant holds the humerus almost vertical and at the same time pushes the head upwards and outwards. The soft parts are protected by a flexible copper spatula suitably bent, and the saw is applied as shown above.

of the joint being protected from damage by a flexible copper spatula which is pushed in around the head of the bone. A second bone section is then made through the glenoid cavity, and the portion of bone thus detached is removed with lion forceps. In these cases it is simpler to use a Gigli's wire saw for the division of the neck of the bone; it can be passed round the bone by means of a special introducer (see p. 33.)

After-treatment.—As soon as the wound has healed, the arm may be

fixed in position by a starch or water-glass bandage for about two or three weeks, and then passive and active movements should be begun. The time at which these movements should be commenced depends largely upon the amount of bone removed; if the whole of the upper end of the bone has been taken away and the rotators divided, as was done in the old operation, the elbow should be supported and the arm fixed for four or five weeks, otherwise a very lax joint is likely to result; if, on the other hand, the operation we have described above is sufficient, movements should be begun after a fortnight. Special attention must be paid to preserving rotation, which is the movement most likely to be lost; abduction should also be carefully attended to. The axillary pad and the wrist-sling should be continued for six or eight weeks.

Results.—The results of the operation are satisfactory on the whole; all the arm movements, with the exception of a certain amount of rotation, may be preserved, but it is seldom that abduction can be carried as far as, and certainly not beyond, a right angle. If, however, the patient can abduct the limb nearly to a right angle he is generally very well satisfied.

OSTEO-ARTHRITIS.

The shoulder-joint is frequently affected by this disease, and here the affection is often monarticular, or at the most only affects two or three joints. The affection in the shoulder is often spoken of as *malum senile*, just as in the case of the hip-joint. In the shoulder-joint the disease is often accompanied by severe pain, beginning in the early stages, and also by marked limitation of movement in all directions. Associated with this is rapid atrophy of the deltoid, so that the head of the humerus and the osteophytes, which are common in this situation, can be felt easily.

TREATMENT.—The treatment must be carried out on the same lines as for the disease elsewhere (see p. 143); the only point that we need deal with here is the question of *excision*. As a means of relieving the pain there is no doubt that excision has great advantages, and therefore, if the patient's general condition is good, and the pain intolerable, it may be justifiable for that reason. The functional result, however, is seldom good in these cases. The movements of the limb are apt to be very imperfect, mainly on account of the atrophy of the deltoid and the other muscles around the joint.

In excising the joint for the relief of the excessive pain, it is advisable to remove the head alone, leaving the greater part of the tuberosities untouched. This can usually be done by means of a chisel and without completely dividing the rotator muscles of the shoulder. The surface of the glenoid cavity should also be removed; and, to prevent anchylosis, a layer of fascia should be inserted between the raw bony surfaces.

After the operation the arm should be kept at rest, with the elbow well away from the side and fixed by a wedge-shaped pad in the axilla, or Middeldorpf's splint (see Vol. II. p. 324). Should fibrous or bony anchylosis occur, this position will give the patient a useful limb, the movements of the shoulder-joint being replaced by the increased mobility of the scapula.

CHARCOT'S DISEASE.

The shoulder is not infrequently the seat of this affection, especially in connection with syringo-myelia. The treatment offers no points of special importance, and has already been described in connection with the disease in general (see p. 134).

CHAPTER XXIII.

DISEASES OF THE ELBOW-JOINT.

INFLAMMATION OF THE BURSA BENEATH THE BICEPS TENDON.

Inflammation of the bursa between the tendon of the biceps and the tubercle of the radius sometimes occurs; but as the bursa lies deeply and seldom gives rise to any noticeable swelling, even though markedly distended, the diagnosis is often difficult. When the bursa is much distended it is apt to be mistaken for a solid tumour. A characteristic point in the diagnosis is the occurrence of pain when the elbow is flexed with the forearm fully supinated, whereas there is little pain if the limb is in the pronated position. This arises from the fact that in the former case the biceps alone is called into play, whilst in the latter the brachialis anticus is the most important agent. There is also special tenderness on pressure just over the bicipital tuberosity, and the pain is increased by rolling the biceps tendon laterally over the bursa, and by alternate pronation and supination.

TREATMENT.—The treatment consists in rest on a rectangular splint which throws the biceps out of action. After a short time moderate elastic compression and massage should be employed; in persistent cases it may be necessary to open and drain the bursa.

ACUTE SUPPURATION.

This affection usually occurs after septic penetrating wounds of the joint, and is soon followed by disorganisation of the articulation with all its accompanying risks.

TREATMENT.—The joint should be opened freely by incisions on the inner and outer sides, draining both the front and back of the joint (see Fig. 50). This may be followed by continuous irrigation if the case is severe (see p. 88).

The question of excision may arise in these cases because it is difficult to drain the joint properly and because the ultimate result will be a stiff joint. We have already discussed the question of excision in cases of septic inflammation of joints (p. 86), and for the reasons there stated we would avoid it if possible. It may, however, be worth risking this operation in preference to amputation when the patient is a young and vigorous adult, the wound being left open, and irrigation or the water bath being employed; should signs of osteo-myelitis set in, amputation must be performed at once. When, however, the acute stage has passed and only chronic sinuses are left, there is not the same risk in excision, and, if care is taken to disinfect the sinuses with undiluted carbolic acid and free drainage of the wound is kept up, excision is quite permissible.

When the condition is very severe, amputation through the upper arm may be required, and, when this is done, the state of the medulla must be carefully examined, for osteo-myelitis is not uncommon.

ACUTE AND CHRONIC SYNOVITIS.

Distension of the elbow-joint with fluid shows itself by a fluctuating swelling on either side of the olecranon. The movements of the joint are considerably interfered with, flexion particularly being diminished and causing considerable pain. The position assumed by the limb when the joint is distended is one of slight flexion.

TREATMENT.—The joint should be immobilised, with the elbow at a right angle and the forearm midway between pronation and supination, and if there is much pain, an ice-bag or evaporating lotions may be applied. The treatment of these affections is fully described in Chap. XII.

OSTEO-ARTHRITIS.

This joint is often affected with osteo-arthritis, and the lesions are usually well marked. The condition not infrequently follows fractures extending into the joint. Osteophytic outgrowths are usually well marked and a villous condition of the synovial membrane is not uncommon, particularly between the olecranon and the condyles.

TREATMENT.—The general treatment of osteo-arthritis has already been dealt with (see p. 143). Excision combined with Murphy's arthroplasty to prevent anchylosis (see p. 153) may be advantageously performed in cases in which the osteophytes are numerous and the joint is stiff and painful.

LOOSE CARTILAGES.

After the knee, the elbow is perhaps the most frequent seat of these bodies. They are most commonly met with in the olecranon fossa.

TREATMENT.—When an operation is decided upon, the incision must be made on the side on which the foreign body has been felt, or over the seat of the pain. To explore the joint the lateral incisions recommended for excision (see p. 247) are best, as both the front and back of the joint can be examined through them.

CHARCOT'S DISEASE.

The chief point in the treatment of Charcot's disease of the elbow-joint is to provide a splint which will give a certain amount of firmness to the joint while permitting flexion and extension. This may be used after the stage of acute swelling has subsided, and should take the form of a leather case for the upper arm and another for the forearm, the two being connected at the elbow by jointed lateral steel rods. The splint must be held in place by bands passing over the shoulders.

TUBERCULOUS DISEASE.

This affection generally occurs in early adult life ; only about 33 per cent. of cases begin before ten years of age. As is the case with the disease elsewhere, the primary deposit may be in the synovial membrane, especially in the neighbourhood of the radio-ulnar articulation, or in the bone, usually in the olecranon or the external condyle of the humerus. It would appear that primary bone disease is more common than the primary synovial form. Owing to the superficial nature of the elbow-joint, it is sometimes possible to diagnose the presence of an osseous deposit before the joint has become involved, and this is particularly the case when it is situated in the olecranon.

The disease runs the same course here as elsewhere. The swelling in the joint is most marked on each side of and above the olecranon ; the elbow is flexed and the forearm pronated. Abscesses most commonly point about the posterior and outer aspects of the joint.

TREATMENT.—The treatment of tuberculous disease of the elbow-joint may be divided into expectant and operative treatment.

Expectant Treatment.—The joint is put up with the forearm flexed to, or slightly beyond, a right angle, and the hand midway between pronation and supination, as this is the most useful position of the limb should the joint become stiff. A very good method of fixing the joint is to envelop the elbow in a large mass of cotton-wool and then to apply a bandage impregnated with a solution of silicate of potash firmly over it. The bandage should extend from the wrist—or in bad cases from the knuckles—up to the shoulder, and the forearm should be carried in a sling ; the fingers should be left free and the patient encouraged to move them. This apparatus is kept on for six or eight weeks, when lateral poroplastic or leather splints may be substituted

for it ; these can be taken down frequently so as to allow inspection of the joint and the employment of the other procedures such as Bier's treatment, or injections of iodoform and glycerine, which have already been discussed (see p. 118).

The result of expectant treatment is generally a stiff elbow, except in some cases of pure synovial disease, which may recover fairly rapidly with a good movable joint. In children, expectant treatment may be continued for a considerable time; but in adults we are of opinion that in most cases it is mere waste of time to employ it for a prolonged period, as on the whole a better result can be obtained by excision. The elbow is the joint of all others in which operative treatment yields a satisfactory result. We therefore strongly recommend that operative treatment should be adopted before abscesses or sinuses occur—as soon, indeed, as it is evident that the disease is not coming to a standstill under expectant treatment.

Operative Treatment.—In children the operation should be arthrectomy; in adults, excision. *In children* arthrectomy is a very satisfactory operation and often leaves a considerable amount of movement. When the operation is performed early in the case, the restriction of movement afterwards is not, as a rule, very great and the result is excellent, but anchylosis may occur in the cases in which the disease has been advanced. This can, if desired, be remedied by excision when adult life is reached.

In adults excision is the better operation. Arthrectomy does not give such good results as far as the mobility and usefulness of the joint are concerned, nor is it so easy to remove the disease by its means ; the mobility after arthrectomy is not nearly so great as after excision. The question of early excision in elbow-joint disease depends upon the condition of the patient, his willingness to undergo an operation, and his occupation. It must be remembered that a stiff elbow without any removal of bone will no doubt be stronger than the movable elbow obtained after excision, and in some occupations it is more important for the patient to have a strong arm which is stiff than a movable one which is weak ; hence, before deciding upon operating, it is important to consult the patient himself as to the relative value of movement and strength in his work. In the majority of cases, however, both as a time-saving method and as giving greater utility, excision is preferable to prolonged expectant treatment.

Arthrectomy of the Elbow-joint.—This operation is most easily performed through two long lateral incisions, one on each side of the joint (see Fig. 99). On the inner side, the incision should reach from just below the point at which the ulnar nerve pierces the internal intermuscular septum to about two or three inches below the level of the joint. On the outer side, the incision may extend slightly higher up the arm, but must not reach so low down on the forearm, otherwise there is a risk of

injuring the posterior interosseous nerve opposite the neck of the radius. It is well to make the incisions as free as possible, because plenty of room is required to enable the surgeon to see clearly what he is doing.

The incisions are carried down to the condyles of the humerus, and the removal of the synovial membrane from the back of the joint is first proceeded with. The capsule can usually be readily defined, especially on the outer side, and the skin and subcutaneous tissues are raised from it by the handle of the knife or a blunt dissector. The whole of the capsule over the radio-ulnar and the radio-humeral articulations is thus gradually separated as far as the edge of the olecranon. The triceps is also raised from the capsule as far as the middle line of the joint; a similar procedure is adopted on the inner side, care being taken to raise the ulnar nerve from its groove behind the internal condyle along with the soft parts. The fingers can then be made to meet across the back of the joint between the triceps and the capsule, and the whole upper part of the synovial membrane is separated and can be divided by a knife at its reflection on to the bone and peeled downwards; it is also divided on each side in the line of the incisions, and is cut away below at its attachments to the olecranon and to the radius and ulna respectively.

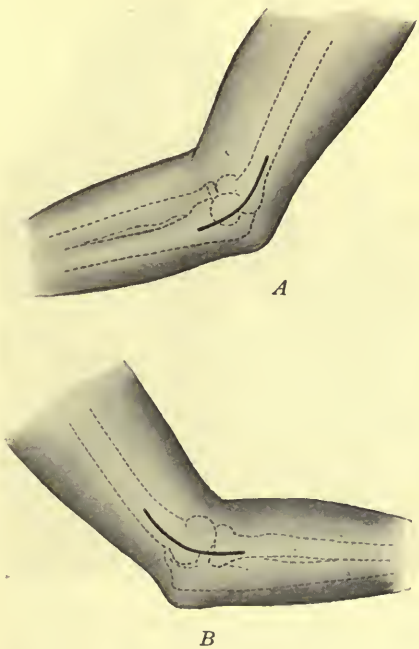


FIG. 99.—INCISIONS FOR ARTHRECTOMY OF THE ELBOW-JOINT. These are similar to those recommended for use in excision. *A* is the incision on the inner; *B*, that on the outer side.

The next step is to deal with the anterior part of the synovial membrane. In order to do this it is advisable partially to detach the tendinous origins of the muscles from the condyles of the humerus, beginning on the outer side. The periosteum is incised and stripped forwards along with the muscles, which are pulled forwards by an assistant who holds the limb flexed to a right angle, while the anterior surface of the capsule is defined and separated by a blunt dissector and the fingers. Special care must be taken not to damage the posterior interosseous nerve in the lower part of the incision.

The structures on the inner side are then dealt with in a similar manner,

the periosteum and the tendinous origins of the muscles being detached from the internal epicondyle, and the capsule defined and separated from them. The finger can soon be made to pass across from one incision to the other between the capsule and the superficial structures, amongst which will be the brachial artery which, owing to its pulsation, forms an important guide. By passing the finger from one incision to the other and by stripping the soft parts upwards and downwards the anterior portion of the capsule can be separated and may be cut across at its attachment to the bones and removed in one piece. The lateral ligaments having been divided, the ends of the bones can be easily protruded through the wound; the olecranon is first pushed through whichever incision it can be made to project from more easily—generally the outer—and the synovial membrane of the radio-ulnar articulation is completely removed. If the orbicular ligament is diseased it must be removed. The lower end of the humerus is then protruded through one of the wounds—generally the inner—and similarly examined (see Fig. 100). Special attention must be paid to the olecranon and coronoid fossæ.

FIG. 100.—METHOD OF PROTRUDING THE ARTICULAR ENDS IN ARTHRECTOMY OF THE ELBOW. If the lateral incisions shown in the preceding figure are long enough, it is quite easy to protrude the end of the humerus, as shown above, after dividing the ligaments. The upper ends of the radius and ulna may be protruded in a similar manner through either of the lateral incisions.

After the disease has been thoroughly removed, the bones are replaced, the wounds stitched up without a drainage tube, and antiseptic dressings and lateral poroplastic splints applied.

Should septic sinuses be present they must be scraped and disinfected with pure carbolic acid first of all and then excised if possible. The articular surfaces should be sponged over with undiluted carbolic acid at the end of the operation, and a drainage tube inserted; when sinuses are not present drainage is seldom necessary.

After-treatment.—The splints should be kept on for about a fortnight, at the end of which time the arm may be placed in a sling for another two or three weeks and the patient encouraged to move the joint. The case may then be left to nature. There is no particular advantage in performing forcible movement; in a child, the arm will be constantly

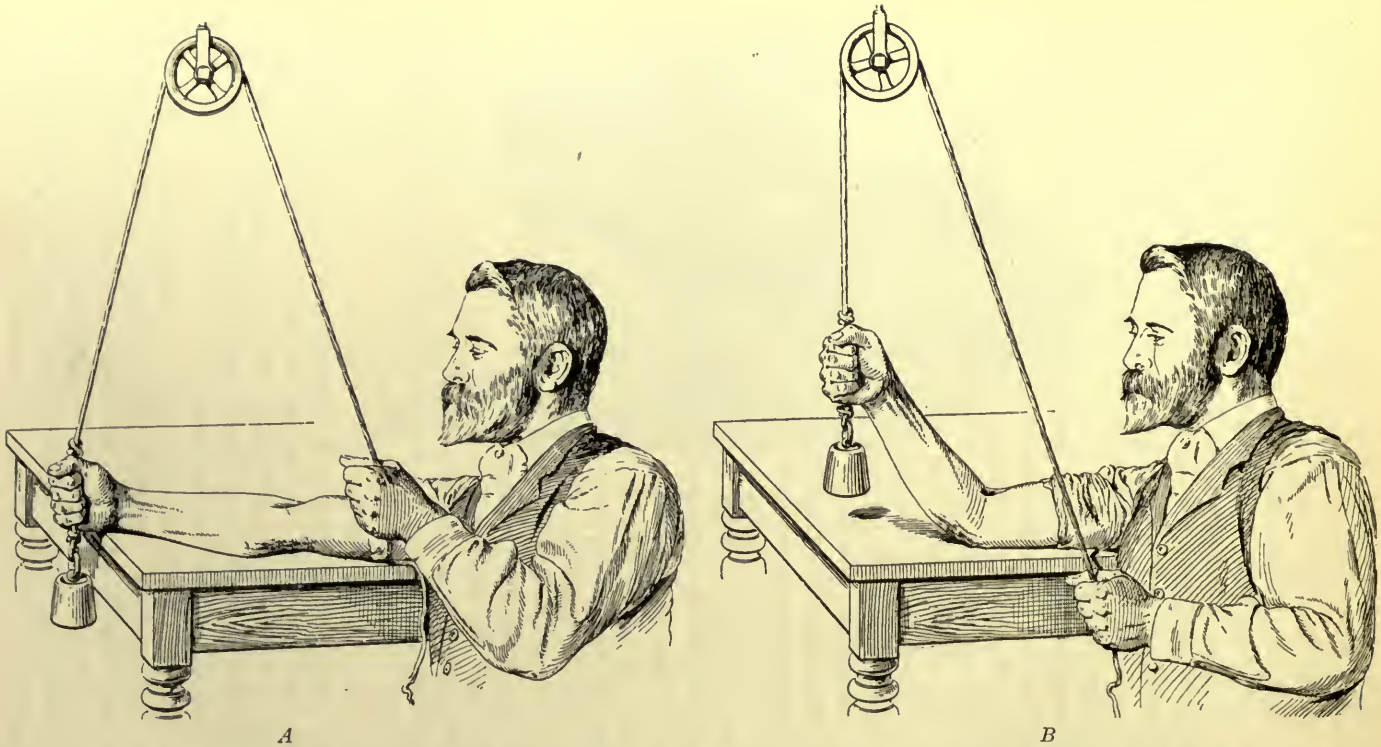
used and the result will be as good by leaving the case to nature as by forcible passive movement. The only form of passive movement that is really desirable is rotation of the hand, and this may be practised diligently both actively and passively from the first.

Excision of the Elbow.—Various incisions have been recommended; the older operations through a vertical or an H-shaped incision have the drawback that it is difficult to remove the synovial membrane properly. After trying various methods, the conclusion we have come to is that the best incisions for excision are those just recommended for arthrectomy; in fact we are of opinion that in excision the synovial membrane should be removed in the same manner as in arthrectomy, the operation being carried out in the two cases in an identical fashion up to the point of protruding the ends of the bones (*vide supra*).

When the ends of the bones are protruded, the periosteum over the back of the olecranon should be peeled off with a raspatory, leaving the triceps still attached to it; the olecranon process and the articular surface of the ulna are then removed with a saw applied just below the level of the coronoid process. The head of the radius is next nipped off with bone-forceps, at the same level, after which the humerus is protruded through the wound and sawn off just above the condyles. This leaves part of the olecranon fossa behind, and this should be thoroughly scooped out so as to remove all the cartilage; the bones are then replaced and the incision stitched up. The limb is fixed upon an internal angular splint with a joint at the angle and a rotatory hand-support. If no sinuses were present before operation, drainage is unnecessary; if there were any, they should be disinfected and removed, the wound swabbed out with undiluted carbolic acid and drainage tubes inserted. If a drainage tube is employed, it should be retained until it is certain that no suppuration will occur, that is to say for about three or four days.

Fig. 101.—The levels at which the Bones are divided in Excision of the Elbow.

After-treatment.—Pronation and supination should be carried out every day from the first. At the end of a fortnight the stitches may be taken out and gentle flexion and extension practised daily. Unless a large amount of bone has been removed—in which case there may be much looseness of the joint—the splint may be left off after four weeks, the arm carried in a sling, and passive movement still more vigorously



A *B*

FIG. 102.—APPARATUS FOR PROMOTING FLEXION AND EXTENSION OF THE ELBOW AFTER EXCISION. The arm is laid flat upon a table and the weight is grasped as shown in *A*, while the rope is pulled upon by the other hand. This raises the hand to the position shown in *B* and so makes flexion. When the pull upon the cord is relaxed, the weight carries the hand back and so makes extension. By arranging the limb so that the elbow is immediately beneath the pulley, the flexion can be carried to its full extent if the arm is rotated somewhat outwards after the forearm has been raised to the vertical. The weight grasped in the hand then carries the flexion of the elbow to its fullest limit, the pull on the rope by the other hand being meanwhile relaxed.

employed. This is the critical period in the case, as about this time stiffness tends to increase very rapidly, and therefore active movements should be encouraged. A good apparatus designed to enable the patient to practise passive movement for himself may be made by carrying a rope, to one end of which a weight is attached, round an overhead pulley. The patient grasps the free end of the rope with the sound hand, and seizes the other end a little above the weight with the hand on the affected side. All that is necessary is to pull upon the rope with the sound hand ; this flexes the forearm, and, when the pull is relaxed, the weight extends the limb (see Fig. 102) ; this should be done for from half an hour to an hour at a time twice or three times daily. There is seldom any difficulty in preserving pronation and supination.

In carrying out the after-treatment, two conditions must be carefully guarded against : on the one hand, the limb must not be allowed to get stiff, on the other, a flail-joint must be avoided. It is not until about a month has elapsed after the operation that the surgeon is able to judge what is likely to happen. When the case is going on well there will be some slight difficulty in obtaining complete flexion and extension, although movement should be fairly good ; if, on the other hand, the joint be quite loose and complete extension can be got without difficulty, a flail-joint is to be feared, and it is then best to put the arm up in plaster of Paris or water-glass for three or four weeks without attempting any further passive movement. It will then be seen whether the joint is still loose or whether sufficient contraction has occurred to require passive movement.

When, after this time, it is found that the joint is too lax, it is well to apply an apparatus consisting of two pieces, one of which grasps the upper arm and the other the forearm, the two being connected by a metal band over each side of the elbow jointed to permit of flexion and extension. As the splint is apt to slip down over the upper arm, it should be held up by straps over the shoulders. This apparatus prevents lateral mobility, and, if worn for some months, it is quite possible that a joint which was at first very lax may finally become satisfactory.

CHAPTER XXIV.

DISEASES OF THE WRIST AND HAND.

DISEASES OF THE WRIST.

ACUTE INFLAMMATION.

The carpal and radio-carpal joints are comparatively seldom attacked by acute inflammation, but penetrating wounds may occur and lead to dangerous suppuration in the irregular synovial cavity, with all the severe general symptoms already described (see Chap. XI.). Twists and sprains set up a subacute synovitis, sometimes associated with hæmorrhage into the carpal articulations. The wrist-joint is a common seat of acute and gonococcal rheumatism.

In acute and sub-acute inflammations of the wrist, the chief swelling is not so marked in the joint itself as in the tissues around it, and not uncommonly the tendon sheaths which lie over the dorsal surface become infected.

TREATMENT.—In all cases of inflammation of the wrist-joint, the proper treatment is to fix the joint on a palmar splint arranged so as to throw the carpus and metacarpus backwards; this splint is fully described on p. 255. In the acute stage the application of cold is of value.

When the synovitis has followed a sprain, the fixation should not be continued for more than three or four days, otherwise adhesions may form in the joint and also in the tendon sheaths in its neighbourhood. The frequent association of a fracture with a sprain must not be forgotten, and persistent synovitis is often kept up by such a lesion (see Vol. II. p. 359).

Massage should be commenced about the third day, and in the intervals pressure should be applied either by an elastic bandage or by strapping (see p. 117). In all cases, whether the joint is fixed upon a splint or not, the fingers should be left free and constantly moved

passively and actively. Should there be any difficulty in this, faradisation to the muscles acting upon the fingers may be employed daily.

CHRONIC INFLAMMATION.

There is a form of chronic inflammation of the wrist in young people which leads to marked deformity and which is not generally recognised. No marked destructive changes take place in the joint, and the affection is often overlooked entirely until the onset of a subluxation of the carpus which is pulled forwards on the radio-ulnar arch. If this condition lasts for any length of time, the articular surfaces become altered so that the radio-ulnar surface becomes oblique and the carpus cannot be replaced in its normal position. This affection is frequently associated with certain trades, and is often met with in washerwomen and in those employed in trades in which the wrist is carried beyond its normal range of movement.

In other cases the affection occurs chiefly in the radio-ulnar joint, the ligaments becoming relaxed and the styloid process of the ulna projecting backwards, while the carpus is displaced forwards on the ulnar side. This is particularly the case in boxers, cricketers, and tennis players and the result of the condition is pain about the ulnar side of the wrist, which is relieved for a time by rest and is finally associated with a marked prominence of the ulnar styloid process. If the causes producing the affection continue, there may be actual arrest of growth in the lower end of the ulna or permanent disability of the joint.

TREATMENT.—The causes producing the disease should be removed in the early stages and an attempt made to prevent further strain on the weak parts by fixation of the joint. The patient will often state that the pain is relieved by applying a firm bandage around the wrist, and many sufferers from this condition find great relief from wearing a leather or elastic wristlet so as to control the movements. Change of occupation, together with the use of a wristlet, is all that is necessary in most cases.

TUBERCULOUS DISEASE.

The wrist, like the shoulder, is chiefly affected by tuberculous disease in adult life. Disease of this joint is not very common and is frequently accompanied by phthisis.

The disease may begin either primarily in the synovial membrane or as a deposit in one of the bones ; probably it is more often primary in the synovial membrane. When it commences in the bones, the deposit is generally in the lower end of the radius or in the base of one of the metacarpal bones, usually the second. It is very seldom that these deposits are found in the carpal bones.

The disease soon leads to considerable swelling of the joint, which is especially noticeable over the back of the hand, and from quite an

early period there is marked lateral mobility of the wrist, as ascertained by fixing the forearm with one hand and moving the carpus laterally upon it with the other ; this is due to softening of the lateral ligaments and is a most characteristic symptom of a tuberculous wrist.

As the disease progresses, there is a great tendency to dislocation forwards of the carpus, and much pain and rigidity about the joint. The patient cannot hold up the hand without support, and if no treatment has been adopted the hand is flexed at the wrist and the fingers are extended. Adhesions may form in the tendon sheaths surrounding the wrist, and tuberculous disease of these structures is not uncommon. Abscesses and sinuses are chiefly found over the dorsal aspect of the wrist.

TREATMENT.—The treatment may be expectant or operative.

Expectant Treatment.—There is a great tendency to stiffness of the fingers from adhesions in the tendon sheaths, and therefore active and passive movements of the fingers should be assiduously kept up. A second important point is that the metacarpus should be thrown backwards on the splint. If anchylosis of the wrist-joint occurs with the metacarpus in a line with the bones of the forearm or at all flexed, it is almost impossible to shut the fingers into the palm, even when there are no adhesions in the tendons about the joint. In order to enable the fingers to be flexed properly, it is necessary for the metacarpus to form an obtuse angle with the back of the forearm ; this point is often neglected, the forearm and hand being usually put up on a straight anterior splint.

The best *splint* for disease of the wrist-joint is that introduced by Lord Lister for the after-treatment of excision of the wrist. This takes the form of a flat wooden splint, on the lower part of which a wedge-shaped piece of cork is fixed on which the metacarpus rests (see Fig. 103). The cork ends abruptly opposite the knuckles so as to allow flexion of the fingers and it is cut away on the radial side so as to permit the thumb to hang down. This position of the thumb is very important; with any other the power of opposition is apt to be lost. It is not uncommon to find that the hand has been placed on a straight splint with not only the metacarpus in the same line with the forearm, but also with the thumb on the same plane and closely applied to the other fingers. If the thumb becomes stiff in this position, all power of opposition is lost even though movement be retained in the fingers, and Lord Lister specially pointed out the importance of making the splint sufficiently narrow to allow the thumb to drop.

The result of these precautions is that, during the treatment, movement of the fingers and thumb can be kept up, and, even if a certain amount of stiffness should occur, the power of grasp in the thumb will be retained. The splint should reach as high as the elbow and may be fixed on by silicate bandages. The arm should be carried in a sling during the day, and at night should be laid upon a pillow or

upon an inclined plane. It is well to provide the splint with a wooden support on the under surface so as to raise it when it lies upon an inclined plane or a pillow, and thus allow the thumb to hang down, otherwise the pressure of the inclined plane may push the thumb up.

Operative Treatment.—If the disease is progressive, and especially if internal tuberculosis is present, some form of operative procedure must be adopted, the choice lying between excision or amputation.

Excision is only suited for cases occurring in comparatively young adults who are healthy and strong, and in whom there is no sign of tuberculosis elsewhere; when the patient is feeble and old, when there is tuberculous mischief in the lungs, when the local mischief has spread to the tendon sheaths, or when there are abscesses and sinuses, amputation is the best practice.

Excision of the Wrist-joint.—The operation introduced by Lord Lister is perhaps the one that offers the greatest advantages. It is a complicated procedure and may be modified according to circumstances. Another operation through a single dorsal incision was introduced by Langenbeck.

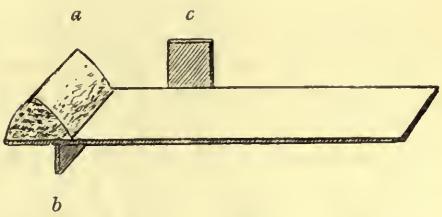


Fig. 103.—Lister's Wrist Splint. This splint, which is generally used for excisions of the wrist, is most useful in any inflammatory condition of that joint. The cork pad, *a*, extends the metacarpus and carpus upon the forearm, and is only of sufficient width to support the four inner metacarpals. That of the thumb hangs down beside the splint, which is allowed for by raising the latter upon the block, *b*. There is a lateral piece, *c*, to keep the forearm and hand in the same straight line.

Before commencing the operation, the fingers must be thoroughly moved so as to break down any adhesions present, because after the operation this cannot be done nearly so readily. The operation is admirably described by Mr. Jacobson in 'The Operations of Surgery' (third edition), p. 38, from which the following description is taken:—

'The radial incision is . . . planned so as to avoid the radial artery and also the tendons of the extensor secundi internodii and indicis. It commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. Thence it is at first directed towards the inner side of the metacarpo-phalangeal joint of the thumb, running parallel in this course to the extensor secundi internodii; but, on reaching the line of the radial border of the second metacarpal bone, it is carried downwards longitudinally for half its length, the radial artery being thus avoided, as it lies a little further out. These directions will be found to serve, however much the parts may be obscured by inflammatory thickening. The tendon of the extensor carpi radialis longior is next detached with the knife, guided by the thumb nail, and raised, together with that

of the extensor brevior, also cut, while the extensor secundi internodii, with the radial artery, is thrust somewhat outwards. The next step is the separation of the trapezium from the rest of the carpus by cutting forceps applied in a line with the longitudinal part of the incision, great care being taken of the radial artery. The removal of the trapezium is left till the rest of the carpus has been taken away, when it can be dissected

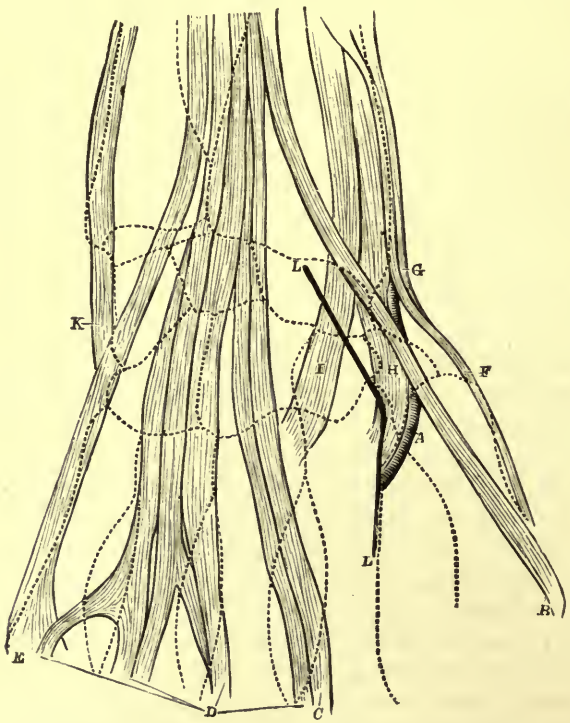


FIG. 104.—LISTER'S EXCISION OF THE WRIST TO SHOW THE ARRANGEMENT OF THE TENDONS ON THE BACK OF THE WRIST. The bones are shown in dotted outline. *LL*, the radial (dorsal) incision (the ulnar incision, being on the front of the wrist, is not shown); *A*, the radial artery; *B*, the tendon of the extensor secundi internodii pollicis; *C*, the tendon of the extensor indicis; *D*, the extensor communis digitorum tendons; *E*, the tendon of the extensor minimi digiti; *F*, the tendon of the extensor primi internodii pollicis; *G*, the tendon of the extensor ossis metacarpi pollicis; *H* and *I*, the tendons of the extensores carpi radialis longior et brevior; *K*, the tendon of the extensor carpi ulnaris. (*Holmes's System of Surgery.*)

out without much difficulty, whereas its intimate relations with the artery and the neighbouring parts would cause much trouble at an earlier stage. The hand being bent back to relax the extensors, the ulnar incision should next be made very free by entering the knife at least two inches above the end of the ulna immediately anterior to the bone, and carrying it down between the bone and the flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone at its palmar aspect.

The dorsal lip of the incision is then raised, and the tendon of the extensor carpi ulnaris cut at its insertion, and its tendon dissected up from its groove in the ulna, care being taken not to isolate it from the integuments, which would endanger its vitality. The finger extensors are then separated from the carpus, and the dorsal and internal lateral ligaments of the wrist joint divided, but the connections of the tendons with the radius are purposely left undisturbed. Attention is now directed to the palmar side of the incision. The anterior surface of the ulna is cleared by cutting towards the bone so as to avoid the artery and nerve, the articulation of the pistiform bone opened, if that has not been already done in making the incision, and the flexor tendons separated from the carpus, the hand being depressed to relax them. While this is being done, the knife is arrested by the unciform process, which is clipped through at its base with pliers. Care is taken to avoid carrying the knife farther down the hand than the bases of the metacarpal bones; for this, besides inflicting unnecessary injury, would involve risk of cutting the deep palmar arch. The anterior ligament of the wrist joint is also divided, after which the junction between carpus and metacarpus is severed with cutting-pliers, and the carpus is extracted from the ulnar incision with sequestrum forceps, any ligamentous connections being touched with the knife. The hand being now forcibly everted, the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound, or very superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The ulna and radius are thus left of the same length, which greatly promotes the symmetry and steadiness of the hand, the angular interval between the bones being soon filled up with fresh ossific deposit. A thin slice is then sawn off the radius parallel with the articular surface. For this it is scarcely necessary to disturb the tendons in their grooves on the back, and thus the extensor secundi internodii may never appear at all. This may seem a refinement, but the freedom with which the thumb and fingers can be extended, even within a day or two of the operation, when this point is attended to, shows that it is important. The articular facet on the ulnar side of the bone is then clipped away with the forceps applied longitudinally.

'If the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom. The metacarpal bones are next dealt with on the same principle, each being closely investigated, the second and third being most readily reached from the radial, the fourth and fifth from the ulnar, side. If they seem sound, the articular surfaces only are clipped off, the lateral facets being removed by longitudinal application of the pliers.

'The trapezium is next seized with forceps and dissected out without cutting the tendon of the flexor carpi radialis, which is firmly bound

down in the groove on the palmar aspect, the knife being also kept close to the bone so as to avoid the radial. The thumb being then pushed up by an assistant, the articular end of the metacarpal bone is removed. Though this articulates by a separate joint, it may be affected, and the symmetry of the hand is promoted by reducing it to the same level as the other metacarpals.

'Lastly, the articular surface of the pisiform is clipped off, the rest being left, if sound, as it gives insertion to the flexor carpi ulnaris and attachment to the anterior annular ligament. But, if there is any suspicion as to its unsoundness, it should be dissected out altogether, and the same applies to the process of the unciform.

'The only tendons divided are the extensors of the carpus, for the flexor carpi radialis is inserted into the second metacarpal below its base, and so escapes. Only one or two small vessels require ligature. Free drainage must be given. The hand and forearm are put up on the well-known splint of Lord Lister, with the cork support for the hand, which helps to secure the principal objects in the after-treatment—viz., frequent movements of the fingers—while the wrist is kept fixed during consolidation.

'Passive movement of the fingers is begun on the second day, whether the inflammation has subsided or not, and continued daily. Each joint should be flexed and extended to the fullest extent possible in health, the metacarpal bone being held quite steady to avoid disturbing the wrist. By this means the suppleness gained by breaking down the adhesions under chloroform is maintained.

'Pronation and supination, flexion and extension, abduction and adduction, must be gradually encouraged as the new wrist acquires firmness. When the hand has acquired sufficient strength, freer play for the fingers should be allowed by cutting off all the splint beyond the knuckles. Even after the hand is healed, a leather support should be worn for some time, accurately moulded to the front of the limb, reaching from the middle of the forearm to the knuckles, and sufficiently turned up at the ulnar side. This is retained *in situ* by lacing over the back of the forearm.'

The results of this operation vary very much, and on the whole are perhaps not entirely satisfactory. A splint must be employed for a very considerable time—from three to six months—and the main complications to guard against are the tendency of the hand to fall into a position of adduction, and also of the base of the first metacarpal bone to be drawn inwards against the rest of the metacarpus. In very bad cases the whole hand becomes rigid and useless. In some cases, however, a very satisfactory result is obtained.

Amputation.—Amputation is best done as close above the wrist as possible, and by means of the modified circular method described in Vol. II. p. 519.

DISEASES OF THE PHALANGEAL JOINTS.

SPRAINS.

Sprains of the fingers may be followed by considerable trouble unless great care is taken in their treatment. There is often partial or entire rupture of the lateral ligaments of the articulation, with pain in the joint, localised tenderness over the attachment of one of the ligaments, swelling and interference with movement. This condition may be very obstinate even in healthy patients, while, in those who are predisposed to rheumatoid arthritis or tuberculous disease, it may be the starting-point of these affections.

TREATMENT.—The treatment of sprains has been fully discussed on p. 79. In very bad sprains of the fingers the affected finger may be immobilised, and pressure employed for a few days. The best plan is to apply Scott's ointment spread on lint and fixed on firmly with rubber strapping; outside this a palmar splint of block-tin is applied. The splint should have a broad portion fitting the palm and reaching down to the metacarpo-phalangeal joints and as high up as the wrist; it is cut away opposite the thenar eminence so as to allow movement of the thumb. From the palmar portion a trough extends down for the reception of the affected finger. This splint should be kept on for about a week, after which passive movement and massage should be diligently employed.

SYNOVITIS.

Acute synovitis may be the result of injury, and as a rule soon passes off. The chief trouble lies in the adhesions which are left behind. *Chronic synovitis* with effusion, corresponding to the hydrops articuli of the larger joints, is very rare.

The treatment of these conditions is similar to that already described for other joints (see p. 93), and presents no features of importance.

GOUTY ARTHRITIS.

This is one of the commonest diseases of the phalangeal joints, and is associated with the deposit of chalkstones in the neighbourhood of the articulation, accompanied by some difficulty in complete extension. The urates are deposited not only around the joint, but actually in the cartilages, leading to alteration in their shape, and accounting for the difficulty in movement.

TREATMENT.—The essential point is the general treatment for gout—regulation of the diet, diminution in the amount of nitrogenous food, and the employment of suitable drugs and mineral waters (such as lithia and Contrexéville waters) to increase the excretion of uric acid and

urea. Gouty arthritis, however, practically comes under the care of the physician, and further details as to treatment should be sought in medical text-books.

RHEUMATOID ARTHRITIS.

All the joints of the fingers may be involved, and the affection may be associated with a similar condition in the larger joints. The fingers are usually deflected towards the ulnar side, and the joints much enlarged from the outgrowth of fresh bone around the articular surfaces, by which the movements of the fingers are much hampered; the joints are usually somewhat flexed. The condition is generally associated with considerable pain, and marked exacerbations of the trouble occur from time to time.

TREATMENT.—This is disappointing, as the disease is obstinate and generally ends in more or less crippling, in spite of any treatment that may be adopted. In the early stage the usual remedies already described for rheumatoid arthritis (see p. 143) should be had recourse to.

In all elderly subjects, and especially in those predisposed to rheumatoid arthritis, it is of the highest importance to remember that fixation of the fingers or joints of the upper extremity, after injuries such as sprains, fractures, or dislocations, is very apt to be followed by this form of disease. Hence in the case of fractures in the arm, forearm, or hand, the greatest care must be taken to leave the fingers free and to encourage active and passive movement from the very first, if it be possible to do so without interfering with union. Even when splints must be applied to the fingers, they should be taken off daily, and the joints exercised, so as to prevent adhesions occurring and to hinder the onset of this crippling disease. These remarks apply perhaps more particularly to Colles's fracture than to any other, as it is frequently followed by rheumatoid arthritis in the wrist and fingers if prolonged immobilisation, which is so commonly practised, be persisted in.

TUBERCULOUS DISEASE.

Tuberculous disease of the phalangeal joints is comparatively rare. The deposit much more frequently occurs in the shaft of the bone, in the form of a tuberculous osteo-myelitis, which has already been described (see Vol. II. p. 452). Nevertheless, primary tuberculous arthritis may occur, or tuberculous osteo-myelitis may spread into and invade the joint.

TREATMENT.—This is similar to that for tuberculous joint disease elsewhere. The parts are kept at rest with the fingers slightly bent, and this is best effected by putting the hand and affected finger into a silicate bandage and leaving the other fingers free to move. It is important to remember that it is not sufficient to fix the finger alone; the hand

must also be fixed. When the case is one of infection of a metacarpo-phalangeal joint, the fixation should extend to the wrist-joint also; otherwise the flexor and extensor tendons keep up a certain amount of movement.

When the disease is progressing in spite of treatment, *operative measures* must be considered, and either excision or amputation may be performed. In some cases excision of the ends of the bones gives a very good result, and leaves a certain amount of movement and a useful finger, but it is rarely that it can be employed, because in this affection the trouble is apt to spread to the tendon sheaths as they pass over the joint, and excision of the articulation will therefore fail to cure the disease. Hence, when there is disease of the tendon-sheath or of the neighbouring bone as well as an affection of the joint, or when abscesses are present, amputation is the better practice, the site of the amputation being dependent upon the joint affected.

SYPHILITIC DACTYLITIS.

This is an affection that is not very uncommon in the fingers. It has been fully described (see p. 133), and nothing further need be said about it here.

DIVISION II.

THE SURGICAL AFFECTIONS OF THE SPINE.

CHAPTER XXV.

INJURIES OF THE SPINE.

Injuries of the spine are of common occurrence and vary in gravity according to the severity of the violence producing them.

The most common *cause* of severe injuries of the spine is sudden extreme flexion of the spinal column, such as occurs in hunting or bicycle accidents, in which the patient falls upon the head or shoulders, and the spine is forcibly bent. Damage may also be caused by sudden twisting or over-extension of the spine, as contrasted with over-flexion, and also from very powerful muscular action. Direct violence, such as a blow on the back driving the upper part of the spine forward, while the lower remains stationary, is a very important cause of serious injury; for example, masses of earth, or heavy bags, falling on the upper part of the spine are very apt to cause a fracture-dislocation at a lower level. Other causes of spinal injury are jars and concussions, such as occur in railway accidents, and falls from a height upon the back, the feet, or the buttocks.

The *results* of these injuries vary very greatly in degree according to their severity, the position of the patient at the time of the accident, and the strength of the muscles and ligaments concerned.

1. The mildest form of injury is a *sprain* of the spinal muscles and ligaments, resulting in severe cases in more or less complete rupture; these lesions usually follow violent flexion or rotation of the spine.

2. In more severe forms of injury the ligaments of the vertebral canal are torn, and hæmorrhage results; hæmorrhage may also occur without rupture of the ligaments. The blood may collect either outside or inside the dura mater; this condition is known as *hæmato-rachis*.

3. As the consequence of severe injuries or jars—with or without rupture of ligaments or muscles—*concussion* of the spinal cord may result; here there is more or less complete but temporary loss of function of the cord.

4. Apart from hæmorrhage into the spinal meninges, bleeding in the substance of the cord itself—*hæmato-myelia*—may occur in some cases of severe injury. According to Thorburn this is practically limited to the cord in the lower cervical region.

5. Lastly, we may have *dislocation* of the spine, occurring chiefly in the upper cervical region, or, much more frequently, a *fracture-dislocation*, which is most common in the lower cervical and the dorso-lumbar regions.

SPRAINS.

Severe sprains of the spine are usually associated with partial rupture of ligaments or tearing of the tendinous insertions of the spinal muscles. In very severe injuries, the ligamenta subflava may be actually torn; these cases are grave, and are accompanied by hæmato-rachis. Sprains most often affect the lumbar region, and less frequently the cervical region, this distribution being due to the fact that these are the most mobile portions of the spinal column.

The symptoms vary much in severity. In the mildest cases there may be only slight pain at the time of the accident, but considerable pain and tenderness on pressure generally develop in the course of from twelve to twenty-four hours. In severe cases, the patient often experiences agonising pain on attempting to move the spine or the limbs, so that the back is kept absolutely rigid, and a condition of paraplegia may be diagnosed, unless the examination is conducted carefully. Extravasation of blood may be present in bad cases, but usually there are no symptoms indicating injury of the spinal cord unless intra-spinal hæmorrhage has occurred.

These injuries are of great practical importance, because, unless treatment is prompt and sufficiently prolonged, the patient is liable to great, and even permanent, disability as the result of chronic inflammation of the damaged tissues. In some cases also, especially in children, sprains of the spine may be followed by the development of tuberculous disease.

TREATMENT.—The treatment differs according as the patient is seen immediately after the injury, or does not come under observation until a considerable time has elapsed.

(a) **In Recent cases.**—In cases which are at all severe, absolute *rest* in the recumbent position should be enforced for a few days, the pain being

relieved by the application of *fomentations* to the seat of injury; usually *aspirin* or some *narcotic*, such as chloral or bromide of potassium, will be required for the first night or two. In injuries about the lumbar spine the urine should be examined for blood, as the kidney may have been contused; if there is hæmaturia, special treatment for the arrest of the bleeding will be called for. Rest, however, must not be prolonged too long, otherwise the condition may become chronic. *Massage* should be carried out almost from the first, for a quarter of an hour or twenty minutes at a time; for four or five days it should consist of gentle rubbing in the upward direction, and, if the injury is severe, it can be done without turning the patient over. After the first week, the massage should be more vigorous and should be applied for a longer time, and it is well to follow it with some *stimulating liniment*, such as linimentum terebinthinæ aceticum or the following:—

℞ Menthol . . . . ʒss.
Lin. belladonnæ } . . . . āā ʒss.
Lin. camph. co. }

Under this treatment the symptoms will usually subside in the course of two or three weeks, but active movement should be restricted until recovery is practically complete. When the patient first gets about, he will find great relief from wearing a firm binder round the loins, or strapping if massage is not being carried out.

(b) In Long-standing cases.—When the patient is not seen until some time after the accident, and pain is still present on movement, there is probably chronic inflammation of the damaged structures with adhesions.

When there is much pain and tenderness it may be well to commence the treatment with *counter-irritation*, by means of blisters or the cautery (see Vol. I. p. 19), the patient being kept in bed for the time. After a week or two, however, this may be given up and *massage* and other methods employed. The massage should be more vigorous than in the recent cases and should specially aim at breaking up the adhesions and freeing the muscles. In addition, *douching* the spine with hot and cold water alternately, or hot-air baths, are very useful.

When the case proves obstinate, great benefit is often obtained by giving the patient gas and *forcibly moving the spine* so as to break down adhesions, in the same way that adhesions in joints are treated. This should be followed by *active and passive movements* repeated two or three times a day the patient wearing only a light garment on the trunk; at first they should be done under the supervision of the medical attendant or a competent masseur, who should instruct the patient as to the exercises which are most suitable. *Vibratory massage* may also be very useful and in the intervals between the treatments a firm bandage should be applied to the spine. In some cases *cataphoresis* of iodide of potassium or carbonate of soda is of value.

In these chronic cases there is often a rheumatic or a gouty tendency, and, under these circumstances, a sojourn at Bath, Buxton, or some similar watering-place, may be beneficial.

HÆMATO-RACHIS.

Hæmato-rachis or hæmorrhage into the membranes of the spinal cord may follow rupture of the ligamenta subflava, or may result from a severe blow on the back or a fall without rupture of these ligaments. The blood is usually extravasated between the dura mater and the bones, but sometimes the extravasation may occur within the theca.

The *symptoms* are very similar to those which follow meningeal hæmorrhage in the brain ; in the early stage there are signs of irritation of the cord, followed by definite pressure symptoms if much blood has been effused. As the clot has more room in the spinal canal than in the cranial cavity, the pressure symptoms are not so frequent, however, and the irritative symptoms are more prominent. Hæmato-rachis may be suspected when there is severe pain both at the seat of the injury and along the distribution of the nerves arising from the corresponding area of the cord, and also when there are irritative symptoms, such as muscular cramps, due to irritation of the motor nerve-roots.

TREATMENT.—The patient should be put to bed at once, and kept perfectly quiet in the prone position. Ice should be applied to the spine, and subcutaneous injections of adrenalin chloride (five to ten minims) or of ergotinine citrate ($\frac{1}{200}$ gr.) may be given with the view of checking the bleeding promptly. A smart purge—calomel, gr. v.—should also be administered, and, as in all spinal injuries, the condition of the bladder must be ascertained, lest there should be retention of urine. Should the symptoms show no improvement under this treatment, and more especially when pressure symptoms supervene, it is well to open the spinal canal, and evacuate the clot. This is done by the operation of laminectomy, the steps of which have already been described (see Vol. II. p. 131). As a rule the clot is outside the dura mater and is thus easily evacuated ; should it not be found there, the dura mater must be opened and the clot removed from beneath it.

CONCUSSION OF THE SPINE.

By the term concussion of the spine is meant a condition in which there is a molecular disturbance of the nerve cells, without any gross organic lesion ; this leads to temporary loss of function. In the majority of cases of supposed concussion, whether cerebral or spinal, minute lesions, chiefly in the form of capillary hæmorrhages, are present. A certain number of cases, however, occur in which no such lesion can be detected, and in these we can only attribute the paraplegia to a temporary

disturbance of the nerve cells. Concussion of the spine is usually caused by a severe blow on the back or by a fall from a height upon the feet, buttocks, or back.

There is more or less complete loss of motion and sensation in the legs immediately after the accident, and sometimes weakness of the arms as well. There may also be incontinence of urine and constipation. The symptoms usually pass off in a few hours, but they may not entirely disappear for some days; when there is no actual organic lesion, recovery practically always occurs. Should there be defective recovery, such as permanent weakness affecting a single muscle or a group of muscles, it is probable that there has been some actual lesion, such as hæmorrhage into the cord.

TREATMENT.—In the early stage it will suffice to keep the patient in bed and apply a spinal ice-bag; ergotinine citrate ($\frac{1}{200}$ gr.) may be given if there is any reason to suspect hæmorrhage. If there is retention of urine, it must be relieved. The diet should be non-stimulating and should consist mainly of milk.

'*Railway spine.*'—The condition known as 'railway spine' is usually a sprain of the muscles and fasciæ which has been neglected, but some cases, in which degenerative spinal changes subsequently occur, are probably the result of hæmorrhage into the cord or membranes; other cases are simply due to hysteria following the general nervous upset.

The condition is one of great importance, partly from the difficulty in arriving at an accurate estimate of the damage sustained, and partly from the obstacles that are so often thrown in the way of treatment. The fact that the injury has been met with upon the railway, and that compensation may therefore be claimed, doubtless has a tendency to discount the gravity of the case in the eyes of the surgeon and to increase it in those of the patient. It frequently requires not only a good knowledge of surgery, but also a keen insight into character to arrive at a just conclusion.

There are often very serious difficulties in carrying out the *treatment* successfully. In the first place, complete rest, quietude, and abstinence from all mental work are called for immediately after the accident. The latter, however, is often most difficult to secure, and, from the circumstances of the case, business worries and interviews and correspondence regarding compensation, etc., are very difficult to prevent. In many cases also, the obscure nerve symptoms, which may be absolutely genuine, do not develop until some time after the injury. When the question of compensation has been finally disposed of, rapid improvement may occur.

After a short time devoted to rest and quiet, the treatment must aim at causing the absorption of any effusion about the spine, and the early restoration of its functions. Practically it is the same as that employed for sprains of the spine (*vide supra*). It is a point of the

highest practical importance in these cases to get the patient up and about as soon as the local condition of the spine will permit. Unduly prolonged rest only serves to accentuate the various vague spinal, muscular, and nerve pains from which the patient suffers, while the mental condition becomes proportionately bad. In the more markedly hysterical cases some form of the Weir Mitchell treatment must be employed (see p. 138), and in some cases treatment by 'suggestion' may be of value. In the less severe ones, an entire change of scene and surroundings, such as a sea-voyage or the like, may be sufficient.

HÆMORRHAGE INTO THE CORD OR HÆMATO-MYELIA.

This condition may be considered in connection with spinal concussion, because the injuries which lead to the one are very apt to produce the other, while the two are very often combined. The presence of punctiform hæmorrhages in the substance of the cord has been alluded to, but in the cases under consideration there is more extensive bleeding, which gives rise to a clot in the grey matter of the spinal cord. This condition usually follows acute flexion of the spine, and, according to Thorburn, is practically confined to the region of the fourth, fifth, and sixth cervical vertebræ.

When the lesion is severe, there may at first be complete paraplegia; this is subsequently recovered from to a certain extent, only some slight weakness being left in the lower extremities. The severe symptoms, however, mainly affect the upper extremities, and permanent loss of power, and wasting in some of the muscles often remains. When the hæmorrhage is less, the symptoms are confined to the arms from the first; this differentiates these cases from those of spinal concussion, in which the symptoms are most marked in the lower part of the legs and in which the arms are comparatively slightly affected. After partial recovery, the paralysis may extend again as the result of the onset of myelitis. Unless the hæmorrhage is severe and followed by myelitis, there is usually a considerable amount of recovery.

TREATMENT.—This consists simply of rest in bed, ice to the back, injections of ergotinine citrate ($\frac{1}{20}$ gr.), and the use of purgatives. It can hardly be expected that an operation for the removal of the intra-medullary clot would be of any practical value.

DISLOCATION AND FRACTURE-DISLOCATION.

The injuries already mentioned (see p. 263) may also produce dislocation of the spine, or more commonly fracture-dislocation.

True dislocation of the spine without fracture is very rare and is practically confined to the cervical region. In it the articular processes become displaced from one another, and the inter-vertebral disc and the

common ligaments are lacerated. The upper part of the spine is practically always displaced forward. Paralysis may occur, varying in situation and in degree according to the injury inflicted upon the cord, and the nerves may also be subjected to pressure as they pass through the inter-vertebral foramina. Owing to the smallness of the bodies of the vertebræ and the large size of the spinal canal in the cervical region, the damage to the cord is not usually so extensive as when the injury occurs lower down, so that in some cases marked benefit may result from the reduction of the dislocation.

Fracture-dislocation, on the other hand, is a combination of fracture and dislocation, and may result either from direct or indirect violence; the latter is the more common, the spine being forcibly bent forwards. Fracture-dislocation by direct violence is comparatively rare, but it may be caused by severe kicks, blows, or the passage of heavy bodies across the spine; it often occurs in adult labouring-men, as the result of a fall from a height. Fracture-dislocation may occur in any portion of the spine, most commonly in the lower cervical and the dorso-lumbar regions.

As a rule the line of fracture runs obliquely from above downwards and forwards through the body of the vertebra, the upper part of the spine being carried forwards, and the posterior edge of the lower portion of the vertebra forming a sharp projection over which the cord is stretched and bruised. Accompanying the fracture there is dislocation of the articular processes, and it is well to bear this in mind during attempts at reduction, because these processes may form the chief obstacle to replacement of the fractured vertebra.

The spinous processes and the laminæ may also be fractured independently of the body, either from violent flexion of the spine or, more usually, from direct violence.

The gravity of a case of fractured spine depends on the amount of damage done to the spinal cord, which in turn depends on the degree of displacement that has occurred. The cord is acutely flexed over the projecting lower part of the body of the fractured vertebra, and, if the flexion is great, the cord may be very severely damaged; in some cases it is so pulped up that its structure is unrecognisable and it is merely represented by a tube of dura mater containing a mass of blood-clot and disintegrated nerve elements. It is important from the point of view of the efficacy of operation to remember that the lesion of the cord is generally caused not by continued pressure, but by sudden contusion at the time of the injury, so that the chances of doing good by reducing the fracture-dislocation or by removing bone pressing on the cord are very slight indeed.

SYMPTOMS.—Fractures of the spine are accompanied by a series of symptoms due to the damage that the cord has sustained, and these vary in nature and severity with the situation of the fracture and the

amount of this damage. The signs of the fracture are deformity, localised pain, and, in most cases, injury to the spinal cord. The deformity is only noticeable when the case is one of fracture of the body with dislocation forwards, and the amount evident when the patient is first seen is no measure of the degree of displacement at the time of the injury or of the damage done to the spinal cord; it is not at all uncommon for the deformity to disappear, or at any rate to become distinctly less, when the patient is laid flat upon his back. This disappearance of the deformity does not however necessarily relieve the spinal symptoms at all, as these are caused by the damage done to the cord at the time of the accident.

In cases of fracture of the neural arch there is seldom any noticeable deformity, but sometimes crepitus and mobility can be made out by lateral pressure on the spinous processes. In fractures of the bodies, on the other hand, mobility and crepitus are usually absent.

There is generally more or less complete paralysis of motion and sensation in the parts supplied by the nerves coming off from the cord at or below the seat of injury. This varies with the amount of damage done to the cord, and, if it is not completely destroyed, the motor paralysis is more marked than the sensory. Above the area of complete sensory paralysis there is generally a zone of hyperæsthesia due to irritation of the nerves in the neighbourhood of the fracture. The reflexes are abolished at the time of the accident, but may become re-established later on; their return generally indicates a partial lesion of the cord. In fractures of the spines or the laminæ the pressure effects on the cord, if any, are usually only partial.

Certain special symptoms accompany fractures of the spine, of which the following may be mentioned:—

Urinary disorders.—These are met with in all fractures above the lower lumbar region. When the fracture is in the dorso-lumbar region there is generally incontinence of urine; when it is higher up, there is retention with overflow. After a time, in spite of the greatest care, the bladder becomes the seat of cystitis, the urine is filled with thick, ropy muco-pus, and later on, the inflammation spreads upwards and leads to pyelo-nephritis. A variety of organisms may be present in the urine, of which bacilli belonging to the *coli* group are the most common. There is generally much priapism—often painless, but sometimes causing considerable inconvenience.

Alimentary troubles.—When the fracture is in the lower dorsal region there is often considerable interference with the sympathetic nervous system, leading to intestinal disturbances—such as vomiting, tympanites, and constipation. This condition is aggravated by the paralysis of the abdominal muscles, and may be so severe as to simulate acute intestinal obstruction.

Respiratory troubles.—Fracture in the upper dorsal region entails

paralysis of the intercostal muscles, and when it is in the lower cervical region all the accessory muscles of respiration are paralysed as well as the intercostals, and respiration is carried on by the diaphragm alone. In fracture above the third cervical vertebra death is usually immediate from paralysis of the phrenic as well as of the other respiratory nerves. As a result of the interference with the muscles of respiration in the fractures in the dorsal and lower cervical regions, there is a great tendency to imperfect expansion and aëration of the lungs, leading to congestion of the bases followed by hypostatic pneumonia ; this is a frequent cause of death.

Nerve troubles.—There are other changes common to all fractures of the spine accompanied by injury to the cord ; for example, the circulation is affected, the pulse being markedly irregular and often very rapid, whilst vascular disturbances—such as flushing—are frequent. The temperature, at first at any rate, is usually subnormal. Trophic changes are met with in the paralysed parts, the most important being the occurrence of acute bed-sores which appear on any part subject to pressure, more especially over the sacrum. The slightest pressure may lead to rapidly spreading gangrene of the skin, the pressure of one knee against the other being sufficient in some cases to cause it. These bed-sores are often fatal from septic infection. Cutaneous rashes, or bullæ, are also frequently met with in the paralysed parts.

PROGNOSIS.—The prognosis varies according to the region of the spine that is the seat of fracture, and according as the fracture affects the spinous processes and laminæ or the bodies of the vertebræ.

When the neural arches are fractured, the spinal symptoms are mainly due to depression of the fragments, and the compression which results does not necessarily give rise to much permanent damage to the spinal cord. Indeed, if means are taken to relieve the pressure at once, the patient may recover entirely. When the cauda equina alone is pressed upon, as is the case in fractures in the lower lumbar region, the recovery following removal of the pressure may be complete.

In fracture of the bodies of the vertebræ the prognosis is much graver on account of the immediate and often irreparable damage done to the cord—a damage that can seldom be remedied by any attempt to relieve pressure. The prognosis is most favourable *in fractures of the lumbar spine,* and least in those about the upper dorsal and cervical regions. In fractures of the lumbar spine, even though there may be permanent paralysis of motion and sensation in the parts below, along with the attendant trophic changes, the patient may live for a long time, especially if the condition of the bladder is carefully attended to. The cause of death in these cases is usually either sepsis in connection with acute bedsore or septic infection of the urine, both of which can be guarded against, at any rate to a certain extent.

When the fracture is in the dorsal region, the mortality is much greater.

Here the urinary troubles are more severe and, in spite of the greatest care, it is hardly possible to stave off the occurrence of pyelo-nephritis for any considerable length of time. The patient is, moreover, exposed to the risk of dangerous hypostatic congestion of the lungs from the want of proper aëration of the bases, owing to the paralysis of the abdominal and lower intercostal muscles; this risk not uncommonly increases as time goes on, because secondary myelitis generally occurs above the injury to the cord, and thus leads to extension of the trouble upwards and a further interference with the nerve supply.

When the fracture is in the cervical region death almost invariably results within a few days, or weeks at the utmost, chiefly owing to the respiratory embarrassment due to the paralysis of most of the respiratory muscles, and the resulting imperfect aëration of the lungs.

TREATMENT.—In connection with the treatment, we shall consider separately true dislocations, fractures of the bodies, fractures of the neural arches, and the chief complications.

1. Of Dislocation.—An attempt may be made to reduce the cervical dislocations by placing the patient under an anæsthetic, and making extension by grasping the occiput with one hand and the chin with the other, counter-extension being made by fixing the shoulders and trunk. The extension is made in an upward and backward direction, and in some cases the dislocation is reduced with a sudden jerk or snap; reduction may be followed by sudden cessation of breathing which necessitates recourse to artificial respiration for a few minutes.

If the dislocation cannot be reduced in this way, operation is advisable. The surgeon exposes the seat of dislocation by laminectomy (see Vol. II. p. 131), and divides any structures which interfere with reduction, such as the superior articular processes of the vertebra below the seat of dislocation. If it is necessary to remove the articular processes, the transverse and spinous processes above and below the seat of dislocation must be subsequently drilled and united by silver wire (see Fig. 105). Great care must be observed throughout the operation to prevent undue movement of the parts, otherwise the injury to the cord may be increased.

The wound is closed, and when it has been dressed, a poroplastic splint which takes purchase from the shoulders, and embraces the neck, the chin and the occiput, should be applied; if necessary, this may be strengthened by suitable pieces of metal. The head is thus fixed, and the risk of fresh displacement avoided.

2. Of Fracture of the Bodies of the Vertebræ.—In taking charge of these cases it is very important to remember the grave damage which may have already been done to the cord, and the serious risk of increasing this by incautious movements of the spine. In examining these cases it is not permissible to turn the patient over or to raise him, so as to seek for deformity or other symptoms of fracture,

because the displacement may be reproduced and aggravate the damage already present. The symptoms of fracture of the spine are always sufficiently clear to render such a course as unnecessary as it is dangerous, and, if required, the condition can be shown by a radiogram.

Removal of the patient.—It sometimes falls to the lot of the surgeon to be called to a case of fractured spine, while the patient is still lying on the spot at which he received the injury; he then becomes responsible for the patient's removal, which must be done with the utmost care and with the aid of intelligent assistants. The patient should be laid flat upon the ground or floor, without anything beneath his head, and all attempts at movement must be delayed until a suitable stretcher or litter is ready for him. This should be firm and unyielding, a shutter or door being as useful as anything if a stretcher cannot be obtained; indeed, in any case it is a good plan to place a narrow shutter or a wide plank of suitable length beneath the patient, and to lift him on to the stretcher on this. A board of this kind can be readily slipped between the patient and the floor without raising him more than an inch or so, and it prevents him from sinking down in the stretcher and thus increasing the deformity. In raising the patient it is very important to remember that a certain amount of extension should be made. At least, four assistants are required, two of whom take the lower extremities, while the other two grasp the thorax in cases of fracture of the dorso-lumbar region or the head in fractures higher up; in the latter case two more are required to support the trunk. As the patient is raised from the ground the assistants make extension. The surgeon at the same time places his hand beneath the spine and keeps it as horizontal as possible. The board or shutter is then rapidly slipped beneath the patient immediately there is room for it, and upon this he can be lifted and carried home, or the entire apparatus may be placed upon a stretcher. It is well, if possible, to encircle the patient and the stretcher in a sheet, and to bandage the arms to the sides so as to prevent all movement. The stretcher should in all cases be carried by hand so as to prevent the jolting which wheeled carriages entail, and, as is well known, the stretcher bearers at the two ends should not walk in step.

When the patient reaches his home or the hospital, he should not be disturbed until the bed has been prepared for his reception; fracture-boards should be placed upon the bed-frame and over them a horse-hair mattress, consisting of three parts, the central one (*i.e.* that beneath the sacrum) being again subdivided vertically into two lateral halves; each of the segments should have a separate sheet (see Fig. 115). A water-bed is not suitable at this stage. The initial shock, although sometimes severe, is surprisingly slight in the majority of cases. If it is marked, plenty of hot blankets should be piled over the patient and stimulants administered. It must be remembered that the lower extremities are anæsthetic, and therefore no hot bottles must come in

contact with the skin, otherwise extensive and intractable burns are certain to result; the bottles should be placed outside the blankets.

Reduction of the fracture.—In some cases the fracture spontaneously reduces itself when the spine is in the horizontal position; in others, however, the deformity remains, and it may be advisable to attempt reduction, especially when the injury is in the cervical region. This should be done under full anæsthesia, but its induction must be very gradual, and the greatest care must be taken to see that the patient does not struggle during the initial stages. When the patient is fully anæsthetised, gradual and steady extension should be made without raising the patient from the horizontal position. After the attempt has been made, a convex pillow may be placed beneath the spine at the seat of the injury so as to maintain any reduction that may have been obtained, the knees being flexed over a pillow to relax the psoas muscles.

Operative treatment.—The advisability of attempting to remove the pressure on the cord by operation in fracture of the bodies has been much debated; in our opinion it is of very doubtful value. Indeed, in the majority of cases in which the displacement is marked and there is no doubt that the cord has been irremediably damaged, operation is not only useless, but adds considerably to the immediate risks. The only cases in which laminectomy seems advisable or even justifiable are those in which the damage to the cord appears to be incomplete, that is to say, the paralysis is partial and, judging from its gradual increase and the irritative symptoms accompanying it at first, is probably due to pressure by blood-clot rather than by bone; under these circumstances it is well to perform laminectomy at once. In other cases, again, in which the paralysis, although complete at first shows signs of improvement, it may be also advisable to perform laminectomy with the view of removing any pressure which may be still present. In fractures in the cervical region, in which the spine is more accessible and the injury to the cord may be less, laminectomy may also be of use. Except under these circumstances, however, the operation does not seem advisable for the ordinary fracture-dislocations. The operation is described in Vol. II. p. 131.

After-treatment.—When recovery is taking place, the patient must be kept in the horizontal position for at least two months, at the end of which time he may be fitted with a well-moulded poroplastic or plaster of Paris jacket, and allowed to get about on crutches if the paralysis is only slight. As a rule, however, the patient remains bed-ridden throughout the rest of his existence, the sitting position being the utmost that he is able to assume. The condition of the urine usually varies considerably at different times. Treatment may also be required for the various trophic nerve lesions that are apt to occur.

3. Of Fracture of the Spinous processes and Laminæ.—In these cases the prognosis is much more hopeful, because the cord is seldom pulped up by the depressed bone. Any paralysis present is

usually due to direct pressure of the fragments of the bones or of blood effused between the cord and the bone.

Laminectomy, with the view of relieving the pressure on the cord, should be carried out as soon as possible. When the depressed bone is removed or the blood-clot cleared out, it is not uncommon for complete recovery to take place, unless the cord has been badly lacerated at the time of the injury. In these cases the position of the patient on the operating table is important. He must be in the fully prone position; but as the breathing is often largely, and sometimes entirely, diaphrag-

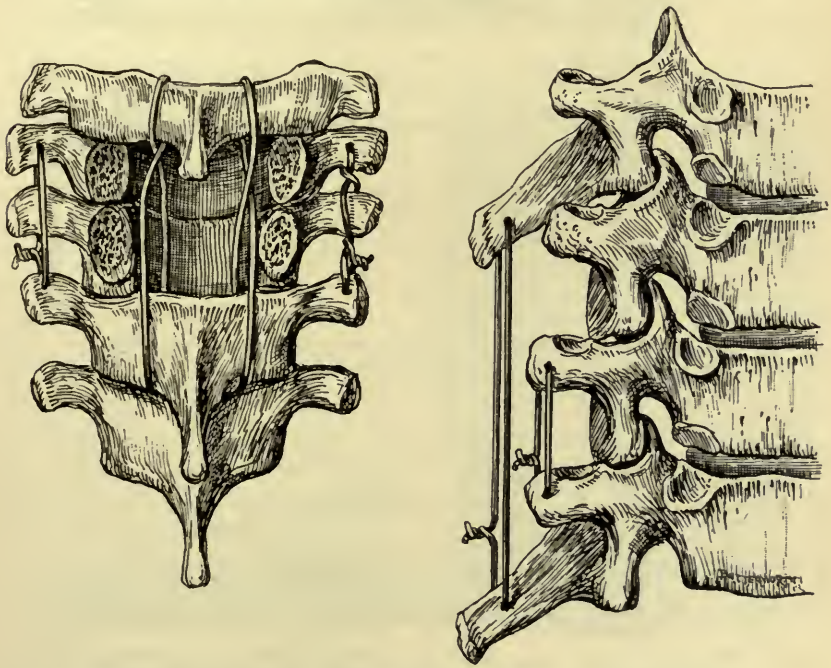


FIG. 105.—WIRING THE VERTEBRÆ TOGETHER AFTER LAMINECTOMY FOR FRACTURED SPINE. Various methods are shown, the wires uniting the laminæ, spines, and transverse processes. Any or all of them may be used.

matic the abdominal muscles must have full play. The positions shown in Figs. 106 and 107 are the best for this purpose.

The method of performing laminectomy has been described in detail in Vol. II. p. 131, and the details, up to the point when the laminæ are exposed, are the same. At this stage the condition of the spines and laminæ can be seen, depressed fragments can be removed, spicules of bone clipped away and blood-clot cleared out. It is seldom necessary to open the dura mater, but, should it be deemed advisable, this is best done by a vertical incision, care being taken to tie the vessels as they bleed. The chief reason for opening the dura mater is to remove blood-clot

pressing on the spinal cord. In doing this great care should be taken to prevent the escape of any considerable quantity of cerebro-spinal fluid. It is well, therefore, to incline the table so that the head is lower than

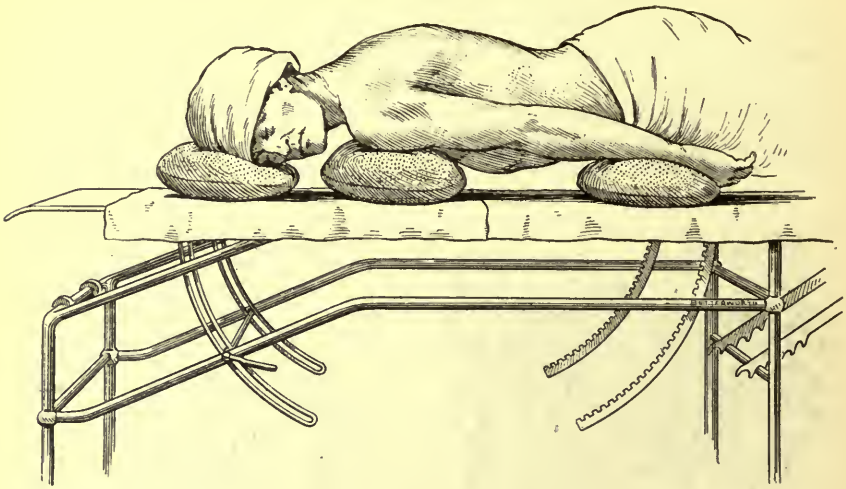


FIG. 106.—POSITION FOR LAMINECTOMY IN THE DORSAL AND LUMBAR REGIONS. (*After Thorburn.*)

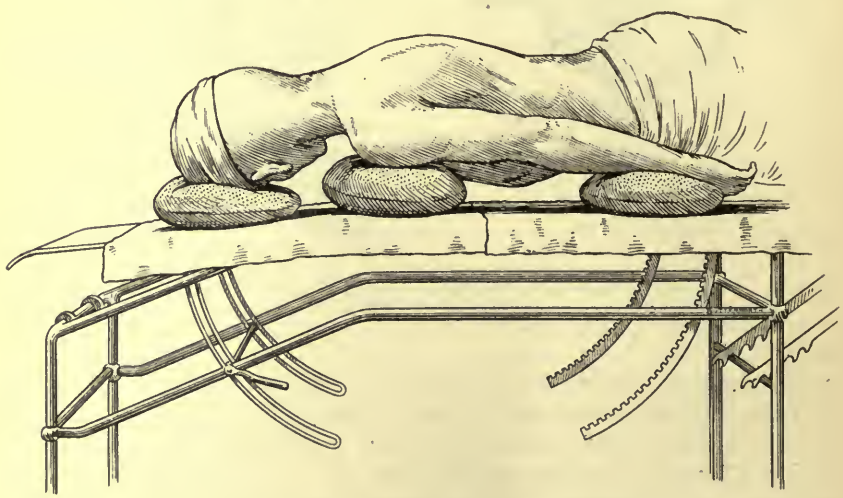


FIG. 107.—POSITION FOR CERVICAL LAMINECTOMY. (*After Thorburn.*)

the feet, in order to allow the fluid to collect in the cranial cavity, and as soon as the inspection of the cord is satisfactorily accomplished, the dura mater should be closely stitched up with a fine catgut suture. No drainage tube is used.

After-treatment.—After the application of the dressing and before the patient is turned over, a large shield of poroplastic material or plaster of Paris is moulded to the back and sides of the trunk and fastened in position so as to ensure immobility. If the dura mater has been opened, it is well to keep the patient for some days with the head low and the foot of the bed elevated, in order to prevent excessive leakage of cerebro-spinal fluid. Unless the dressings become soaked with discharge, they need not be changed for ten days, and the stitches may then be taken out.

4. **Of Complications.**—Perhaps the most important point in these cases is the avoidance of complications and their proper treatment when they arise. Death is almost invariably due to these complications, of which the most important, surgically, are urinary infections and bed-sores.

Fig. 108.—Incisions for Laminectomy. These are the incisions discussed in Vol. II. p. 131.

It is necessary in most cases to have recourse to the systematic use of the catheter. Sometimes, however, there is true *incontinence*, the urine escaping as soon as it reaches the bladder, and catheterisation is therefore unnecessary; septic decomposition of the urine is, however, apt to occur in these cases. With the view of preventing this, glass urine-bottles should be provided, which must be sterilised by boiling before use and changed at least every three hours. In the male, the meatus should be disinfected two or three times a day by washing with 1 in 2000 sublimate solution, and the entire penis should be washed twice a day with soap and the same lotion.

When *retention* is present, regular catheterisation is called for, and hence the risks of cystitis are much increased. The softest of instruments, of which the best is Jaques' red rubber catheter, should be employed, and must be scrupulously sterilised. The best plan is to place the catheter in water for about half an hour after use, and then to remove all mucus from the interior by forcibly syringing water through it. It is then sterilised by boiling for a quarter of an hour and kept in 1 in 2000 sublimate solution till required. Previous to use, the instrument should be anointed

with olive oil, sterilised by boiling, or glycerine and perchloride of mercury (1 in 4000). The meatus should be washed with 1 in 2000 sublimate solution immediately before the catheter is introduced, the fossa navicularis being cleansed with a small pledget of wool. After the urine has been drawn off, care should be taken to prevent the introduction of air into the bladder by pinching the catheter as it is withdrawn, and the glans penis should be washed and enveloped in sterilised gauze.

Cystitis.—In spite of the greatest care, cystitis frequently supervenes. In treating the cystitis the principal reliance must be placed upon washing out the bladder with antiseptic lotions, of which the best are sanitas (℥j. to the pint of water), boro-glyceride (1 in 20), dilute Condy's fluid or boric lotion; internally urotropine may be given in ten- to thirty-grain doses. When the urine is alkaline and contains thick ropy pus, it is well to use a lotion containing five grains of sulphate of quinine and ten minims of dilute sulphuric acid to the ounce of water, or a quarter to half a grain of nitrate of silver in an ounce of distilled water. If hæmaturia is present, turpentine (♏x.–xx.) or balsam of copaiba (♏xx.–xxx.) may be useful; terebine (♏v.–xv.) may also be advantageously employed on account of its action both on the kidneys and the lungs. When there is pyelo-nephritis, vaccines are employed according to the organisms present, and they seem to do some good if the infection is due to the *Bacillus coli.* Generally, however, the case goes from bad to worse in spite of the most careful treatment, and the patient eventually dies of suppurative nephritis.

Bed-sores.—The prevention of bed-sores is always most difficult and sometimes almost impossible. Every care should be taken to see that there is no undue pressure at any point; even the knees must not be allowed to rest against one another without the intervention of a suitable pillow or pad. The various precautions recommended against bed-sores (see Vol. I. p. 70) must be scrupulously adopted, and, above all, the skin must not be allowed to become soiled or wet. It is almost essential to employ a divided mattress in the early stages, so that the central portion can be pulled out to allow of the introduction of a bed-pan or of applications to the skin of the back. Two to three weeks later, when the fracture is beginning to consolidate, a water-bed may be employed. The empty water-bed is slipped under the patient beneath the sheet, and is readily filled through a funnel or by means of an ordinary douche-can provided with enough india-rubber tubing to allow it to be well raised.

The food must be concentrated and easily digestible; it should consist of strong soups, milk, and beef-tea. The state of the bowels must be carefully attended to, as constipation is the rule. The breathing must be facilitated as much as possible, and symptoms of commencing congestion of the lungs should be watched for, and treated immediately they arise. Carbonate of ammonia (gr. v.–x.) and diffusible stimulants, such as alcohol or ether, must be had recourse to, and oxygen may be

administered. The prognosis is, however, practically hopeless if pneumonia develops, as the patient is unable to clear the lungs owing to the embarrassment resulting from the paralysis of the abdominal and other muscles.

WOUNDS OF THE SPINE.

STABS.—Penetrating wounds of the spine are very uncommon except in military surgery, but they are occasionally met with as the result of stabs, or falls upon sharp-pointed instruments. The symptoms and their severity vary with the amount of damage done to the spinal cord, and in all cases in which the spinal canal is penetrated the occurrence is one of considerable gravity, owing to the risk of septic spinal meningitis.

Treatment.—The treatment of these wounds must be conducted on the same lines as for penetrating wounds elsewhere. If the opening in the skin is small, made with a clean instrument, and seen at once, it will probably suffice in most cases to disinfect the skin and the orifice of the wound, and to apply an antiseptic dressing. If there are symptoms of hæmorrhage, it will be necessary to perform laminectomy (*vide supra*), arrest the hæmorrhage, and remove the clot. Urotropine should be given in large doses as it is said to be of considerable value in preventing infection of the cerebro-spinal fluid.

BULLET WOUNDS.—The chief penetrating wounds of the spine are, however, due to bullets, and almost any lesion may result. Perhaps the most common occurrence is that the bullet is embedded in the body of the vertebra; in other cases it may fracture the neural arches and cause compression of the cord; or again, it may perforate the spinal canal and divide the cord.

Treatment.—When the laminæ are fractured or when there are signs of injury to the cord, whether due to fracture of bone and pressure on the cord or to direct injury by the bullet, the proper procedure seems to be to perform laminectomy as soon as possible. This will enable the surgeon to remove any fragments of bone or blood-clots which may be pressing on the cord, and to ascertain what the exact injury is. If the cord has been injured by the bullet the operation cannot, of course, do any good; but in most cases the spinal symptoms are due to the pressure of fragments of bone, and their removal may be of great service. A radiogram will help in determining whether the spinal symptoms are due to perforation of the cord by the bullet or to the pressure of pieces of bone, and will also locate the bullet.

Whether an operation should be performed, in the absence of spinal symptoms, simply to remove a bullet is a matter which is not so easy to decide. In many cases a conical bullet makes a clean wound and may

remain embedded in bone without causing trouble; in such a case operation would not be necessary. If, on the other hand, there is evidence that the bullet has carried clothing in with it, or if it is producing symptoms of pressure or inflammation, the proper course would be to remove it if possible.

When no operation is advisable, or when the injury to the cord is irremediable, the treatment will be similar to that described under fracture-dislocation of the spine.

CHAPTER XXVI.

SPINA BIFIDA.

By the term 'spina bifida' is meant a congenital condition in which there is a cleft in the posterior wall of the spinal canal, due to imperfect development and want of union of the neural arches. This defect is usually accompanied by a protrusion of the spinal membranes through the gap, and in some cases also of the nerves or the spinal cord itself. The cleft may affect one or several vertebræ and is most common in the lumbar or lumbo-sacral region, although it may occur in almost any part of the spine.

Fig. 109.—Spina bifida. Part of the vertebral column of an infant with lumbo-sacral spina bifida. (*Museum of the Royal College of Surgeons.*)

VARIETIES.—There are several varieties of this deformity.

1. *Spina bifida occulta.*—Here there is simply a defect in the laminæ without any swelling or protrusion of the meninges; the defect is often indicated by a distinct dimple of the skin. In association with this condition there is usually a tuft of hair on the skin over the defect. Although there is no protrusion, various paralytic conditions may be present—such as talipes, paraplegia, and want of control over the sphincters.

2. *Meningocele.*—Here only the membranes of the cord project through the gap, and there are no nerve elements in the tumour.

3. *Meningo-myelocele.*—This is the most common variety, and in it there is protrusion both of the meninges and of various nerve elements. When the spina bifida occurs low down, the cauda equina may be spread out over and adherent to the interior of the sac. When

somewhat higher up, the spinal cord itself may be adherent along the median vertical line of the tumour behind, and the nerves lie on the inner surface of the sac wall as they proceed to the inter-vertebral foramina, or they may pass directly across the cavity.

4. *Syringo-myelocele.*—This is a rare condition in which the central canal of the cord is dilated, and a portion of the spinal cord is spread out over the interior of the sac.

5. *Myelocele.*—Not only is the bony framework deficient, but the skin

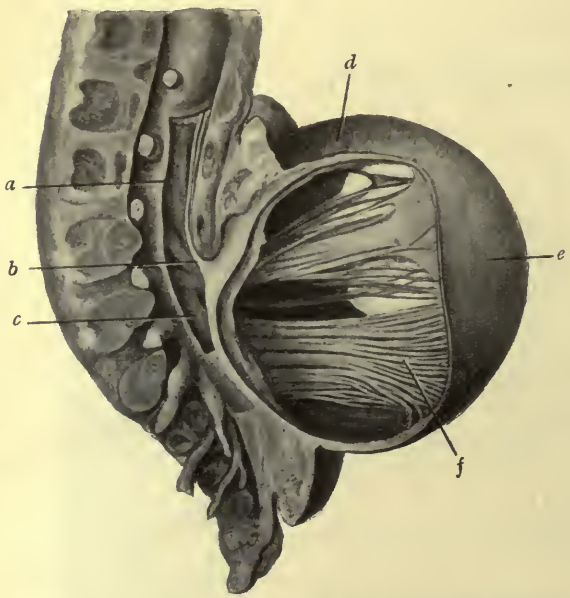


FIG.—110.—MENINGO-MYELOCELE. A sacral spina bifida dissected. The continuation of the dura mater (*a*) and arachnoid (*b*) entering into the formation of the walls of the sac (*d*) are displayed. The spinal cord passes directly backwards from the upper part of the sac and is continued down its posterior surface (*e*). In its course, the nerves (*f*) are given off in a double vertical series. The nerves pass horizontally forwards from the back of the sac. The anterior and posterior roots are distinct; the ganglia on the posterior roots (*c*) occupy the usual position. (*Museum of the Royal College of Surgeons.*)

FIG. 111. — MYELOCELE. The central canal of the cord is dilated and the soft parts over it are defective. (*Museum of the Royal College of Surgeons.*)

also is undeveloped and there is a communication between the interior of the spinal canal and the surface of the body. This leads to a free discharge of cerebro-spinal fluid, and the death of the infant in a very few days.

From the point of view of treatment the following *clinical characters* are important :—

(*a*) *The size of the tumour*, which may range from a small rounded swelling the size of a walnut to a large ovoid sac occupying the area of several vertebræ.

(*b*) *The size of the defect in the laminæ.*—This may vary from an opening too small to admit a finger to a wide furrow occupying a considerable portion of the spinal column. There is no constant ratio between the size of the tumour and the defect in the bones.

(*c*) *The coverings of the tumour.*—The swelling is sometimes covered by normal skin; more commonly it is only surrounded by normal skin at the periphery. Towards the centre the wall is thin, membranous, and translucent, the skin being either very imperfectly developed or entirely absent, and its place being taken by a thin cicatrix. The area uncovered by skin is frequently ulcerating, and sloughy patches or perforations, through which the cerebro-spinal fluid escapes, are sometimes present.

(*d*) *The contents of the sac.*—A point of the very greatest importance is whether nerve elements are present in the sac and adherent to its wall. When they are absent, the tumour is translucent in all directions; when present, they throw a shadow on transillumination, and their distribution and character may often be made out very distinctly, especially when the covering of the sac is membranous. Too much reliance, however, must not be placed on the absence of a shadow as indicating absence of nerves, for in some cases no satisfactory shadow is cast, although nerves are present. The presence of nerves in the sac is also often denoted by a depression in the centre of the tumour, or by a median vertical furrow corresponding to the attachment of the cord to the wall of the sac.

(*e*) *Malformations and paralyses.*—In the great majority of cases other congenital malformations are also present, the most common being talipes calcaneus, or paralytic conditions such as want of control over the sphincters, the urine and fæces being continually voided, or loss of sensation and motion in the lower extremities; trophic ulcerations occur in connection with these paralyses. Hydrocephalus is a frequent accompaniment of the disease, and not uncommonly follows attempts at a cure.

Very few children who are the subjects of spina bifida reach adult life. Death usually occurs in the early weeks of life from marasmus, convulsions, and septic troubles consequent upon the ulceration and rupture of the thin membranous sac, or, at a subsequent period, from hydrocephalus. As a rule in those who reach maturity the tumour is covered with healthy skin and contains no nerve elements.

TREATMENT.—The treatment of spina bifida may be either palliative or radical.

Palliative Treatment.—The first important question is, whether operative or palliative measures should be adopted. The latter should be employed in all cases when operation is refused, when the child is obviously so feeble that surgical interference is not warranted, when the opening into the spinal canal is very extensive, or when the tumour is small and covered with healthy skin and there is very

considerable probability that the child may grow up ; operation may also be delayed when ulceration is present on the surface of the tumour, so as to give time for the ulcer to heal, provided that there is no imminent danger of perforation.

Shields.—The first essential in the palliative treatment is to protect the tumour from injury by some form of accurately fitting shield which should be moulded directly to a cast of the swelling. This shield may be made of various materials ; among the most satisfactory are aluminium or celluloid, which should be perforated with holes so as to allow the perspiration to evaporate. These shields may be fixed on by strapping applied around the margin (so as to prevent them from shifting laterally) and by a broad abdominal belt fastened in front. Poroplastic felt also makes a very good shield ; it allows the escape of perspiration, especially if holes are bored in it, but if the tumour is large it will require strengthening to enable it to resist pressure. This is easily done by adding two strips of light steel at right angles to each other over the exterior of the shield. Beneath the shield a piece of boric lint should be placed, and, if ulceration is present, this lint should be spread with quarter-strength boric ointment, and changed night and morning. Great care must be taken to prevent soiling of the part, especially when the tumour is situated at the lower part of the spine.

Operative Measures.—The only operative measures that promise any reasonable hope of success are injection of Morton's fluid and excision of the sac. Such procedures as ligature of the sac, galvano-puncture, or the introduction of setons, are bad, on account of the septic infection which practically always follows, and of the injury frequently done to the nerves present in the sac.

1. **Injection of Morton's fluid.**—The plan of injecting these tumours with irritants was practised for many years, but was not followed by real success until Dr. Morton suggested the combination of iodine with glycerine. Fair results have been obtained by this method ; indeed, in some cases a cure has followed. Morton's fluid consists of ten grains of iodine and half a drachm of iodide of potassium to the ounce of glycerine. The object of the iodine is to cause sufficient irritation to lead to thickening of the sac wall and its ultimate contraction and obliteration, while the glycerine prevents unduly rapid diffusion of the solution, thus ensuring a more concentrated action of the drug and a diminished risk of spinal meningitis. The iodide of potassium is added as a solvent of the iodine.

In using this method, several points must be attended to. In the first place, it is most important that the needle (which should be sufficiently large to allow the fluid to flow readily through it) should be introduced through normal skin on one side of the base of the tumour ; care must also be taken to avoid any spot where there is puckering or depression of the sac wall, as that usually indicates the attachment of nerve elements,

The needle is introduced first and, if the sac is tense, a small quantity (not more than a third of its contents) should be drawn off; if there is no marked tension in the sac it is unnecessary to draw off any of the fluid. The syringe is now fitted to the needle, and a quantity of Morton's fluid, varying from fifteen drops to a drachm according to the size of the tumour, is slowly injected. As the needle is withdrawn, the puncture is pinched up and closed with a small collodion dressing.

After-treatment.—After the injection the child should be kept on its face or side for a few hours until the puncture has closed, so as to avoid the escape of cerebro-spinal fluid. In the course of a few hours, however, the child may be turned over and kept lying on its back. The tumour should be protected from friction and pressure by cotton-wool or a moulded shield. The first effect of the injection is irritation, pain, increase in size of the sac, and elevation of temperature; if benefit follows, the sac will become thickened, the fluctuation less evident, and the translucency diminished. It is usually necessary to repeat the injection several times before a complete cure is obtained; this may be done at intervals of about a fortnight.

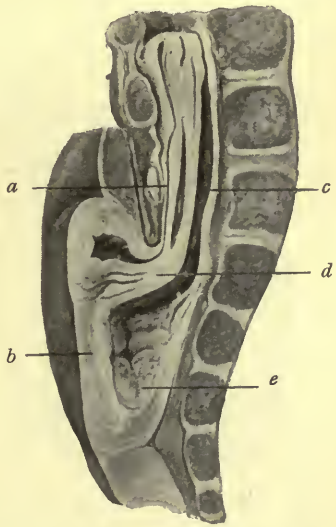


FIG. 112.—SPINA BIFIDA CURED BY IODINE INJECIONS. *a*, The arachnoid; *c*, the dura mater; *b*, the thickened skin and sac-wall; *d*, the nerves; *e*, the thickened arachnoid. (*Museum of the Royal College of Surgeons.*)

Cases suitable for injection.—Children who have been cured of spina bifida not infrequently become the subjects of fatal hydrocephalus. Hence it is never advisable to inject a spina bifida so long as the child is doing well and the sac is not threatening to burst; moreover, the older the child the better it stands the injection. We should say that the only cases really suited for Morton's injection are those of simple meningocele in very young children, in which the tumour is rapidly increasing, and also those cases of ulcerating spina bifida in which excision is out of the question and perforation is imminent.

2. Excision.—In performing excision, the redundant meningeal structures and skin are removed, the nerve elements, if present, separated from the sac wall and replaced in the vertebral canal, and the skin and meninges carefully sutured over the defect. An attempt should also be made to restore the bony roof of the spinal canal, so as to prevent, on the one hand, the possibility of recurrence and, on the other, the risk of injury to the cord in later life. At the present time this operation has

taken the place of all other procedures when the tumours are increasing in size, and it is preferred by most authorities to injections with Morton's fluid.

Strict asepsis during the operation is essential for the success of the operation. This is by no means an easy matter to obtain when the tumour is in the lumbo-sacral region, especially when the child is only a few days or weeks old. Failure to obtain asepsis means a fatal result from septic spinal meningitis. In some of these operations also there is considerable shock, especially when it is necessary to dissect out a number of nerves or the cord itself. In fact, when we consider the age of the patient, the situation of the tumour, the liability to septic infection and the magnitude of the operation, it is a very severe procedure, and in bad cases the mortality is great. Hence operation should not be resorted to unless it is absolutely necessary.

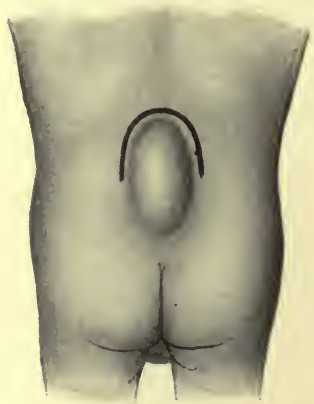


FIG. 113.—INCISION FOR SPINAL MENINGOCELE. This incision would only be used when healthy skin covers the tumour. The convexity of the incision may be to one side if the shape or size of the tumour demands it.

Cases suitable for excision.—From this point of view we may divide the cases into the three following groups:—

1. *Cases in which the sac is covered by normal skin and does not contain nerve elements.*—Unless the tumour is large and increasing in size, these cases may, as a rule, be left alone, or at most treated by Morton's injections. When an operation is considered necessary because of the continued increase in size of the tumour and the gradual thinning of the skin, the following is the best procedure: The skin is rendered aseptic, and scrupulous precautions are taken against shock both before and during the operation (see Vol. I. p. 117). The extremities should be wrapped up in cotton-wool, the child laid on a warm pillow, and the operation performed as rapidly as possible. When the skin over the tumour is thick and there is a plentiful supply of subcutaneous tissue, a curved incision may be made round the upper edge of the tumour and a horseshoe-shaped flap turned down (see Fig. 113). In most cases, however, the skin over the centre of the tumour is so thin that it would slough if it were dissected off the sac and therefore elliptical incisions enclosing and removing a considerable portion of the skin over the prominence of the swelling are better (see Fig. 114). All the tissues down to the sac itself should be taken up in the skin-flap; when the sac is exposed, it is usually easy to peel off the skin and subcutaneous tissues.

The sac is now pricked and the cerebro-spinal fluid allowed to flow out gradually, the child's head and shoulders being kept dependent so as to avoid too sudden escape of the fluid. The next point is to ascertain whether nerve elements are present in the sac. The opening is gradually and carefully enlarged, and the inner surface of the sac inspected both by touch and sight. The redundant portion of the sac is now excised and the remainder of its wall sutured over the gap. In excising the redundant portion of the sac, the incision should be made to one side, so that the deep line of sutures do not correspond with the sutures in the skin, which

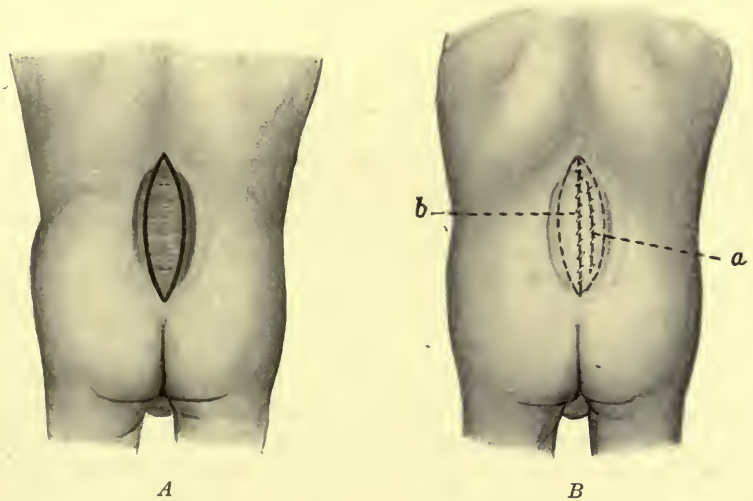


FIG. 114.—EXCISION OF A SPINA BIFIDA. *A* shows the usual elliptical incision through the healthy skin surrounding the base of the tumour; *B* shows how the cicatrix, *a*, made by suturing the meninges of the sac, can be made to lie well away from that formed by suturing the skin (*b*), if the elliptical incision in the meninges is made to one side.

lie more or less in the middle line (see Fig. 114, *B*). The skin-flap is then laid down, and united by a continuous suture, antiseptic dressings applied and the child kept on its face, with the head somewhat dependent, until healing is complete.

When the defect in the neural arches is very wide and the coverings of the tumour are almost entirely membranous, it may be impossible to make the flaps meet in the middle line. It will then be necessary either to undermine the skin for some distance around and bring the edges together with stitches of relaxation (see Vol. I. p. 140), or else to perform a plastic operation and turn in a skin-flap from below.

Osteoplastic procedures.—Whenever it is possible, an attempt should

be made to repair the defect in the bone; in newly-born children such a procedure can hardly be carried out, because it is essential that the operation should be performed as quickly as possible. At a later date, however, when the child can bear a longer operation, this procedure may be of considerable value. When portions of the laminæ are present on each side, attempts have been made to close in the opening by dividing their attachment to the articular processes and pedicles of the vertebræ with a chisel, and in this way allow the fragments to be pulled inwards over the sutured sac wall. In another method, which has been carried out in the sacral region, the soft tissues are peeled off the side of the sacrum for some little distance, and then a thin layer of the bone, with the periosteum attached to it, is chiselled up on each side and left attached at the edge of the defect. This plate of bone is then bent over the gap.

Success has been obtained in several instances by bone-grafting, the bones employed being either the scapula or the skull bones of rabbits. The scapula, divested of its muscles, forms a very satisfactory plate between the skin and the sac, and has succeeded in more than one instance. The exact method of grafting bones from animals, including the preparation of the animal, have already been described in Vol. II. p. 436. Portions of the tibia from the patient may also be chipped off and placed over the defect, and this is likely to succeed better than the bones of the lower animals.

The after-treatment mainly consists in taking care to avoid septic infection. The dressings should be fixed on with collodion or strapping instead of with bandages, and each dressing should be small in quantity and renewed at least twice daily, especially when the affection is in the lower sacral region and when consequently there is great risk of soiling the wound.

2. *Cases in which the sac is partly membranous and contains nerve elements.*—In these cases the operation differs from the above in several important particulars. The centre of the sac is usually covered by membrane, and any attempt to make a flap is out of the question. Hence the thin portion of the sac should be enclosed by an elliptical incision and removed; the further steps for the isolation of the sac are the same as in the preceding group of cases. After the sac has been separated, it is opened and the nerve structures detached from its wall; for this purpose a small incision is made, and the cavity is examined and the distribution of the nerves noted. It is important not to make this incision in the middle line, for two reasons: in the first place, the cord if present will escape damage, and, in the second place, the line of suture of the sac will not correspond to that of the skin. The sac is laid freely open and the nerves dissected out and returned into the spinal canal; this may be quite easy or, on the other hand, it may be a matter of great difficulty. When the nerves simply pass across the cavity of the

sac on their way to the inter-vertebral foramina there is no particular difficulty in isolating them; when, however, they are intimately adherent to the sac wall, which itself is thin and membranous, or when the cord is flattened out and adherent to the sac, the difficulties are very great, and considerable time may be required for the operation. The various structures must be carefully identified and separated, and, if the nerves cannot be dissected free from the sac wall, portions of the latter must be left adherent and returned with them into the canal. The subsequent steps of the operation are similar to those just described. It is particularly in these cases that the difficulty in bringing the skin-flaps together at the end of the operation is most likely to be met with.

3. *Cases complicated by ulceration of the sac wall.*—This is a complication of the very gravest nature: on the one hand, it demands early operation, otherwise rupture of the sac and fatal septic meningitis are certain; while, on the other hand, it minimises the surgeon's chance of obtaining a good result owing to the difficulty of securing asepsis. In all cases in which nerve elements are present in the sac and are adherent to the wall beneath the area of ulceration, the chances of recovery are very slight, because the ulcerated surface must be removed and the risk of carrying infection inwards is very great. If the imminence of perforation of the sac demands that something must be done, it will be best to have recourse to Morton's injections (see p. 284).

When matters are not so hopeless and operation is called for, disinfection of the ulcerated surface must be effected with undiluted carbolic acid, which should be thoroughly rubbed into the whole of the ulcerating surface, while the skin around is disinfected in the usual manner. The elliptical incision must go quite wide of the septic area, and if there is difficulty in getting the edges of the skin wound together—as usually happens—the skin around may be undermined or flaps made so as to enable the edges to come together without any great tension (*vide supra*).

When septic meningitis is present or is likely to ensue, large doses of urotropine should be given. This drug appears to be of considerable value in combating sepsis in the cerebro-spinal fluid.

Treatment suitable for the individual forms.—A few words may be said as to the applicability of these methods to the varieties of the affection already mentioned:—

(*a*) *Meningocele.*—As there are no nerve elements in the sac and the tumour is generally covered by sound skin, this is the most favourable condition. When the opening into the spinal canal is small, Morton's injections may be used, though excision is probably better.

When the opening is large, the operation should be delayed as long as is consistent with safety, the child wearing a shield in the meantime. If the tumour tends to enlarge as the child grows, excision followed by an attempt at osteo-plastic repair should be employed.

(*b*) *Meningo-myelocele and Syringo-myelocele.*—Should the skin be sound all over the tumour, excision, with isolation and return of the nerve elements, is best. In all cases in which operation is required on account of increase in the size of the tumour or a tendency to ulceration over the sac, excision is the best procedure. When the tumour is ulcerating, excision is essential if it can be done; if not, Morton's injections may be used.

(*c*) *Myelocele.*—Here there is nothing to be done, except to purify the parts and apply antiseptic dressings.

CHAPTER XXVII.

TUBERCULOUS DISEASE OF THE SPINE: TUBERCULOUS DISEASE OF THE SACRO-ILIAC JOINT.

TUBERCULOUS DISEASE OF THE SPINE.

The spinal column is the most common seat of tuberculous bone disease in children; 23 per cent. of all cases of tuberculous disease of bones and joints at that period of life occur in the spine. The majority commence before the age of ten. The favourite seat of the disease is in the dorsal vertebræ, from the middle downwards; then in the upper lumbar vertebræ, and less frequently in the upper cervical spine.

The disease may affect either the body of the vertebra or one of its processes; it is most common in the former situation, and when we speak of tuberculous spinal disease we mean disease of the body. In that situation it may commence either in the interior of the bone or on the surface, giving rise in the former case to soft deposits or sequestra; in the latter to a tuberculous periostitis.

Tuberculous Periostitis.—When the disease begins in the periosteum it spreads along the surface of the vertebra for a considerable distance, causing more or less extensive superficial caries. As the disease extends from one vertebra to another, it spreads inwards along the intervertebral discs and destroys them, so that ultimately there may be superficial erosion of a number of vertebræ and also want of continuity between the bodies owing to the destruction of the discs. Hence the curvature in these cases is usually gradual and of considerable extent; it is increased by absorption of the upper and lower surfaces of the adjacent bodies. This form of the disease occurs more especially in adults and is often associated with abscess; at first there may be no curvature and later only a gradual bend resulting from the loss of a number of inter-vertebral cartilages. This periostitis may occur either as a primary disease, or may be secondary to a deposit in the substance of the bone which has reached the surface.

Osseous Deposits.—The deposits in the interior of the bone usually commence near the inter-vertebral cartilages, but not actually in connection with them, and rarely affect more than one or two vertebræ. They generally make their way to the surface on the anterior or lateral aspects of the bodies, and, having reached the surface, they spread beneath the periosteum and lead to superficial caries. They may also spread towards the adjacent inter-vertebral cartilage and destroy it either completely or in part. It is only in rare cases that they extend backwards and reach the posterior surface of the body. These deposits destroy the body of the vertebra in which they occur more or less completely, while the weight of the trunk and the contraction of the muscles surrounding the spine cause the vertebræ above to sink down, and thus a curvature results. When only a single vertebra has been destroyed the curvature is very acute. Not uncommonly, however, two or three adjacent bodies are attacked simultaneously, the result being that the curvature is not so abrupt. Perhaps the most common condition is for one or two bodies to be more or less completely destroyed by primary deposits in their interior and, secondarily to this and as a consequence of periosteal extension, the inter-vertebral cartilages of several adjacent vertebræ disappear; in this way a gradual curve is formed affecting a number of vertebræ, with a more acute curve in the centre due to complete destruction of one or more vertebral bodies. When the deposits reach the surface of the bone they often lead to the formation of an abscess either at the sides of the vertebral column or, should they extend backwards, in the spinal canal itself. The deposits in the interior of the bone occur chiefly in children, and are less frequently associated with abscess than is the case with tuberculous periostitis.

In these cases the destructive processes are to a large extent due to osteitis and absorption of the inflamed bone. The inflammation is set up in the first instance by the tuberculous disease, and is then kept up by the pressure of the inflamed bony surfaces against each other; this pressure is partly due to the weight of the head and upper part of the spinal column causing bending of the body forwards at the seat of the disease, and partly to the contraction of the muscles surrounding the spine, which keep the inflamed parts in constant and firm contact. This tonic muscular contraction is of very great importance, because, unless measures are taken to counteract it, the curvature may go on in spite of the use of various forms of apparatus which apparently support the upper part of the spine.

When the disease primarily attacks the transverse or spinous processes, it usually commences as a superficial caries quickly followed by abscess.

SYMPTOMS.—The symptoms of tuberculous disease of the spine are well known and we need not go into them in any detail. In the early stages there is uneasiness and aching in the back, neuralgic pains around

the body or down the limbs, difficulty in bending, difficulty in going downstairs, the occurrence of curvature followed by abscess, nervous symptoms from pressure on the spine, leading to pain, abnormal sensations in the limbs, and ultimately paraplegia. When the case is untreated, abscesses form and burst, and the patient may die from exhaustion due to prolonged suppuration, from phthisis, or from tuberculous meningitis.

Rigidity of the spine is one of the most important early symptoms, and is due to the tonic contraction of the muscles surrounding the affected vertebræ. It is a most important diagnostic point, especially in distinguishing the disease from hysterical affections. The antero-posterior curvature has already been described; in some cases there is a lateral bend in addition to the antero-posterior curve. This is not a true scoliosis, but a lateral bending due to absorption of the bodies of the vertebræ on one side more than on the other.

Abscess.—Chronic abscess is a frequent accompaniment of tuberculous disease of the spine and occurs most commonly in tuberculous periostitis; it is thus more common in adults than in children, and when the curvature is slight or apparently absent than when it is marked. These abscesses form in front of or at the sides of the bodies of the vertebræ, and occasionally in the spinal canal itself; they point in various situations according to the region affected.

In the upper cervical region they usually form in front of the vertebræ and give rise to retro-pharyngeal abscess. In other cases they may extend into the upper part of the anterior triangle, or may pass backwards and point in the sub-occipital region. Lower down in the neck, they usually appear in the lower part of the posterior triangle, or they may project forward beside the œsophagus or trachea; thence they may pass down into the thorax or the axilla.

In the dorsal region the abscesses form inside the thoracic cavity in front of or at the sides of the vertebræ, and they generally make their way backwards between the transverse processes and project in the back, forming dorsal abscesses. In other cases they extend laterally beneath the pleura and pass out between the ribs at the side, or even on the front of the chest, giving at first sight the impression that the case is one of abscess in connection with disease of the rib; indeed the rib may be actually diseased at the point where the abscess becomes superficial owing to infection from the pus. Abscesses from disease in the dorsal region may also pass downwards through the pillars of the diaphragm and, entering the sheath of the psoas muscle, form typical psoas abscesses. Sometimes, though very rarely, they extend into the posterior mediastinum and burst into the pleura or the lung.

In the lumbar region the pus generally passes downwards in the sheath or substance of the psoas muscle, forming a psoas abscess, or it may extend backwards and form a lumbar abscess. When the last

lumbar vertebra is affected, the pus may collect in the iliac fossa and point above the outer part of Poupart's ligament. Sometimes, though rarely, it passes downward into the pelvis, and then backwards through the sacro-sciatic notch or the obturator foramen; the abscess then points in the buttock, the back of the thigh, or even the perineum.

Pressure symptoms.—The disease may also exert pressure upon the spinal cord. In a considerable proportion of cases pressure symptoms become manifest after a time, and lead to interference with the innervation of the parts below the seat of the disease. This pressure originates in two ways, the most common being the development of pachymeningitis, the dura mater becoming infected and thickened; the thickened membranes fill up the spinal canal and press on the cord. In rarer cases an abscess forms in the spinal canal outside the dura mater, and, projecting backwards, compresses the cord against the laminæ. In the latter case the pressure symptoms may suddenly subside when the abscess is opened externally, as the internal abscess communicates with and empties itself into the external one. It is very doubtful whether interference with the functions of the cord is ever caused by the acuteness of the curvature, though some have supposed that, when the bend is very acute, the cord may be stretched over the bodies of the vertebræ and pressed upon, or that a spicule of bone may compress the cord; it has also been supposed that, under similar circumstances, the symptoms may arise from kinking of the cord and interference with its circulation. It is possible that some cases may arise in this way, but in the great majority one of the conditions just mentioned leads to the paralysis. If the pressure on the cord is not relieved, myelitis occurs at the seat of compression, the cord becomes flattened, softened, and in some cases almost diffluent, and secondary degenerations spread from this point. The nerves passing out through the inter-vertebral foramina about the seat of the disease may also be pressed upon and undergo structural alterations.

TREATMENT.—The treatment will have to be modified to some extent according to the region affected, but we shall first discuss the treatment of spinal disease in general and then refer briefly to certain special points.

TREATMENT OF SPINAL DISEASE IN GENERAL.

The first essential in the treatment is to place the affected part absolutely at rest and to remove all sources of irritation as far as possible. To effect this it is necessary to prevent antero-posterior and lateral movement, to take off the weight of the upper part of the body, and to put a stop to the tonic contraction of the muscles of the spine surrounding the diseased area. These requirements may be met by rest in the recumbent posture, extension of the spine and fixation in suitable forms of apparatus.

Rest.—At the commencement of the treatment it is best to put the patient to bed and keep the spine absolutely at rest for from six to twelve months. In this way the condition of the spine can be carefully watched, while extension to overcome the tonic contraction of the muscles can be efficiently applied. The patient should lie on his back: the prone position, which was formerly adopted, being objectionable in every way.

The bed should be firm, otherwise the body is apt to sink in the middle, and the pressure will not be taken off the diseased part. The mattress should be of hair, and fracture boards should be placed beneath it; it is well to have two mattresses, one on the top of the other, so as to diminish the hardness of the bed. The upper one should be divided into three parts, and the narrow portion beneath the pelvis is further divided into two halves (see Fig. 115), each with a separate sheet. When the bed-pan is used, one half of the mattress is pulled out, and the bed-pan substituted for it, and then the other half is gradually withdrawn as the bed-pan is pushed into position. Any acute prominence of the spine, or any part where a bed-sore is threatened, can be protected by ring or oval pillows. No pillow or bolster should be placed under the head; at the most a soft pillow may be put under the neck; in disease in the lower lumbar region, however, the head may be raised but not the shoulders. The thighs must be kept horizontal and fixed. If they are free, the psoas muscle is thrown into action every time they are drawn up and the spine is constantly moved.

The body and limbs should be fixed between sand-bags. A long heavy sand-bag should extend on each side from the axilla to the sole of the foot, and a shorter one on the inside of each leg from the perineum downwards. The patient is fixed by placing a strong draw-sheet over the thorax and abdomen, and another over the thighs and legs. The heavy sand-bags are then placed over the draw-sheet along the outer sides of the body from the axillæ to the feet and the smaller ones along the inside of the limbs; the ends of the draw-sheets are then wrapped around the sand-bags.

In disease of the cervical region, the head and neck must also be placed between short broad sand-bags. In very restless patients it may be advisable to mould a light plaster of Paris casing over the front and sides of the trunk so as to control movement more efficiently.

Extension.—One of the most valuable factors in the treatment of spinal disease at all stages and in all situations (except perhaps the lower lumbar region), is extension to the head and lower extremities. It is carried out as follows: the ordinary extension apparatus (see p. 166) is attached to both thighs and in children a weight of about three pounds is affixed to each leg to begin with, the limbs being somewhat abducted; in adults a little more weight may be employed. A similar weight is attached to the head by means of a chin-strap and an occipital band

meeting above the ears and continued up to a pulley at the head of the bed (see Fig. 115). As a rule three pounds is as much as can be borne comfortably at the head. It is not, however, necessary or desirable to have powerful extension, because the object is not to stretch the spine but to tire out the contracted muscles around the focus of the disease, and a light weight acting constantly will suffice for this purpose. The combination of double extension with absolute fixation of the spine is in our opinion the ideal treatment for spinal disease during the progressive stage and in all parts of the spine.

It might be thought that the general health would suffer from the confinement to bed, but the contrary is the case. The immediate cessation of the inflammatory process and the pain, leads to improvement in health, appetite, and general condition, and if the patient is kept under good hygienic conditions, the general health will not suffer for a long

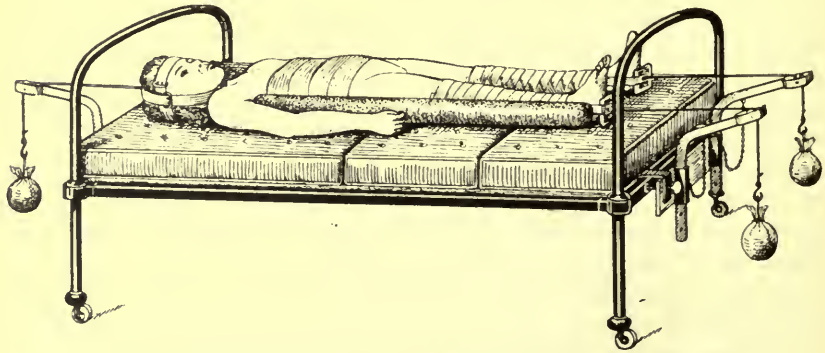


FIG. 115.—DOUBLE WEIGHT-EXTENSION FOR SPINAL CARIES. The long sand-bag reaching from the axilla to the ankle is shown, as is also the divided mattress. The patient should be farther down in the bed than is shown in the figure; the pelvis should lie over the middle segments of the mattress.

time. When improvement in these respects does not follow confinement to bed, it usually means either that efficient rest is not being given to the affected part or that some grave visceral disease is present as well.

This treatment should be carried out until the pain in the spine has disappeared and the signs of active disease have passed off. Several months will be necessary, and in children this line of treatment should be continued until the disease is cured, because in them it is impossible to fit on a satisfactory spinal support owing to the non-development of the pelvis. As the disease becomes quiescent, however, arrangements should be made by which the child may be carried about and moved out of doors. Among these may be mentioned Gauvain's tray, plaster of Paris casings, Phelps's box, and a double Thomas's splint.

Gauvain's tray.—A very valuable method of securing complete immobility of the spine is that used at the Hôpital Maritime, Berck-sur-Mer, and at the Treloar Home at Alton. The details of this plan are given in

full in a paper by Mr. Gauvain on the ' Mechanical Treatment of Spinal Caries,' published in the *Lancet* on March 4, 1911.

We may mention the main points: The patient is fixed on a board resembling a Phelps's box, except that it is not divided for the legs (see Fig. 116). The foot end is much higher than the sides so as to take the weight of the bed-clothes off the feet and thus prevent the onset of foot-drop. The bottom of the board is perforated with holes to ventilate the mattress. Beneath the most prominent part of the angular curvature, a piece of wood, from two to four inches in height and about the same width, is fixed across the board from one side to the other; its place, however, may be taken by a firm pillow. The object of this is to produce hyper-extension of the spine. A firm horse-hair mattress corresponding in length to the trunk of the patient is placed over the tray. Extension is arranged for by slits at the upper and lower ends of the frame, through which elastic webbing, attached to the head and legs can be carried. A jacket composed of stout jean and stiffened with whalebone is fitted accurately to the body of the patient. On the back of the jacket two strips of webbing, crossing each other in the form of a St. Andrew's cross, are let in; they are buckled to the sides of the board and keep the patient in the exact position required. In cases of cervical caries a bridle is fixed to the head of the patient and attached by elastic straps to the upper end of the board.

FIG. 116.—GAUVAIN'S TRAY FOR SPINAL CARIES. The description of the tray is given in the text. The stout jean corset is seen attached to the crossed strips of webbing. (*From a photograph by Mr. Gauvain.*)

The chief disadvantage of the board, in the form described above, is the difficulty of getting at the back without disturbing the patient unduly, and the risk of bed-sores over the points of pressure, especially if a transverse bar of wood is employed. To prevent the latter occurrence it is necessary that the back should be frequently attended to, and this naturally involves considerable movement. Mr. Gauvain has therefore introduced an additional splint, which he terms a ' back-door ' splint (see

FIG. 117.—GAUVAIN'S 'BACK-DOOR' SPLINT FOR SPINAL CARIES. The metal frame (which is shown also in Fig. 121) is seen attached to the child's trunk. The padded 'door' has been removed and is seen on the left of the figure. (*From a photograph by Mr. Gauvain.*)

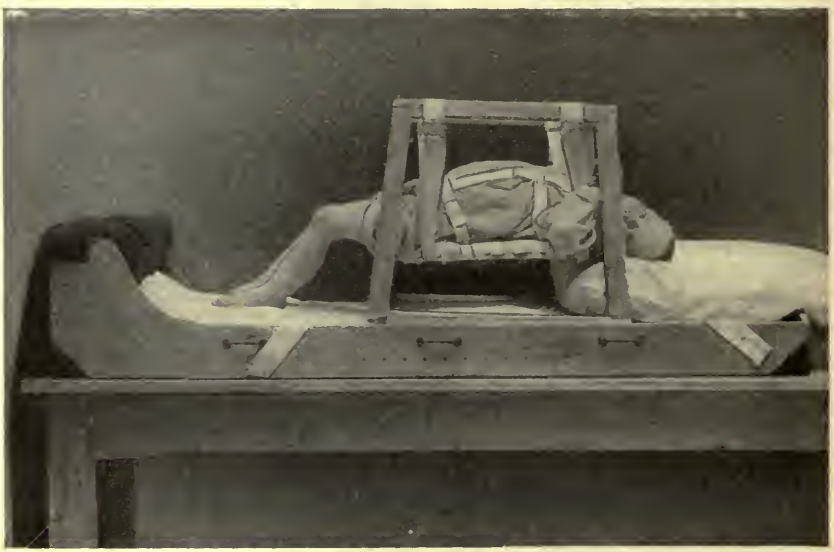


FIG. 118.—GAUVAIN'S SWINGING SPLINT FOR SPINAL CARIES. This is the same splint as in the preceding figure, suspended from a wooden cradle. By its means very efficient hyper-extension can be produced. (*From a photograph by Mr. Gauvain.*)

Fig. 117). This consists of a frame about an inch in width, slightly smaller than the back of the trunk, crossing the body below at the level of the natal fold and extending up to the neck. Into this frame a suitably padded board is fixed, and this can be removed and replaced whenever it is necessary. The frame is fixed to the patient, either by a jacket which is attached to the inner edge of the outer frame or by webbing. The jacket is strapped and laced over the front of the patient, or if webbing is used, one piece should pass over each shoulder and two pieces should be carried round the trunk, all of these being fixed to the inner edge of the outer frame of the splint (see Fig. 121). The patient is thus firmly

Fig. 119.—Gauvain's Spinal Carriage. (*From a photograph by Mr. Gauvain.*)

attached to the splint; he can be turned over on his side, the back door taken out, and the back washed and powdered as often as is necessary. The back door is padded convexly, so as to provide hyper-extension. This splint may be suspended over the board, the weight of the head and the limbs producing additional hyper-extension (see Fig. 118).

Figs. 119 and 120 show a simple and inexpensive carriage, designed by Mr. Gauvain, for transporting children in these splints about the house or into the open air. It can be arranged so that the child can read, play with his toys or take part in a school class. Figs. 121 and 122 show an excellent splint used by Mr. Gauvain which has adjustable leg splints.

Plaster of Paris jackets.—The application of jackets made of plaster of Paris has very largely fallen into abeyance, chiefly because they were improperly applied, and because the patients were allowed to walk about. A distinct disadvantage of these jackets is that the regions in which abscesses may occur are not open to inspection. They are, however, most valuable in suitable cases.

FIG. 120.—GAUVAIN'S SPINAL CARRIAGE ARRANGED FOR READING. (*From a photograph by Mr. Gauvain.*)

The plaster jacket should be put on while the child is suspended in a special apparatus (Fig. 123). If the disease is in the dorso-lumbar region, the plaster may be applied whilst the child is recumbent, but in all other regions, suspension should be employed. When the cervical or cervico-dorsal spine is affected, care should be taken to see that the head is hyper-extended during the moulding of the plaster, which should support the chin and occipital region (Fig. 124).

The patient should be carefully dieted for two or three days, and the

bowels thoroughly evacuated on the day preceding the application of the plaster. Much discomfort and abdominal pain or distension will thereby be prevented.

A well-fitting vest is first put on the chest and abdomen. Between the

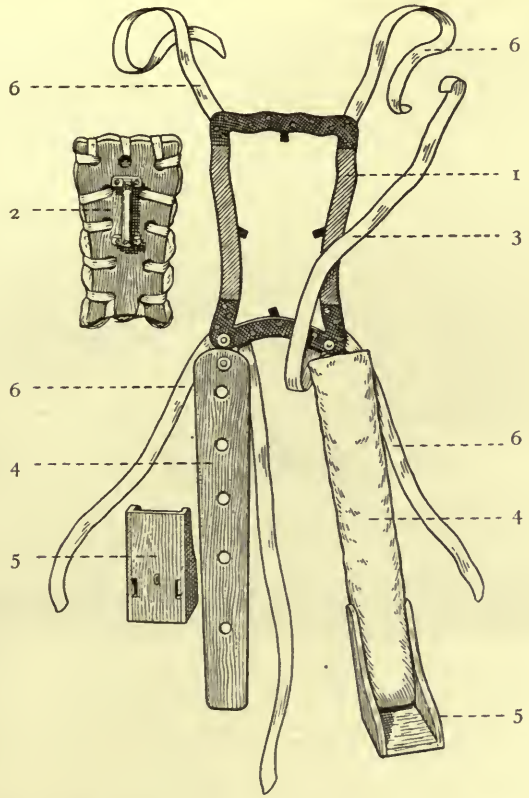


FIG. 121.—GAUVAIN'S 'BACK-DOOR' SPLINT WITH ADJUSTABLE LEG-PIECES. (*From a photograph by Mr. Gauvain.*) (1) Outer frame with clips for holding back-door. This frame is unpadded so that the manner in which it is strengthened with japanned sheet-iron may be shown. (2) Back-door reversed to show handle and tapes which fasten the padding. (3) One of the perineal straps; these straps are padded where they are in contact with the ischial tuberosities. (4) Back splints for legs; so attached to outer frame that they may be abducted, adducted, and hyper-extended, but not flexed or rotated. (5) Adjustable foot-piece through which leg-extension may be applied if desired, and which prevents foot-drop, eversion, and inversion. (6) Straps for fixing the splint to the bed or to a spinal board. The straps or jacket for fixing the patient to the splint not shown (see next figure).

vest and the anterior abdominal wall a large pad of wool is inserted, so as to allow for contraction during the setting of the plaster. It is well to place another pad of wool over the prominent spinous processes. In mixing the plaster cold water should be used in preference to hot, because the jacket is then more durable, though the setting takes longer than

when hot water is employed. The plaster bandages should be put on rather obliquely so as to avoid constriction ; they should not be reversed. Where necessary an additional quantity of plaster may be rubbed in at the points of greatest strain. The moulding is done when the plaster is beginning to set, and special care must be taken to mould the jacket to the crests of the iliac bones.

The places at which windows are to be cut are then marked out (see Fig. 124). The object of these windows is to allow free respiration, to permit abdominal movements, and to afford the opportunity of inspecting the diseased region of the spine ; they should be cut within two

Fig. 122.—Gauvain's Wheelbarrow Splint for Spinal Caries associated with Psoas Abscess or Psoas Spasm. This splint hyper-extends and immobilises the spine and simultaneously stretches and fixes the psoas muscles. Spasm of the psoas muscles can always be overcome by this method of fixation, and psoas abscesses may disappear without further interference. The patient is kept always on the splint during this stage of treatment and may be bathed easily without being moved. The back is washed and powdered through the back-door every six hours. The legs are abducted when the bed-pan is in use ; they are permanently hyper-extended. The night-shirt is worn split down the back to facilitate access. (*From a photograph by Mr. Gauvain.*)

or three days after the application of the casing. Plaster jackets made in this way will last from three to six months, but when the child is growing they must be changed oftener.

Phelps's box.—This is a wooden tray made to fit the body of the patient, with two narrow troughs diverging from each other below to receive the lower extremities (see Fig. 125). The box should be somewhat broader than the patient, so as to allow for the insertion of lateral pads, while he lies upon a mattress so arranged as to prevent undue pressure upon the curve. The floor of the tray is cut away opposite the buttocks so as to permit of defæcation without taking the child out of the splint ; a well-padded circle of wood may be fixed into this opening

after the child has been attended to. The sides of the tray are about six inches high for the trunk and less for the legs ; they are hollowed out opposite the axillæ so as to allow free play for the arms. The feet are bandaged to vertical foot-pieces, a pad, of course, intervening. The box should be about eighteen inches longer than the patient, so as to leave a

Fig. 123.—Application of a Plaster of Paris Jacket. The child is suspended, as shown in the figure, and stands upon tip-toe, steadying himself by the side handles. The plaster bandages are then applied over a vest in the manner depicted above. (*From a photograph by Mr. Gauvain.*)

space above the head for elastic extension by means of bands attached beneath the chin and occiput (see Fig. 126) and carried over the top of the splint. The patient is carefully wedged in with lateral pads and bandaged to the splint.

In this apparatus the child lies at absolute rest, and is easily carried about. Further, if head extension is applied and the lateral pads are

firmly adjusted, the box may be tilted up so that the patient may look out of a window, etc. Defæcation and micturition are performed without any disturbance. By undoing the bandages, the front, sides, and limbs of the child are easily washed without moving him, and when it is necessary to wash the back the apparatus is turned upside down on a bed, the bandages undone, and the splint lifted off the child. He is replaced in the reverse manner, and not by lifting him into the box. Children should be kept in this apparatus for at least two or three years. The whole apparatus with mattresses costs from 15*s*. to 20*s*. and is a most valuable one ; in private practice the boxes can be made more elegant by having the sides of strong wicker-work, the bottom remaining wood.

FIG. 124.—THE PLASTER OF PARIS JACKET FINISHED. This is the same child as shown in the preceding figure. The jacket is trimmed away above and below, and the large abdominal window to allow of free breathing and feeding has been cut out. (*From a photograph by Mr. Gauvain.*)

Thomas's double splint.—An apparatus in some ways more convenient, but by no means so efficient, is a Thomas's double splint, which is provided with a pelvic band and a head-rest, the interval between the two upright bars from the buttocks upwards being filled in with strong canvas.

Jackets and braces.—When the disease is in the lumbar, dorso-lumbar, or the cervical region in adults, it may be treated from the first with spinal supports, but it is better, if possible, to employ absolute recumbency with double extension for six to nine months in the first instance. With perfect recumbency and extension, the inflammatory material will become organised and, to some extent, ossified in a few months, and a suitable apparatus may then be applied. This may take the form of plaster or poroplastic jackets, or, still better, spinal braces.

Jackets.—In the case of children, after recovery has taken place, a light poroplastic jacket worn for a few weeks gives a feeling of security and prevents too sudden use of the spine, and is, therefore, of some advantage ; but at an earlier stage, as a support for the spine

in children, if the patient is allowed to be up and about, it is not only useless, but positively harmful. In adults, however, when the disease is in the lumbar or dorso-lumbar regions and is not extensive, Sayre's plaster of Paris jacket, put on while the patient is suspended from the tripod, may act fairly well; when a removable apparatus is desired, a poroplastic jacket may be substituted. These jackets are not, however, so efficient as the various forms of 'braces,' and should only be used when the latter cannot be obtained.

Braces.—The idea that the thorax should be lifted up and supported by a jacket taking its bearing from the pelvis is quite wrong, and in practice it is found that jackets are inefficient and useless except in cases in which recovery is practically complete. It must be remembered that the articular processes, the laminæ, the spines, and their ligaments, remain intact although the bodies of the vertebræ are destroyed, and that the upper part of the spine falls forward and does not descend bodily; the object of a proper apparatus therefore is not to push up the upper part of the trunk as a whole, but to prevent the upper part of the spine from bending forwards on the pivot formed by the articular processes, etc., and thus crushing the softened bodies together. The principle of the brace is to place a bar on each side of the spine behind, having a fixed point at the pelvis and a fulcrum at the seat of the disease, and then by an apron over the front of the thorax to pull back the upper part of the spine to these bars.

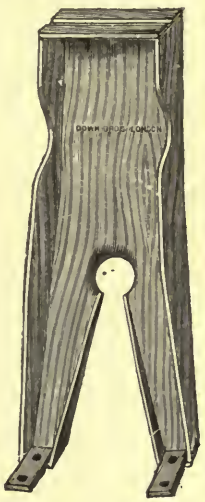


FIG. 125. — PHELPS'S BOX. The splint is here shown without the pads; in the next figure it is shown in use. The holes in the foot-pieces and the slit in the upper end of the splint, through which extension and counter-extension can be made if desired, are seen here, as are also the hollows in the sides of the box over which the child's arms can lie.

Taylor's Brace.—We may quote the description of Taylor's brace from Bradford and Lovett's 'Orthopædic Surgery': 'In the first place, a tracing of the back is made. This is done as follows: The patient lies upon a hard surface, and a strip of flexible metal (lead, or a mixture of lead and zinc), strong enough to retain its position and pliable enough to be readily bent, is laid upon the back, from the neck to the sacrum, so as to accurately fit the lines of curve, presented by the spinal column. The lead is removed, laid on its side upon a piece of stiff cardboard, and the inner outline traced. . . . The simplest antero-posterior apparatus consists of two uprights of annealed steel three-eights or one-half of an inch in width, and thick enough to be rigid. The gauge numbers of the steel as to thickness should be eight to twelve. These uprights should reach from just above the posterior superior iliac spines to about the level of the second dorsal vertebra. The uprights are joined together

FIG. 126.—METHOD OF APPLICATION OF PHELPS'S BOX. The child lies upon suitable firm cushions made to fit the splint; other similar ones are inserted between the sides of the splint and the body. The legs are kept in their respective troughs by bandages, and the thorax is encircled by a broad towel or folded sheet over the splint. The sketch shows the head fastened to the end of the splint by a headstall, and the child's weight allowed to tell upon it by raising that end of the splint. This produces moderate extension, which is most useful in cases of disease high up. If more powerful extension is required, it can be obtained either by attaching strong india-rubber door-springs on either side of the head of the splint, in place of the buckle shown in the figure, or a cord and a pulley as in Fig. 115.

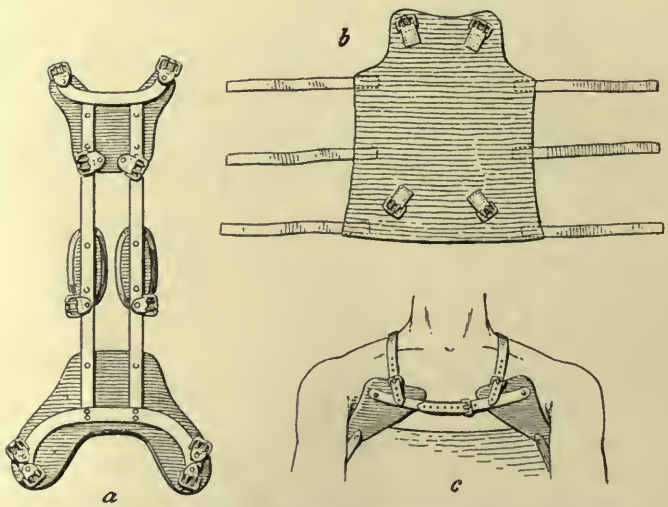


FIG. 127.—TAYLOR'S BRACE. The instrument is shown before application. *a*, The spinal support; *b*, the apron; and *c*, Dr. Taylor's chest-piece. The full description of all these will be found in the text. (*After Bradford and Lovett.*)

below by an inverted U-shaped piece of steel, which runs as far down on the buttocks as possible without reaching the chair or bench when the patient sits down. . . . The uprights are jointed above by another U-shaped piece, the upper ends of which should pass over to the anterior aspect of the elevation of the shoulders, or rather to the root of the neck.

'The uprights should be far enough apart to support the transverse processes of the vertebræ and not the spinous processes. They should be bent according to a card-board tracing of the back, taken as described, and then adjusted to the back. The neck and bottom pieces should be cut out in cardboard to pattern. The whole should then be riveted together and tried on the patient, who should be lying on his face in the recumbent position. Any alteration necessary in the curves of the steel in order to have the appliance fit closely to the back along its whole length can be made with wrenches. The brace can then be wound with strips of Canton flannel, faced with hard rubber and covered with chamois, or be covered smoothly with leather. An accurate fit is essential; the covering is merely a matter of detail.

'Pad-plates covered with felt or hard rubber are needed. In some instances, at the points of greatest pressure (the fulcrum of the lever, etc.), the bars of the brace, if well padded, answer every purpose. Buckles are needed at the ends of the neck-piece, at a level with the axilla, opposite the middle of the abdomen, and at the lower end of the brace. . . .

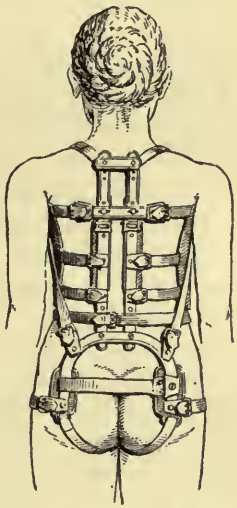
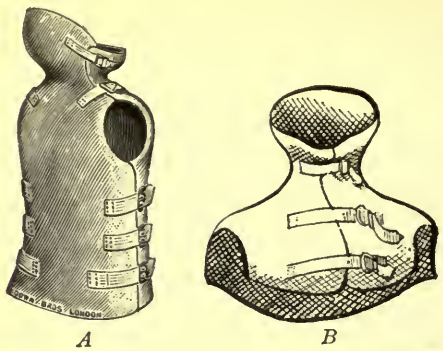


FIG. 128.—TAYLOR'S BRACE APPLIED. (*After Bradford and Lovett.*)

'It is, of course, essential that the trunk be properly secured to the brace. This can be done by means of an apron which covers the front of the trunk, the abdomen, and the chest, reaching from the clavicles nearly to the symphysis pubis. The apron is provided with webbing (non-elastic) straps, which are fastend into buckles attached to the brace. Padded straps passing from the top of the brace, around the arms, under the axillæ, and attached to buckles in the middle of the brace, help to secure it; but the scapulæ, being movable, cannot be relied upon alone to fix the trunk, and the apron must be furnished with straps at the top, which pass over the shoulders to buckles in the top of the brace.

'In adults, it is often convenient to have the apron split down the front and provided with webbing straps and buckles. It can then be adjusted by the patient himself without touching the straps at the back, which secure the apron to the brace.

'A useful addition in certain cases of dorsal caries is found in the use of Dr. Taylor's chest-piece. By means of hard rubber pads a definite counterpoint of pressure is furnished at the upper part of the chest which keeps the brace closely against the back. The pads of the chest-piece may be made of hard rubber and fit in below the clavicles where they cause no discomfort, and restrict the chest movements less than the apron, besides affording more definite support.



A *B*

FIG. 129.—POROPLASTIC COLLARS FOR SPINAL DISEASE. *A* is a good form of apparatus, taking its support from the pelvis and enclosing the entire thorax. It is easily seen that *B* is a faulty form, as it allows a certain amount of movement of the entire apparatus, which rests upon the shoulders.

'The brace should be worn day and night, and removed daily that the back may be bathed. While the brace is off, the patient should lie on the face or the back. On no account should he sit erect. The back after being washed should be rubbed with alcohol and then powdered with face-powder, corn-starch, or fuller's-earth. The brace should then be applied and buckled tightly in place.

'Chafing of the back is sometimes unavoidable in summer. When a severe chafed spot forms, the brace must be removed for the time, and the child lie flat in bed till the ulcer heals.'

Collars.—When the disease affects the cervical region and the patient is allowed to walk about, the best arrangement is a collar supported from the pelvis and shoulders, and grasping the head so as to fix and support it. There are several kinds of collars which act very well; a very simple and efficient one can be made of poroplastic material. The essential basis of support should be the pelvis (see Fig. 129); a poroplastic jacket should extend upwards from a pelvic band, grasping the thorax, covering the shoulders, and expanding above to receive the head. Flexion of the cervical spine is thus effectually prevented, which is not the case when the apparatus rests on the shoulders alone or even when it is fixed round the thorax. Another very good arrangement is to attach a steel ring to a Taylor's brace by an upright

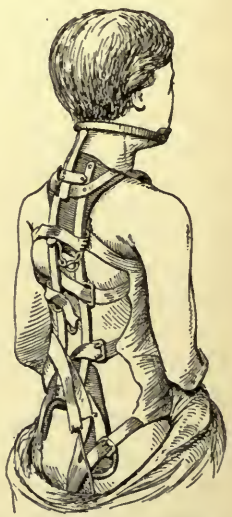


FIG. 130.—TAYLOR'S BRACE AS MODIFIED FOR USE IN CERVICAL SPINAL DISEASE. This is the ordinary brace, to which is added the metal ring supporting the chin which is fixed to an upward prolongation of the spinal support. (*After Bradford and Lovett.*)

rod, the ring being made to open in front, and arranged so as to act as a rest for the chin and occiput, counter-pressure being arranged at the upper part of the dorsal region (see Fig. 130).

THE TREATMENT OF COMPLICATIONS.

The two chief complications of spinal disease are paralysis and abscess.

Paralysis.—When paralysis is present or is threatened, we are strongly of opinion that double extension should be rigorously employed in the first intance ; in a large number of cases in which we have used this method it has acted like a charm, the paralysis being very rapidly recovered from without any necessity for operative interference. In children improvement may be noticed within three days from the commencement of the extension, and may progress steadily to complete recovery. Mere recumbency in bed, however rigidly the spine may be fixed, is not sufficient. The double extension acts by tiring out the muscles and preventing their tonic contraction and, as a result, the inflammation of the vertebræ and the secondary inflammation of the membranes is arrested and absorption of the inflammatory products very quickly occurs. The marked benefit of double extension as compared with simple rest in bed shows what an important part this tonic contraction of the muscles plays in keeping up the disease. Even in old-standing cases of paralysis, we think that a fair trial should be given to double extension for several weeks before proceeding to operative measures. In our experience laminectomy will only be required in a very small percentage of cases.

Laminectomy.—Certain cases remain, however, in which laminectomy is the only treatment which promises relief ; such are the presence of abscesses or masses of caseous material in the spinal canal, or constriction of the cord from thickening of the dura mater around it, *i.e.* pachymeningitis. The operation of laminectomy has already been described (see Vol. II. p. 131). On opening the spinal canal one or other of the conditions already mentioned should be looked for, more especially the presence of pus in front of the cord or thickening of the dura mater. Pus must be evacuated if present ; spicules of bone should be removed, and any soft granulation tissue or cheesy material in front of the cord scraped away. If pachymeningitis is present, the dura mater should be slit down in the middle line posteriorly so as to relieve the pressure on the spinal cord.[1] In these cases the laminæ and spinous processes must be removed altogether ; if replaced, they are apt to become affected with tuberculous disease.

[1] If the dura mater is left open, great care must be taken for the first few days to prevent any excessive escape of the cerebro-spinal fluid. The patient should lie with the head low and the foot of the bed raised on blocks.

Abscess.—We have already described the treatment of chronic abscess generally (see Vol. I. p. 233) ; in spinal disease we usually adopt the plan of washing out and scraping the abscess, injecting iodoform and glycerine, and stitching up the skin wound again, or else we employ repeated aspiration with or without injection of various fluids. It is only in abscess connected with posterior disease, especially of the spines, or in some rare cases of cervical abscess, that one can dissect out the abscess wall and deal with the diseased bone. The abscess should be opened at the point which gives the freest access to the whole cavity, but at the same time the opening should be made as far as possible from sources of contamination so that, should union by first intention fail, the dressings are not likely to be soiled.

The best situation for opening a *retro-pharyngeal abscess* is behind the sterno-mastoid ; it should never be opened from the pharynx. An incision is made parallel to the upper third of the posterior border of the sterno-mastoid muscle, above the point of exit of the spinal accessory nerve ; after dividing the deep fascia, the muscle is lifted up, and the finger or a blunt instrument is gradually insinuated behind the vessels and in front of, and close to, the transverse processes and bodies of the vertebræ, until the abscess cavity is reached and the pus let out. A sharp spoon is then introduced and the abscess wall thoroughly scraped, care being taken not to perforate the wall of the pharynx ; sometimes the actual focus of disease in the spine can be reached, and a sequestrum or a caseous deposit removed. A small quantity of iodoform and glycerine is then injected, and the wound stitched up. Should the cavity fill up again or should healing fail to occur, it is easy to open up the wound and repeat the process, or insert a tube.

When the disease is in the *lower cervical region* and the abscess is in the posterior triangle, the greater part of the wall can usually be removed and the affected bone scraped or gouged away.

When the disease affects the dorsal vertebræ, the pus accumulates in many cases in the posterior mediastinum, pushing forwards the pleura. A radiogram will often reveal the presence of a large collection of pus in this situation, even although there are no external signs of it. The operation of *costo-transversectomy* may be advantageously performed under these circumstances. A curved incision is made over the site of the abscess on one side of the spinous processes, the centre of the incision being opposite the most prominent spinous process (see Fig. 131). The transverse processes which are removed should belong to the vertebræ which are most diseased—that is, those nearest the maximum point of curvature —and, when possible, the operation should be done on the right side. A radiogram will often indicate on which side the operation should be performed, as frequently the pus is shown to be more on one side than on the other. The muscles are detached from the spinous and transverse processes of the vertebræ most affected, and are then pulled outwards

by a retractor. The transverse processes of three or four vertebræ are cut through with bone-scissors or forceps as close to their origins as possible (see Fig. 132); the ligaments uniting the apices of these transverse processes to their corresponding ribs are then severed. Any remaining fibrous connections between the ribs and the transverse processes are divided and the latter structures removed. After the removal of the transverse processes, the posterior extremities of the corresponding ribs come into view. They should be divided as near as possible to the bodies of the vertebræ, and an inch and a half to two inches should be removed. The severed portions are lifted out of the wound, and the abscess wall is exposed. The pleura may be seen in the outer part of the wound, and care must be taken not to damage it (see Fig. 133). After gauze packing has been placed over the margins of the wound, an incision is made into the abscess, its walls are gently scraped and the cavity is washed out. Iodoform and glycerine is then injected,

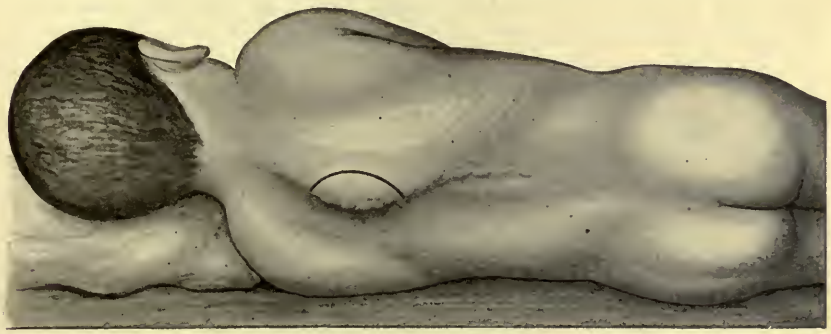


Fig. 131.—The Incision for Costo-transversectomy.

the deeper parts of the incision are brought together by catgut sutures, and the superficial parts of the wound closed without drainage. The operation is not a difficult or severe procedure; hæmorrhage is easily controlled, and if the normal relations of the important structures in the mediastinum be remembered, there is no great risk of damaging them. If the pus re-accumulates, the operation may be repeated through the same incision.

When paraplegia is present as well, it may be possible to relieve this by removing a portion of the bodies of the vertebræ after the pus has been evacuated. The granulation tissue outside the dura should be exposed, and may be removed by gentle scraping with a sharp spoon. When the paraplegia is due to the presence of pus outside the spinal cord, the evacuation of the pus from the mediastinum may lead to the relief of the pressure on the cord.

In *psoas abscess*, the best incision is just internal to the anterior superior spine; if necessary a second incision can be made farther back

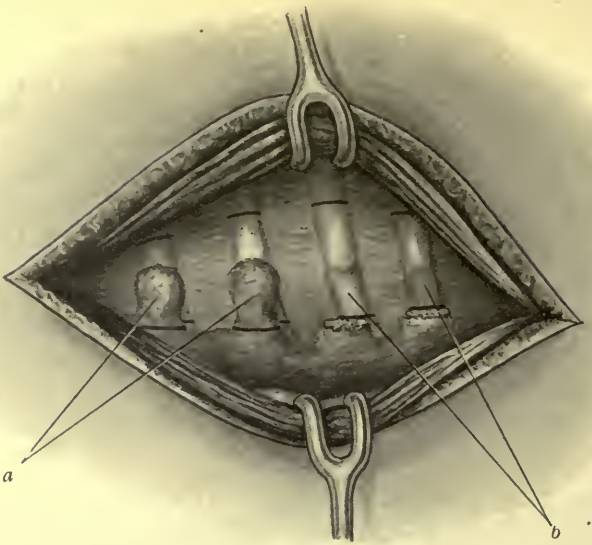


FIG. 132.—REMOVAL OF THE TRANSVERSE PROCESSES IN COSTO-TRANSVERSECTOMY. *a*, The transverse processes with the line of section marked upon them; *b*, the ribs, also marked by the lines of section.

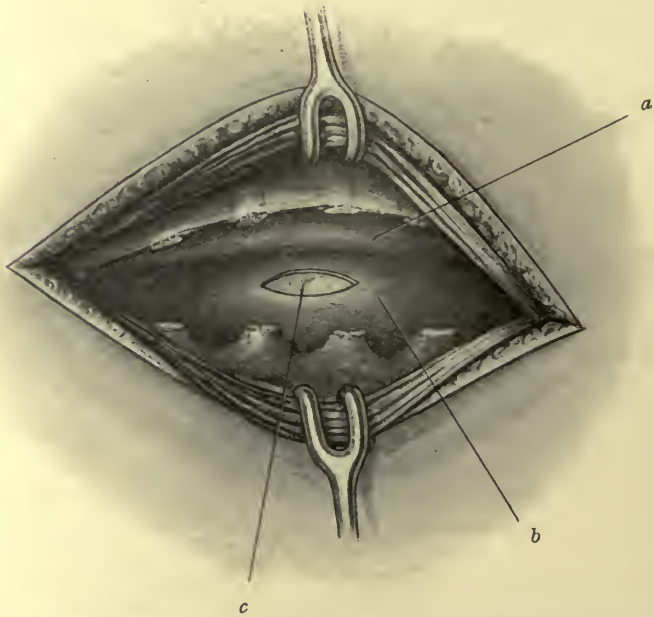


FIG. 133.—EXPOSURE OF THE ABSCESS IN COSTO-TRANSVERSECTOMY. The ribs and transverse processes have been removed. *a*, The pleura; *b*, the covering of the abscess, formed by the anterior common ligament and connective tissue, which has been incised to show the caseous material and pus, *c*.

over the crest of the ilium, in order to facilitate access to the bone in cases of disease of the lumbar vertebræ. It is, however, impossible to deal satisfactorily with the bone disease in this region; in the first place it is too far away, and in the second place it is too extensive, and not sufficiently limited to one side to allow it to be properly dealt with. Sequestra may, however, be removed in some cases through the upper incision.[1]

TREATMENT OF THE DISEASE IN SPECIAL SITUATIONS.

The variations in treatment according to the situation of the disease have been already indicated, to some extent. *In disease of the upper cervical spine* complete recumbency should be enjoined until the case is practically well. In the later stages, however, when there is no longer any pain on movement and the patient is evidently in a fair way to recovery, he may be allowed to get about with a suitable apparatus. Of these the best are Taylor's brace with a ring support for the head (see Fig. 130) or a plaster of Paris casing surrounding the trunk and supporting the head (see Fig. 124). The jury-mast, which is so commonly used, is practically of no value.

In the cervico-dorsal or upper dorsal region a neck collar is absolutely essential if the patient is to be allowed to walk about, but we would strongly advise that he should be kept lying flat until he is well. *In disease lower down* in children the patient should be kept in Gauvain's tray, a Phelps's box, or a double Thomas's splint with a head-piece, until recovery has taken place; but an adult may be allowed to get about wearing a Taylor's brace after the acute symptoms have passed off.

DISEASE OF THE SACRO-ILIAC SYNCHONDROSIS.

This disease may be primary or it may be secondary to disease of the lower lumbar vertebræ; it is often combined with lumbo-sacral disease. When secondary to lumbar disease, the disease of the synchondrosis usually commences as a periostitis of the ilium or sacrum. When it begins primarily in connection with the joint, it generally takes the form of a deposit in the sacrum or ilium, usually in the former; as these deposits enlarge they invade the articulation. The interosseous ligament is usually only partially destroyed, but it sometimes remains intact.

SYMPTOMS.—The first symptom is pain in the lumbar region, which is worse after exertion; there is often also pain in the buttock or along the sciatic nerve. There is generally some swelling over the joint behind, and the muscles of the buttock waste. The patient limps, the

[1] Upon the question of the removal of sequestra through a lumbar incision, the original paper by Sir Frederick Treves, in the *Med. Chir. Trans.*, vol. lxvii., may be consulted.

limb on the affected side being apparently longer than the other because the pelvis is tilted downwards. Pain may be elicited by pressure over the joint behind, or by grasping the anterior superior iliac spines and trying to separate them. As time goes on, the pain and difficulty of movement increase, the leg often becomes swollen from pressure on the iliac vein, and abscesses form in various situations in front of, or behind, the joint; if behind the joint, they point there, but they generally form in front, and may then burrow in various directions. For example, they may track upwards and point above the crest of the ilium, backwards through the sacro-sciatic notch into the buttock or the thigh, downwards through the obturator foramen or into the perineum, or outwards into the iliac fossa or along the sheath of the psoas muscle into the thigh.

In young subjects, when recovery takes place, anchylosis follows, and oblique deformity of the pelvis is apt to result.

TREATMENT.—The first essential is rest in the recumbent posture between sand-bags, or better, in some arrangement like Phelps's box (see p. 302); no satisfactory apparatus has been constructed to allow the patient to get about. The actual cautery applied behind the articulation before suppuration has taken place is sometimes of use. When *operative interference* is desirable, the joint may be got at from behind, and portions of bone chiselled away until the disease is reached. A long curved incision is made posteriorly, with the convexity running along the middle of the sacrum and going well above the crest of the ilium and downwards over the sacro-sciatic notch. The flap of skin and fascia and the gluteal muscles are turned outwards. A chisel is then applied to the ilium, and the sacrum and ilium are chiselled away until the whole joint is excised or the bone deposit is found and removed. Great care must be taken as the anterior surface is approached, on account of the vessels. In some cases the disease may be reached more conveniently by enlarging the sciatic notch upwards.

CHAPTER XXVIII.

SPONDYLITIS DEFORMANS: ACUTE OSTEO-MYELITIS: ACTINOMYCOSIS: NEW GROWTHS OF THE SPINE: HYSTERICAL SPINE: SACRO-COCCYGEAL TUMOURS.

SPONDYLITIS DEFORMANS.

This is the name given to chronic osteo-arthritis of the spine, which usually occurs in persons past middle age. Alterations take place in the articular surfaces similar to those found in other joints, and outgrowths occur around the margin of the inter-vertebral discs. Osteophytes also form in connection with the transverse processes, and there is a tendency to ossification of the ligaments and anchylosis of the vertebræ. The spine usually assumes a uniform kyphotic curve, and is rigidly fixed.

The symptoms are mainly great pain and increasing rigidity, the pain not being limited to the spine itself, but following the course of any nerves which may be pressed upon as they pass out of the spinal canal.

TREATMENT.—The condition is a very hopeless one. There is no special form of treatment for the spinal affection; it must be on the lines already detailed (see p. 143) for osteo-arthritis elsewhere.

ACUTE OSTEO-MYELITIS.

This is an extremely rare affection, and, beyond pointing out the possibility of its occurrence, we need say very little about it. The condition is even more often fatal than in the long bones, possibly on account of the large amount of medullary tissue in the bodies of the vertebræ; sometimes, however, the patients recover if the condition is diagnosed and the pus evacuated sufficiently early. Only a very few cases are on record.

ACTINOMYCOSIS.

This is very rare as a primary disease of the spine, and it is accompanied by abscesses. The cases should be treated by scraping out the abscesses and administering iodide of potassium in large doses (see Vol. II. p. 459). When actinomycosis attacks the spine, it usually involves other structures in the neighbourhood, such as the pleura and ribs. The chances of recovery are small.

NEW GROWTHS.

Tumours in connection with the spine may be divided into those which grow in connection with the bones, and those which occur in the interior of the spinal canal and form the so-called tumours of the spinal cord.

TUMOURS OF THE VERTEBRÆ.

Tumours of the spine may be either primary or secondary, the **primary tumours** being usually *exostoses* and *sarcomata*. The most common malignant tumour of the spine is a **secondary** *carcinoma* following a primary growth elsewhere, more especially in the breast; this generally affects the bodies of the vertebræ, and leads to extensive destruction.

The earliest and most marked symptom of cancer of the vertebræ is intense pain, which is not merely limited to the spine, but after a time radiates along the course of nerves which pass out of the inter-vertebral foramina in the immediate neighbourhood. A second characteristic symptom is paralysis, which sets in very quickly, and has not that gradual onset which is seen in cases of tuberculous disease, or of tumours of the spinal cord; complete paralysis may develop within a few hours. Angular curvature also occurs in some cases of cancer of the spine, but it is not such a marked feature as the pain and the paralysis.

TREATMENT.—With the exception of the exostoses, the treatment of these tumours must be purely palliative, and can only be directed to the relief of the symptoms. In cases of secondary cancer, where curvature is becoming evident, the pain may be alleviated to some extent by the application of a spinal support—such as a Taylor's brace—with the view of preventing the bones being pressed together. As, however, most of the pain is due to the involvement of nerves, the chief agent in the treatment must be morphine.

TUMOURS OF THE SPINAL CORD.

Tumours in the spinal canal may be extra-meningeal, intra-meningeal, or in the cord itself. Their most common seat is within the dura mater. The most frequent tumour is a *myxoma*, while *lipomata*, *sarcomata*,

tuberculous tumours, and *syphilitic gummata* occur ; *echinococcus cysts* have also been found.

In the early stages, pain extending down the limbs, varying with the seat of the tumour, is usually the first symptom. As time goes on, the pain is associated with clonic spasms, usually accompanied, first, by extension of the affected limbs, and later, as the extensors lose their power earlier than the flexors, by flexion ; the condition known as spastic paraplegia thus develops. This is followed by complete paralysis of motion and later of sensation. The symptoms are frequently unilateral or, at any rate, more marked on one side than the other, and the motor paralysis is then generally on the same side as the tumour, while the anæsthesia is on the opposite side. There is also usually hyperæsthesia on the same side as the tumour in the early stages, and the reflexes are exaggerated on that side ; in the late stages the reflexes are absent. Usually there is a certain amount of dull pain in the back in the situation of the tumour, and there may be spasm of other muscles as well as those of the limbs ; sometimes there is spasm of the spinal muscles leading to scoliosis.[1] Along with the paralysis there is, in the early stages, retention of urine, followed later by incontinence with cystitis, paralysis of the bowel, and bed-sores. Unless relieved by operation, the patients usually die in from one to three years from exhaustion, bed-sores, pneumonia, or nephritis.

TREATMENT.—The treatment of cases of tumour of the spinal cord is laminectomy and removal of the growth. If left alone, the patient is certain to die, and, although the tumour may not be removable, yet, in a considerable number of cases—about 80 per cent. according to Horsley—the symptoms may be relieved entirely by operation, and even those in which the pain cannot be entirely relieved will be much benefited by the diminution of the pressure. An important point with regard to operative treatment is that the pain is always referred to a lower level than the lesion, and therefore it is of great importance in operating to open the spinal canal well above the suspected area.

Laminectomy.—The steps of the operation have already been described (see Vol. II. p. 131). In these cases it may very often be possible to turn up the laminæ *en bloc* without removing them (see Vol. II. p. 133). When the dura mater has been exposed and when it is seen that the tumour is not external to it, it must be opened by a free median incision with the usual precautions against too sudden escape of cerebro-spinal fluid. Not infrequently the tumour is found between the dura

[1] For further information on the subject of the symptoms and localisation of these tumours various authorities may be consulted. The first paper was published by Gowers and Horsley, in the *Medico-Chirurgical Transactions* as long ago as 1888. See also Starr in *The Medical News*, February 1895 ; Thorburn : *On the Surgery of the Spinal Cord.*

mater and the cord, and compressing the latter; under such circumstances it is readily removed by pulling on it and separating its connections with the membranes by means of a blunt instrument. If the tumour winds round any of the nerves, care must be taken to disentangle them before removing the tumour. After the operation all bleeding is arrested, the dura mater if opened is sewn up, and the laminæ are replaced; it is well to fix the latter in place by wiring them. One or two sutures will bring the spinal muscles together in the middle line and the skin wound is closed without a drainage tube.

In *syringo-myelia*, which is usually a form of *glioma* of the spinal cord leading to dilatation of the central canal, the spinal canal has been opened in several cases, but without any benefit resulting.

HYSTERICAL SPINE.

The spine is one of the most common seats of so-called hysterical disease, and the affection is sometimes mistaken for Pott's disease or for lateral curvature. The distinguishing features are, however, the absence of rigidity, the marked hyperæsthesia which is usually very evident even on light pressure on the skin, and the completely normal appearance and movements of the spine. When the pain complained of is in the lower dorsal vertebræ, the spinous processes may be very prominent, and the skin over them red and tender, so that a casual examination may lead to the belief that the prominent spinous processes indicate angular curvature; this is especially the case in a thin patient who has been wearing tight corsets. When the patient bends the back, however, the free mobility of the bones at once shows that there is no disease of the bones.

TREATMENT.—The treatment of hysterical spine is the same as that already outlined in connection with hysterical joints (see p. 138). It must be directed towards the improvement of the general health, and the removal of any existing visceral disease, more especially ovarian or uterine disorders. No sort of apparatus should be applied; probably the best thing is to subject the patient to a course of rigid Weir Mitchell treatment, and not to pay any special attention to the spine.

SACRO-COCCYGEAL TUMOURS.

Certain swellings occur about the lower part of the sacrum, which are evidently the remains of an imperfect fœtus, and if they cause trouble an attempt may be made to remove them. The true sacro-coccygeal tumours occur in front of the coccyx in connexion with the post-anal duct. They are usually cystic, and may be small and lie in the concavity of the sacrum, or they may be large and project behind the anus, pushing the coccyx backwards.

TREATMENT.—The removal of these tumours is always a very serious matter on account of the great risk of sepsis, owing to their close connection with the anus ; unless, therefore, they are doing harm, it is well to avoid interfering with them, at any rate until the patient has grown up. When removal is undertaken, special pains must be taken not to open the rectum, which may very readily happen, owing to the connection of the tumour with that structure. It must also be borne in mind that there may be a free communication between the tumour and the spinal canal, and consequently cerebro-spinal fluid may escape during the operation.

DIVISION III.

THE SURGICAL AFFECTIONS OF THE HEAD AND FACE.

SECTION I.—AFFECTIONS OF THE HEAD.

CHAPTER XXIX.

AFFECTIONS OF THE SCALP.

Injuries to the head may be limited in their effects to the tissues outside the skull or, if more severe, may cause damage to the bone or the intra-cranial contents. The results vary with the situation of the injury, its severity and the cause producing it. In this chapter we deal only with the effects of injuries in so far as they concern the soft tissues overlying the bone.

HÆMATOMATA.

Injuries to the scalp may produce either an open wound or a lesion of the deeper tissues without division of the skin. In the former case various kinds of scalp wounds result; in the latter, hæmorrhages in different situations, classed together under the name of hæmatomata. These hæmatomata may occur beneath the skin, beneath the tendon of the occipito-frontalis muscle or beneath the pericranium, the last form being often distinguished by the special name of cephal-hæmatoma.

THE SUBCUTANEOUS HÆMATOMA.

Hæmorrhage beneath the skin presents no special points of importance. It does not differ in any material respect from bruises elsewhere, and its treatment is similar to that of an ordinary bruise.

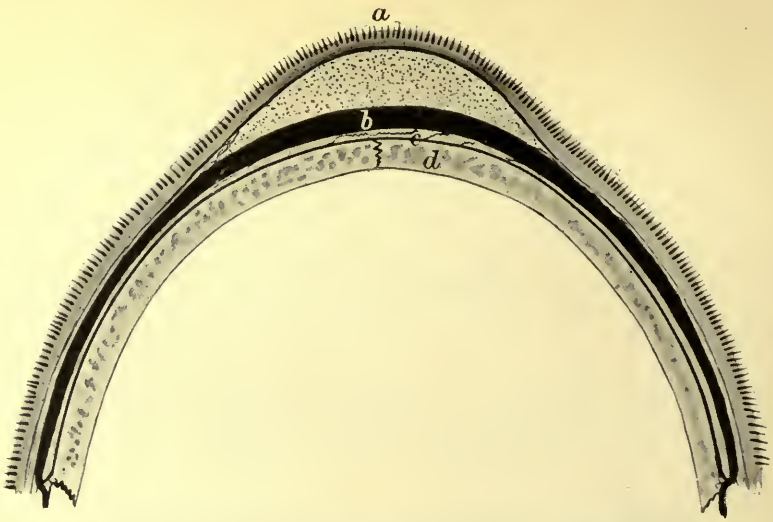


FIG. 134.—THE SUBCUTANEOUS HÆMATOMA OF THE SKULL. The collection of blood is shown diagrammatically between (*a*) the skin and (*b*) the aponeurosis of the occipito-frontalis muscle. *c*, The pericranium, and *d*, the vault of the skull.

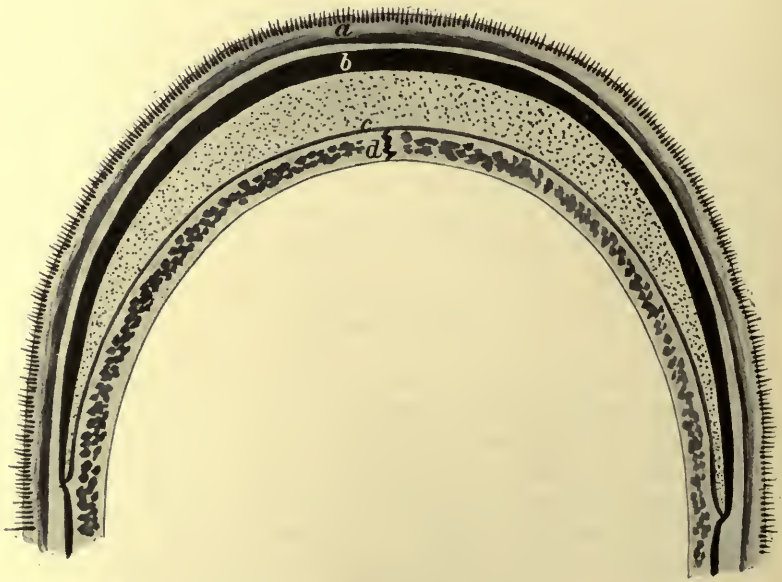


FIG. 135.—THE SUB-APONEUROTIC HÆMATOMA OF THE SKULL. The hæmatoma is shown diagrammatically between (*b*) the aponeurosis of the occipito-frontalis muscle and (*c*) the pericranium. *a*, The skin and *d*, the cranium.

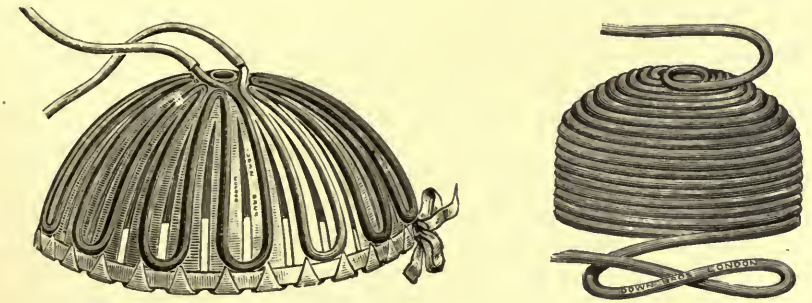
TREATMENT.—In the first instance, an evaporating lotion or lotio plumbi should be applied over the part, but if the effusion of blood

is extensive an ice-bag is often valuable. The first object of the treatment is to prevent further bleeding, but when the hæmatoma ceases to increase in size, the application of cold should be discontinued, as it depresses the vitality of the tissues and so may favour suppuration or sloughing.

As a rule it is unnecessary to shave the head or even to cut the hair unless there is a superficial wound. These hæmatomata generally disappear in a few days.

THE SUB-APONEUROTIC HÆMATOMA.

This is a more important form. In some cases a large amount of blood is effused and may spread over a large area beneath the muscle, and absorption may go on very slowly. This form of hæmatoma is also important because in it—though not to the same extent as in the next variety—a mistaken diagnosis is not uncommon, a depressed fracture of the skull being suspected. After the blood is effused, the



A *B*

FIG. 136.—ICE-CAPS. *A*, The improved form of Leiter's metal ice-cap; *B*, the one made of spirally arranged tubing.

margin of the hæmatoma usually becomes hard owing to clotting of the blood in the tissues around, while the centre may remain soft and fluctuating. When the collection of fluid is small and not tense, the finger pressed over it passes into a depression in the centre, which feels very like a hole in the bone.

When such a blood-cyst forms, absorption may not occur or it may go on very slowly; in some cases the skin over it becomes gradually thinned and ultimately gives way. In other cases again, especially when there has been an abrasion of the skin, suppuration may take place.

TREATMENT.—The treatment of these cases consists (1) in limiting the effusion of blood; (2) in promoting rapid absorption of the blood already effused; and (3) in taking measures to prevent infection and consequent suppuration in the hæmatoma.

1. *To limit the Effusion.*—If the case is seen directly after the accident, it is well to apply an ice-bag or an ice-cap[1] at once (see Fig. 136);

[1] An ice-cap can easily be improvised by coiling india-rubber tubing around the head over a night-cap, to which the coils are stitched to keep them in position.

unless there is a wound it is not necessary to shave the head. The patient must be confined to bed, or at any rate to the horizontal position. The cold should only be continued as long as the hæmatoma increases in size ; it will generally be required for about twenty-four hours. After that, if the hæmatona is small and there is no reason to suspect any other injury, such as a fracture of the skull, little further need be done. The patient may be allowed to go about, but should be cautioned to avoid irritating the part by the pressure of the hat and to be careful not to injure or scratch the scalp when combing the hair. Absorption of the fluid usually takes place readily.

2. *To hasten absorption.* — When absorption does not occur, which is most likely to happen when the effusion of blood is large, a blood-cyst may result and the treatment of that condition is often troublesome. When absorption has come to a standstill, it is well to apply pressure, and this is best done by means of an elastic bandage outside a large mass of cotton-wool. This arrangement should be kept on for two or three days and reapplied as often as is necessary. When no elastic bandage is available, pressure may be applied by means of an ordinary bandage put on in the following manner. A large mass of cotton-wool several inches thick and large enough to overlap the hæmatoma in all directions for at least a couple of inches is applied over the surface. About eight or ten strips of stout unbleached calico bandage three inches wide and about a yard long are then laid over the scalp in such a way that they radiate from the centre of the sagittal suture over which the middle of each strip is placed ; the ends hang down on opposite sides of the head. The strips are next firmly fixed in place by a few horizontal turns of a bandage encircling the skull from the root of the nose in front to below the external occipital protuberance behind. After this has been fastened, the corresponding ends of each strip are taken one by one in each hand and pulled upon tightly so as to stretch the bandage and make it exert pressure over the cotton-wool. They are then turned up and knotted together over the wool (see Fig. 137). In this manner a certain amount of pressure, equally diffused in all directions, can be exerted over the tumour. The pressure obtained in this way is, however, not nearly so efficient as that obtained by the elastic bandage. Pressure should be continued for about a fortnight or longer, provided absorption goes on steadily.

In some cases absorption comes to a standstill in spite of the above treatment, the central portion of the clot becomes fluid and a blood-cyst is formed. Under such circumstances the cure will be expedited by evacuating the fluid portion of the swelling. This can be readily done by means of a full-sized aspirating needle, but great care must be taken to purify the scalp in the vicinity of the puncture, otherwise the needle may carry in infective material from the skin and suppuration may result. It is not, as a rule, necessary to shave the part to be punctured, but it is well to clip away a few hairs around the point where the needle

will enter, and then to scrub the scalp with the ordinary disinfecting solution, *i.e.* ' strong mixture ' (see Vol. I. p. 99).

If preferred, the part may be rubbed with acetone, and then painted with a two per cent. solution of iodine in rectified spirit. It is well also to make a very small incision through the skin at the point where the aspirating needle is to be inserted. A small antiseptic dressing should be applied over the puncture and fixed on with collodion. A mass of wool should then be placed over the hæmatoma and pressure applied as before. It may be necessary to repeat this procedure more than once.

Except in old-standing hæmatoma, this treatment will generally lead to a cure. Occasionally, however, the fluid continues to re-accumulate and it will then be necessary to drain the cyst. A short incision is made at the most dependent part of the tumour and a small drainage

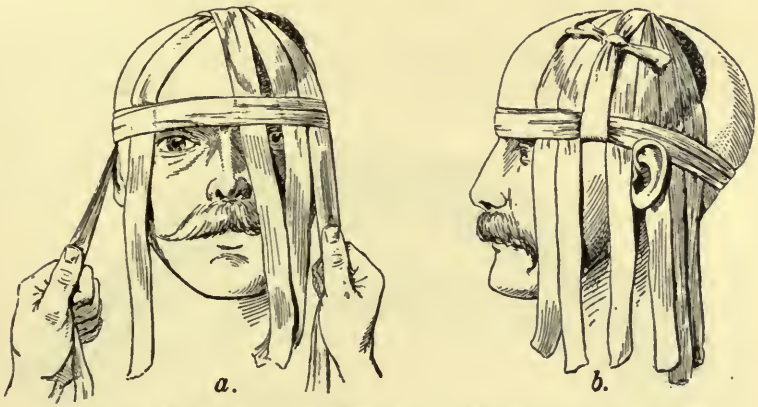


Fig. 137.—Method of applying Pressure to a Hæmatoma of the Scalp. In *a* the strips of bandage are shown in position and kept in place by the horizontal turns. The two ends of one particular strip are being pulled upon preparatory to turning them up and knotting them over the pad of wool as in *b*.

tube (No. 5 or 6) is inserted. Before putting in the drainage tube, it is well as a rule to introduce a sharp spoon and scrape away as much of the blood-clot as possible. This not only removes material which is slow in organising, but also enables the walls of the cyst to fall together. Great care must be taken with the aseptic management of the case, because suppuration beneath the occipito-frontalis is a very serious matter. It may be advisable, therefore, when the head is very scurfy, to shave a considerable area of the scalp in the vicinity of the hæmatoma, and to disinfect the skin very scrupulously, before operating. In other cases only a small area need be shaved, but the skin and the hair around must be thoroughly disinfected, and cyanide paste should be well rubbed into the hair before making the incision. This is made by mixing the double cyanide of mercury and zinc powder with 1 in 20 carbolic

lotion until a thick paste is formed. If the hair is first thoroughly disinfected with strong mixture and then a quantity of this paste is rubbed into it, it practically becomes an antiseptic dressing. At the end of the third day the drainage tube can generally be left out and satisfactory healing will usually be obtained.

3. *To prevent infection.*—When there is a wound of the scalp in the vicinity of the hæmatoma, it should be treated with as much care as an ordinary scalp wound (see p. 328), even though it be a mere abrasion, otherwise violent and dangerous suppuration may occur. Should the hæmatoma suppurate, it must be freely opened and drained at its most dependent point, all breaking down blood-clot being removed. Should the patient strongly object to the necessary shaving, the scalp must be thoroughly disinfected, and the hair impregnated with the double cyanide of mercury and zinc paste referred to above.

THE SUB-PERICRANIAL HÆMATOMA.

This form of hæmatoma occurs most frequently in young children, and is not uncommon at birth ; in that case it may be due to compres-

FIG. 138.—THE SUB-PERICRANIAL HÆMATOMA. The hæmatoma is shown diagrammatically between (*c*) the pericranium and (*d*) the vault of the skull. *a*, is the skin, and *b*, the aponeurosis of the occipito-frontalis muscle.

sion of the fœtal head, with consequent fracture of the external table of the parietal or frontal bone and rupture of the veins of the diploë. It is most commonly situated over the parietal bone. The extravasation is usually limited by the sutures and does not extend beyond the particular bone over which it first occurred. The characters of these extravasations, especially when absorption fails and a true blood-cyst forms, are the same as those already described in the sub-aponeurotic form, and it is especially in these cases that a mistake in the diagnosis between a blood-cyst and a depressed fracture takes place. The absence of signs of compression when the bone in the centre of the swelling is pressed upon implies that the case is one of sub-pericranial hæmatoma rather than of depressed fracture.

TREATMENT.—The treatment of this form is the same as in the previous cases, but it is especially desirable to obtain rapid absorption of the blood as soon as possible, otherwise permanent injury to the bone may result. Indeed, in some cases the bone may become absorbed and perforated. Hence, if absorption of the fluid does not occur in the course of a week or ten days, resort should generally be had to puncture or drainage without further delay.

TRAUMATIC CEPHAL-HYDROCELE.

This rare condition—sometimes called traumatic meningocele—may occur in young children after an injury, in which there has been a fracture of the vault with laceration of the dura mater. Immediately after the infliction of the injury a swelling forms, which presents the characters of a cephal-hæmatoma, but when the effused blood becomes absorbed the swelling persists. The probable explanation of this is, that the fracture in the skull has not united and that the cleft in the bone has become enlarged by absorption of its edges; the dura mater being torn, the subdural space is thus placed in open communication with the sub-aponeurotic tissues. In some cases, there is actually a communication between the sub-aponeurotic space and the lateral ventricle of the brain.

The swelling thus produced is soft and partially reducible, it pulsates synchronously with the heart, it gives an impulse on coughing or crying, and in some cases the fluid entering and leaving the sac produces a systolic bruit.

TREATMENT.—The condition usually subsides spontaneously after a period varying from a fortnight or more to several months. It would seem best not to apply any more energetic treatment than gentle compression by a bandage, possibly combined with occasional aspiration, should the swelling become very tense. The risk of infection is great, and the most scrupulous asepsis must be observed in performing the aspiration.

SCALP WOUNDS.

Wounds of the scalp may vary from a small abrasion or incision to detachment of the greater part of the scalp. These wounds are very liable to sepsis, and this is accounted for partly because micro-organisms are very numerous upon the scalp, and hair and scurf are generally driven into the wound, and partly because the wound is frequently produced by some dirty instrument and is usually more or less contused. Hence, there is a great risk of suppuration in all these cases, and this should be carefully borne in mind because suppuration beneath the scalp is a very serious occurrence; not only may the pus extend far and wide beneath the aponeurosis, but septic thrombosis may occur in the veins of the diploë and subsequently involve the large sinuses. Even without any

thrombosis, the infection may pass to the interior of the cranium and produce a suppurative lepto-meningitis.

From the point of view of treatment, scalp wounds may be divided into three groups, according to their severity: (1) Those in which the wound only passes through the skin, and subcutaneous tissues; (2) those in which the aponeurosis of the occipito-frontalis muscle is divided and the pericranium or the cranial bones are laid bare; and (3) those in which there is detachment of considerable portions of the scalp.

TREATMENT. —In all scalp wounds there are three points which have to be attended to, viz. the arrest of the hæmorrhage, the disinfection of the wound, and the union of the cut edges.

When the wound is superficial the treatment is simple. The hair in the immediate vicinity of the wound is clipped away, the scalp shaved for about an inch around it, vigorously scrubbed with strong mixture, and the cyanide of mercury and zinc paste already alluded to (see p. 325) rubbed into the surrounding hair. The wound itself should be swabbed out with strong mixture (see Vol. I. p. 100), and afterwards washed with 1 in 2000 sublimate solution. In these superficial wounds the bleeding, as a rule, stops spontaneously. If there is much separation of the edges of the wound, one or two stitches, preferably of silkworm-gut, should be inserted so as to approximate them, but the wound should not be sewn up closely. In small wounds a drainage tube is not necessary.

When the wound is quite small, the patient will usually wish to go about his business after twenty-four hours, and under such circumstances the large dressing applied in the first instance should be removed, a small piece of gauze or salicylic wool fixed with collodion over the line of incision, some of the cyanide paste (see p. 325) rubbed into the roots of the hair in the vicinity of the wound and the rest of the hair combed over this so as to prevent it showing. This dressing is allowed to dry and may be left untouched for a week.

When the aponeurosis of the occipito-frontalis has been divided, greater care must be taken in the disinfection of the wound. If the wound has been caused by a blunt instrument, hair is usually driven into it and is found sticking over its surface, and this, if left, is a certain source of infection. In many cases also the bleeding is fairly severe.

In the first place, the hair should be cut, and the wound and the scalp in the vicinity disinfected. If bleeding is going on, the wound cannot be properly disinfected, and therefore it is well to clamp the bleeding points before attempting it, and then to tie the vessels. If the vessels are tied before the wound is disinfected the ligatures may become soiled and lead to infection. In large wounds over the vault of the skull the bleeding may be effectually controlled by passing a piece of stout india-rubber tubing two or three times round the skull from the glabella to beneath the occipital protuberance, so as to act as a tourniquet. Should this not be available, a piece of wetted calico

bandage may be wound around the skull in the same position and then tightly twisted up by means of a rod. This temporary arrest of hæmorrhage in large wounds is important, not only because it is necessary for the proper disinfection of the wound, but also because of the free bleeding which takes place.

The wound is now enlarged, if necessary, and cleaned and disinfected in the usual manner. All hair is removed from it, and any portions of tissue which are visibly dirty are clipped away. When the wound has been caused by a blunt instrument and its edges are badly soiled, it is well to cut away a thin slice of the raw surface ; in this way a healthier

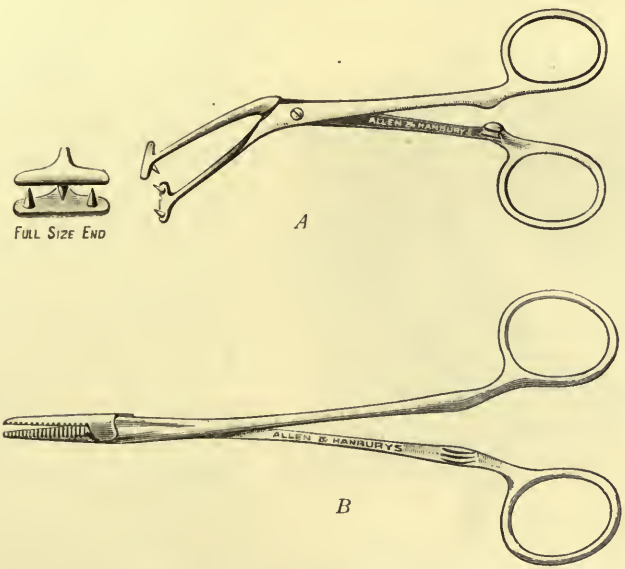


FIG. 139.—FORCEPS FOR HÆMOSTASIS IN OPERATIONS UPON THE SCALP. *A*, Ballance's forceps, which are seen in use in the following figure. *B*, 'Mosquito' forceps—very fine Spencer Wells's forceps, which can be dug into the scalp so as to seize the bleeding vessel.

wound will be left, which will more readily unite by first intention. If the bone is soiled it is advisable to chisel off a thin layer of the surface, taking care, however, not to open up the diploë; unless this is done, infection is apt to spread from the contused area and lead to very serious results. The surface of the bone may then be touched with undiluted carbolic acid, so as to disinfect it more effectually.

The wound having been disinfected, all bleeding vessels must be tied. When the wound in the scalp is small it is quite easy to pick up the bleeding points with pressure forceps and ligature them after the tourniquet has been relaxed. For this purpose the 'mosquito forceps' (see Fig. 139, *B*) are useful. In larger wounds there may be many

vessels bleeding and these should be controlled by sponge pressure and ligatured one by one. In large wounds, and especially when a considerable area of the scalp has been detached, there will in all probability be so many bleeding points that a serious amount of blood may be lost before all the vessels can be picked up; in such cases Ballance's forceps (Fig. 139, *A*) are useful. They should be applied along the whole length of the margins of the wound before the tourniquet is removed (see Fig. 140); they can then be removed one by one, the vessels controlled by each pair being ligatured before the next pair is taken off.

In some situations it is by no means easy to stop the bleeding. For example, in wounds in which the temporal artery has been divided, the vessel may retract under the temporal fascia to such an extent that it is a matter of extreme difficulty to catch the divided ends. In fact, in some cases the external carotid artery has been tied in order to arrest the bleeding. That is, however, a very severe procedure and can hardly ever be necessary, even when secondary hæmorrhage takes place from the vessel. Under ordinary circumstances the proper procedure is to control the bleeding temporarily by digital compression of the trunk of the temporal artery as it passes over the base of the zygoma, and then to slit up the fascia, and search for and tie the divided artery.

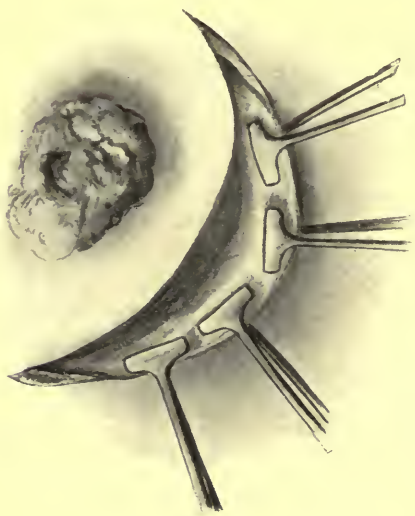


FIG. 140.—BALLANCE'S FORCEPS APPLIED TO ARREST HÆMORRHAGE FROM THE SCALP. The details of the forceps are seen in Fig. 139, *A*. As applied in the sketch they control nearly the whole of the blood-supply of the flap.

The edges of the wound should be brought together by a few interrupted sutures of silkworm-gut, which is firm, soft, and flexible, and at the same time does not absorb moisture and does not therefore become septic. A drainage tube should be inserted at one angle of the wound, because it is impossible to be quite sure that the disinfection has been thoroughly carried out, and also because in any case the vigorous disinfection will lead to a good deal of serous effusion. If a large flap of scalp has been torn down so that the lowest limit of the separation is below the angles of the wound, the best plan is to make a small counter-opening through the centre of the flap at the lowest point and insert a drainage tube.

A large dressing should be applied over the whole scalp and fixed on in the usual manner. If, at the end of two or three days, it is found that infection has not occurred, the drainage tube should be removed and the wound allowed to close. When wounds are large it is well to keep the patient in bed for three or four days.

ERYSIPELAS.

Erysipelas was formerly a very common complication of scalp wounds, but nowadays, when greater care is taken in the disinfection of accidental wounds, it is seldom seen. It may also arise as an extension from erysipelas of the face or neck, or in connection with a boil or other septic affection of the skin. Erysipelas of the scalp presents the ordinary features of erysipelas, which have been already described in Vol. I. p. 196. Its gravity in this region is owing to the great tendency of the inflammation to spread to the skull and lead to septic meningitis or septic thrombosis of the diploic veins.

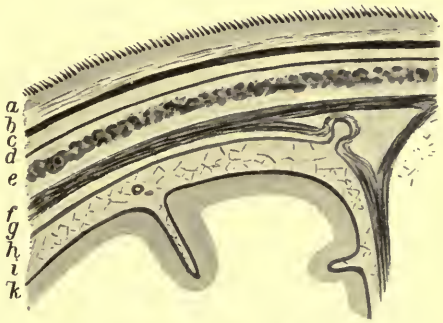


FIG. 141.—THE STRUCTURES IN RELATION TO THE CRANIAL VAULT. *a*, Skin; *b*, subcutaneous tissue; *c*, aponeurosis of the occipito-frontalis muscle; *d*, sub-aponeurotic space; *e*, skull; *f*, dura mater; *g*, sub-dural space; *h*, arachnoid; *i*, sub-arachnoid space; *k*, pia mater.

TREATMENT. — The treatment is practically the same as that of erysipelas elsewhere. It is well to shave the head and thoroughly disinfect the skin, and then to carry out treatment on the lines laid down in Vol. I.

ACUTE CELLULITIS.

Acute cellulitis is a common result of infection of scalp wounds, and may occur in combination with erysipelas. It is a very grave condition, because in the first place the pus tends to spread beneath the fascia over a large area, and in the second place it is extremely liable to lead to sinus thrombosis with pyæmia, or to septic lepto-meningitis.

TREATMENT.—The treatment of this condition has been described in speaking of diffuse cellulitis in Vol. I.; when this affection occurs in the scalp, the treatment must be even more energetic than elsewhere, owing to the rapid manner in which the inflammation may spread over the vertex, and the serious complications which may occur. *Free incisions* must be made through the occipito-frontalis aponeurosis in a

vertical direction (see Fig. 142), and they must extend beyond the edge of the inflammatory area. *Boric fomentations* should be applied after the scalp has been shaved, and in bad cases *irrigation* may be employed, the head and neck being surrounded by a mackintosh in such a way as to carry off the fluid without soiling the bed. When the inflammation has begun to subside, the irrigation may be given up, and antiseptic dressings substituted for it.

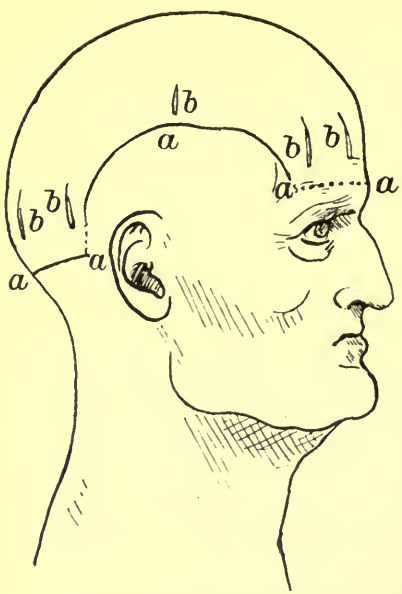


FIG. 142.—LINES OF INCISION FOR CELLULITIS OF THE SCALP. The incisions should be vertical and made in the situations, *b–b*. The attachment of the occipito-frontalis aponeurosis is along the lines *a–a*.

BOILS AND CARBUNCLES.

Boils and carbuncles are not very common on the scalp, but they are sometimes met with about the back of the head or over the mastoid process, and are apt to give rise to dangerous complications—such as sinus phlebitis or meningitis. It is well to *incise and scrape out the carbuncles freely* and apply pure carbolic acid, and at the same time to attend to any constitutional condition, such as diabetes, that may be present (see Vol. II. p. 8).

ULCERS.

Ulcers of the scalp may occur after lacerations, burns, or other injuries, after acute inflammations followed by sloughing of portions of the scalp, as the result of syphilis or tuberculosis, or from the ulceration of malignant tumours.

SIMPLE ULCERS.

When the ulcers of the scalp are due to simple loss of tissue, for example, after burns or lacerations, the slowness in healing is due, to a great extent, to the difficulty in contraction of the wound. When a large area of the soft tissues has been lost, the granulations which spring up fix the edges of the wound to the deeper parts, and very soon prevent the further contraction of the sore. The result is that healing ceases after a time, or, if it goes on, the scar is thin and delicate, and constantly breaks down.

TREATMENT.—Bearing this fact in mind, the best practice is to *skin-graft the whole surface* (see Vol. I. p. 52) as soon as all the sloughs

have separated and the wound is granulating. Provided that the operation is not delayed until the healing process has ceased owing to the impossibility of further contraction, the grafts take well and a sound scar is left.

When skin-grafting is not employed or when the grafts fail to hold, a four per cent. ointment of *scarlet red* should be tried. This substance appears to have a marked effect in stimulating the growth of epithelium. Several substances are sold under this name, but the one that is known commercially as 'oil soluble,' 'Red B,' or 'Pouceau 3 B,' and chemically as toluene-azo-β-naphthol is the best. Amido-azo-toluol is probably the active group in the molecule, and is frequently employed alone in place of the scarlet red. Both these substances can be made up into ointments with a zinc oxide basis or one containing eight per cent. of friar's balsam. It is rather irritating, and hence it is well to alternate its use with that of a simple ointment such as zinc ointment or Lassar's paste.

The skin around the ulcer should be smeared with zinc ointment up to about half an inch from its margin; a piece of lint spread with an ointment containing eight per cent. of the dye is then applied over the wound, and the whole covered with some sterile wool and a bandage. This dressing is left in place for twenty-four hours, and then the scarlet red is cleaned away and a simple ointment applied for twenty-four hours, this process being repeated until the wound has healed. If this plan is inconvenient an ointment containing four per cent. of scarlet red can be applied daily.

SYPHILITIC AND TUBERCULOUS ULCERS.

These ulcerations are usually secondary to syphilitic or tuberculous disease of the skull and seldom begin in the scalp (see p. 360). When gummata commence in the scalp they usually yield readily to anti-syphilitic remedies (see Vol. I.). Lupus occasionally affects the scalp, but it is very rare as a primary disease, and even when there are lupoid ulcers in neighbouring parts of the face, the disease does not tend to spread over the scalp as readily as in other directions. The treatment of tuberculous ulcers of the scalp, whether lupoid or of the ordinary tuberculous type, is that recommended in Vol. II. p. 12.

AIR TUMOURS.

Collections of air beneath the scalp are sometimes met with after injuries about the head; they may occur in two forms. On the one hand, there may be a general *emphysema of the scalp*, the air being diffused through the cellular tissue, or, on the other, a localised tumour containing air, commonly termed a *pneumatocele*.

EMPHYSEMA OF THE SCALP.

Emphysema of the scalp is usually associated with fractures of the nasal or ethmoid bones, or of the anterior wall of the frontal sinus. The air is driven into the cellular tissue when the patient blows his nose, and considerable emphysema may result.

TREATMENT.—As a rule no treatment is required for this condition, but, should the distension be great, the skin may be punctured in order to allow the air to escape.

PNEUMATOCELE.

Of much greater importance, although of greater rarity, is the condition known as pneumatocele, in which there is a cavity beneath the scalp distended with air and communicating with air-cells in the bone beneath. These tumours have been met with most frequently in the region of the mastoid process, but also about the frontal sinus. They arise in connection with defects in the bone, such as sometimes occur in the mastoid region, by which the air-cells open on the surface of the bone. As a result, air is forced from the middle ear through this opening by sneezing, etc., and in the course of time a tumour may be developed. These bony defects may be congenital or acquired; if congenital, they are generally the result of incomplete closure of the squamo-mastoid suture. The tumours rarely give rise to any special symptoms.

TREATMENT.—Punctures and incisions have been employed; apparently good results have followed *puncture and the subsequent injection of iodine*. Unless, however, the tumour is of such a size as to cause deformity it is best not to interfere with it.

TUMOURS OF THE SCALP.

SEBACEOUS CYSTS.

The most common tumour of the scalp is the atheromatous or sebaceous cyst, popularly called a *wen*. These cysts are usually multiple, and some of them may reach a considerable size. They are generally thick-walled and, unless inflammation has occurred from irritation of the skin, the wall of the cyst is usually easily separable from the surrounding parts. Suppuration occasionally occurs around these cysts, and they may be the starting-point of an epithelioma.

TREATMENT.—The treatment of these cysts is *excision*, and, since they tend to increase in size, it is best to remove them while they are still small, an operation which can be readily performed under local anæsthesia. As a rule it is not necessary to shave the skin

over the tumour ; at most, a few hairs along the line of incision may be cut away.

In women the hair on each side of the cyst should be combed aside and plaited, so as to keep it out of the way. When a number of cysts are to be removed, this process must be repeated over each until the patient's hair is confined in a number of plaits, the tumours occupying the partings between them.

The scalp and hair in the neighbourhood should next be thoroughly disinfected, and a quantity of the cyanide of mercury and zinc paste (see p. 325) should be well rubbed in. A straight, narrow-bladed bistoury, with the edge directed outwards, is then pushed through the cyst, and made to cut upwards so as to divide the outer half of the cyst wall. If now a little pressure be made on each side, the cyst wall will be seen to protrude from the bed in which it lies, when it can be seized with

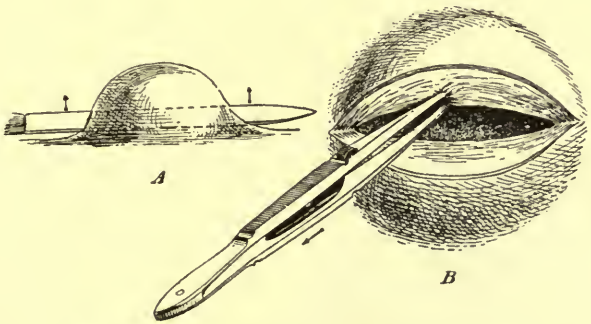


FIG. 143.—METHOD OF REMOVING A SEBACEOUS CYST. The cyst is first cut across by transfixion (*A*), and its contents are squeezed out ; then, as shown in *B*, the wall is laid hold of by catch-forceps and traction exerted. The wall pulls out and only a mere touch of the knife is required.

forceps, and with a little care pulled out from the tissues around (see Fig. 143). When the tumour is larger, it is well to make an elliptical incision enclosing a sufficient amount of the thinned and redundant skin, and, when the cyst wall is reached, to shell out the cyst by means of a blunt dissector. A small vessel may require twisting at the bottom of the cavity, and then one or two interrupted catgut sutures may be inserted so as to bring the skin edges together. As these edges are very thin, they are apt to curl inwards, and this must be borne in mind in putting in the stitches.

For the first twenty-four hours a pad of gauze is fastened over the area of the operation with a firm bandage so as to prevent oozing into the cavity. Unless this is done, blood is apt to collect and distend the cavity. At the end of twenty-four hours the bandage and pad may be taken off, a small collodion dressing fixed on, some of the cyanide paste again rubbed into the scalp, and the hair combed over the dressing. At the end of a

week the dressing may be soaked off with acetone, and the stitches removed.

When the cyst wall has become inflamed and adherent to the surrounding parts, the tumour must be dissected out, and great care taken not to leave any part of the cyst wall behind. A general anæsthetic will usually be necessary. The key to a satisfactory operation is to define the deeper part of the cyst wall where the inflammation is usually less, and then, by passing a dissector around the wall from this region, it will generally be possible to get an indication of the limits of the cyst and remove it entire. A drainage tube must be put in for two or three days, lest the wound should become infected as the result of the previously existing suppuration.

DERMOID CYSTS.

Dermoid cysts are most frequent about the external angular process of the frontal bone, the root of the nose and the region of the fontanelles. The chief point of interest in connection with these cysts is their differential diagnosis from meningocele, with which they are apt to be confounded. They are not, however, influenced in size by pressure, they do not diminish during sleep, and their contents are not so fluid as those of meningoceles.

FIG. 144.—INCISION FOR THE REMOVAL OF A DERMOID AT THE OUTER ANGLE OF THE ORBIT. The dotted line marks the incision which lies in the line of the eyebrow and leaves a scar that is quite unnoticeable.

TREATMENT.—The treatment of these cysts is *removal by dissection* and not by incision of the cyst, as described in speaking of sebaceous tumours. It must be remembered that a dermoid cyst does not lie in the skin as a sebaceous cyst does, but in the subcutaneous cellular tissue.

CARCINOMA AND SARCOMA.

Carcinomata of the scalp may grow either from the superficial epithelium or from the sebaceous glands. Those which grow from the superficial epithelium resemble the skin carcinomata found elsewhere. They spread both superficially and deeply, become adherent to the skull, and infect the neighbouring lymphatic glands. Those which grow from the sebaceous glands frequently originate from a sebaceous cyst which ruptures, fungates, and ultimately presents the appearance of a carcinomatous ulcer. These are sometimes only locally malignant, but they may ultimately become

adherent to the skull, and they tend to recur unless widely removed. *Rodent ulcer* may also occur on the scalp.

Many types of *sarcoma* occur in this situation, but the most characteristic variety originating in the scalp is the so-called *recurrent fibroma*, which should probably be regarded as a slowly growing fibro-sarcoma of low virulence. Sarcomatous tumours may also originate from the skull itself, or may even begin in the meninges and perforate the bone, and ultimately involve the scalp.

TREATMENT.—Malignant tumours of the scalp require wide and early removal, the raw surface left being allowed to granulate and then being skin-grafted. When the tumour involves the skull either primarily or secondarily, operation is usually contra-indicated, but X-rays, radium, or Coley's fluid may be tried.

In some cases, however, when the growth is not spreading rapidly, removal should be attempted in spite of adhesion to the skull. A tourniquet should be applied round the base of the skull and a number of Ballance's forceps (see p. 329) should be in readiness. An incision is then made encircling the growth about three-quarters of an inch from its edge. The area thus enclosed is dissected up for a short distance, and then the outer table of the skull, together with the base of the ulcer, is removed with a sharp chisel. After the bleeding has been arrested, the wound is drawn together as far as possible with stout tension stitches, allowed to granulate and subsequently skin-grafted. After the operation it is well to expose the raw surface to radium and to repeat this after five or six weeks.

NÆVI.

Nævi may occur anywhere on the scalp, but they are most common about the anterior fontanelle and in the frontal region ; in the neighbourhood of the fontanelle the tumour may reach a considerable size and may, in some rare cases, extend to the dura mater.

TREATMENT.—The treatment of nævi has already been described (see Vol. I. p. 255). For small nævi on the scalp the best plan is the application of a stick of *solid carbonic acid*, which should be well pressed down upon the growth for about thirty seconds ; a little dusting powder is then applied, and in a couple of weeks the nævus will have entirely disappeared. If the carbonic acid is not available, the nævus may be excised. For nævi of moderate size (that is to say, up to an inch in diameter), *excision* is better, especially when they are situated over the anterior fontanelle. It is true that these may also be satisfactorily treated with carbonic acid, but several applications are necessary, and the application of carbonic acid to large nævi, especially when it has to be repeated, is apt to cause sloughing. In excising a nævus of the scalp, it is important, in order to avoid dangerous hæmorrhage, to carry the incision wide of the growth and remove it rapidly ; the hæmorrhage

can then be controlled by light sponge pressure, and the vessels picked up and tied. This is a much better plan than attempting to secure the vessels as the operation proceeds. It is nearly always possible to bring the edges of the skin together afterwards by the use of tension stitches, but when this cannot be done, the margins of the wound should be approximated as far as possible, the part left open being allowed to granulate or being covered with skin-grafts. For the largest nævi, *electrolysis* (see Vol. I. p. 256) is the best treatment, combined, if desired, with excision after the size of the nævus has been reduced.

CIRSOID AND OTHER ANEURYSMS.

The scalp is a favourite seat of *cirsoid aneurysm*, which usually affects the auriculo-temporal region. In this form the arteries become elongated and tortuous as well as dilated. The capillaries are also dilated, and the accompanying veins may likewise be involved; the result is the formation of a tumour composed of tortuous vessels. The cause of this condition is practically unknown. Sometimes there is a history of injury; in other cases the condition apparently arises in a previously existing nævus.

TREATMENT.—The treatment of cirsoid aneurysm is a matter of difficulty, and a great variety of methods have been employed. The best of all is *extirpation*, whenever the situation or the size of the tumour permits of its employment. In carrying out extirpation of the tumour, the main trunks of the arteries feeding it should be first exposed and ligatured. In the ordinary situation, the trunk of the temporal artery must be exposed as it passes over the zygoma, and after it has been tied, the skin may be dissected off the tumour, any redundant portion over the most prominent part being removed; outlying large vessels are clamped, and the mass of dilated vessels is taken away.

The only limit to excision is the extent of the tumour. When this is very large and much skin has to be taken away, the space may, however, be filled up by skin-grafts. In cases which are not suitable for excision, various other methods of treatment have been recommended, such as ligature of the main trunk of the external or the common carotid arteries, the application of caustics, the use of electrolysis, or the injection of coagulating materials; but these methods are unreliable and ineffectual.

True aneurysms are rare and can generally be dealt with by the direct operation (see Vol. II. p. 181). *False aneurysms*, the result of injury, may, however, be met with, and in former times were not very uncommon. They were usually found on the anterior branch of the temporal artery and arose in connection with phlebotomy. *Aneurysmal varix* may also arise from simultaneous puncture of the vein and the artery. The treatment of these conditions is excision of the sac (see Vol. II. p. 169).

CHAPTER XXX.

FRACTURES OF THE SKULL.

Fractures of the skull vary in character and gravity according to various circumstances. Thus, the situation of the fracture is of importance, the chief point being whether it involves the vault or the base. The fracture may be slight (simple fissure) or very extensive (comminuted fracture); it may be complete, or only one table may be injured; the broken pieces may be depressed, or not. The character of the instrument which inflicts the injury is also of great importance.

The effects of injuries which are sufficiently severe to produce a fracture of the skull are not limited to the bone itself. Various complications may ensue; among the most important are concussion, laceration, and compression of the brain; septic complications, such as erysipelas and cellulitis of the scalp, osteo-myelitis of the skull, lepto-meningitis, or cerebral abscess; hernia cerebri; paralyses of motion, sensation or special sense, subsequent mental derangements, persistent headaches, or traumatic epilepsy. These complications will be considered in detail later on. In the present chapter we shall simply deal with fractures *per se*, classifying them, according to their situation, into those of the vault and those of the base. Gunshot injuries of the head, although strictly included under these headings, will, for convenience, be considered in a separate section.

FRACTURES OF THE VAULT OF THE SKULL.

These fractures are generally due to direct violence, though sometimes they are merely upward extensions of a widespread fracture of the base; the whole thickness of the skull may be involved or one table only may be broken.

FRACTURE OF THE EXTERNAL TABLE ALONE.

In some cases, especially when the injury has been inflicted with a sharp instrument and the blow has fallen obliquely upon the skull, the outer table alone may be injured. This form of injury may also occur in

situations where there is a considerable interval between the outer and inner tables, notably over the frontal sinus, or the mastoid process. In the case of the frontal sinus, the anterior wall may be broken or depressed without fracture of the deeper part of the frontal bone.

The importance of these fractures mainly depends on whether they are compound or not. When compound, they are naturally prone to become the seat of various septic complications; fractures of the outer table alone are almost always compound.

Treatment.—*When there is no external wound*—This is the type of injury usually found in the anterior wall of the frontal sinus. Although this fracture is, strictly speaking, compound, that is to say, communicates with one of the accessory sinuses, and consequently with the nasal cavity, septic infection is not a common complication, and all that is necessary is to keep the patient at rest for a few days and apply an evaporating lotion to the seat of the injury.

When there is an external wound.—Here the treatment must be that required for a scalp wound and for a compound fracture. The scalp and the wound in the soft parts must be thoroughly disinfected in the manner already described (see p. 328), after which the surface of the skull is carefully examined, any loose or projecting portions of bone removed and any obviously soiled area gouged or chiselled away. The bone and soft parts are then rubbed over with undiluted carbolic acid and a drainage tube of sufficient size is inserted before putting in the sutures. The dressing should be similar to that employed for scalp wounds, and the drainage tube may be left out if no septic complications occur within three days.

FRACTURE OF THE INTERNAL TABLE ALONE.

It is only very rarely indeed that the internal table is broken without the external one being simultaneouly fractured, but a few cases of the kind have been put on record.

In children there may be a sort of green-stick fracture of the skull in which the internal table gives way as the result of a blow, and the external table is simply bent inwards, thus giving rise to a *saucer-like depression* of the bone. Under such circumstances there are not necessarily any symptoms, unless an intra-cranial hæmorrhage accompanies the injury to the skull.

TREATMENT.—Unless the fractured portion of the internal table gives rise to symptoms of cerebral irritation or unless there are signs of compression produced by some co-existing hæmorrhage, the condition may not be recognised. Should these symptoms arise, appropriate treatment (*vide infra*) must be carried out. Usually no symptoms arise if the child is simply put to bed and an ice-bag applied. The bone is elastic and the depression is spontaneously obliterated in a short time; operation is seldom called for.

FRACTURE OF BOTH TABLES OF THE SKULL.

Fractures of the skull vary in character according to the nature of the instrument which causes the injury and the direction in which the force is applied. They are usually divided into three main groups, namely, fissured fractures, depressed or comminuted fractures, and punctured fractures.

Fissured Fractures.—These can only be recognised when the surface of the bone is exposed. When there is no wound, the existence of a fissure may be suspected when complications, such as intra-cranial hæmorrhage, or traumatic cephal-hydrocele, are present. As a rule there is no noticeable difference in level between the two portions of the bone, but the internal table is more widely fractured than the external, and portions of the former may project downwards on to the dura mater.

Depressed Fractures.—Depressed fractures may be simple or compound; as a rule, they are compound. The bone is broken up into several fragments according to the degree of violence producing the fracture; some of these fragments may be loose, so that there is a true comminuted fracture; others again may be only partly detached; even these may be bent downwards and exert pressure on the brain. In addition, it is usual to find fissures of the skull radiating from the area of comminution.

The internal table is always more extensively broken up and more detached than the external, so that the amount of injury evident externally does not fully indicate the amount of damage in the deeper parts. These fractures are always associated with more or less hæmorrhage, and the amount of blood effused beneath the skull is the chief cause of the symptoms of compression which may follow. It is seldom that the bone is sufficiently depressed to cause general compression symptoms of itself, although when the depression is over a motor area it may give rise to paralysis or to symptoms of irritation of that area. When the general symptoms characteristic of compression are associated with a depressed fracture, it will generally be found that there is a collection of blood between the bone and the dura mater, in addition to the depression of the latter. The hæmorrhage in these cases may be severe and usually occurs from branches of the middle meningeal artery. It may also result from injury to one of the sinuses of the brain, or from laceration of the brain at the site of the injury, or at the opposite pole of the skull. This condition of intra-cranial hæmorrhage is considered on p. 370.

Punctured Fractures.—Punctured wounds of the skull are caused by some pointed instrument, such as a bayonet or a sword. The fractures are always compound and the inner table of the skull is often more extensively fractured than the external. In a punctured

fracture—for instance, one caused by a bayonet—a small and smooth hole in the external table is all that is noticeable from the outside, but the internal table is usually considerably detached and the fragments project against the dura mater, and may even perforate it, in which case their sharp edges may project into the brain itself. It is important to remember that, however insignificant the external wound may appear, there is certain to be considerable and serious damage to the internal table, which must be remedied. In these cases also, the instrument itself is very likely to puncture the dura mater and lead to hæmorrhage from the vessels in it, or even from those on the surface of the brain. In sword or axe-wounds the essential conditions are the same, except that, instead of a hole in the external table, there is a long cut—the so-called 'gutter fracture.' The internal table in these cases is also extensively broken up and depressed. As these fractures are always compound, they are liable to be followed by suppuration.

TREATMENT.—**1. Of a simple Fissure.**—Very little in the way of active treatment is required in these cases; unless accompanied by some intra-cranial lesion the injury is only recognised when the fracture is compound, and the treatment is then similar to that of a scalp wound (see p. 328). The disinfection of the wound should be thorough, and, provided it is effectual, the patient will be apparently well after a few days' rest in bed. Every fracture of the skull, however, is of necessity accompanied by some amount of injury to the brain, and although the patient may exhibit no definite symptoms pointing to an intra-cranial lesion, he will none the less be unable to carry out work requiring mental effort and concentration for a considerable time. It is therefore advisable after all cases of serious head injury to prescribe a long period of rest and abstinence from mental work and excitement.

In some cases these fissures are followed by intra-cranial hæmorrhage or intra-cranial suppuration, and in these appropriate treatment must be adopted; otherwise nothing need be done in the way of operation in the first instance. When the fissures are extensive and numerous, and when there is some irregularity about the edges, however, it may be well to make a small trephine opening so as to ascertain the condition of the internal table. The procedure is the same as that described below for other forms of fracture.

2. Of Depressed Fracture.—It may be laid down as an axiom that the depressed fragments should be elevated or removed, any detached portions of bone taken away, and all hæmorrhage arrested, without waiting for cerebral symptoms to supervene. Hence, operation is advisable in all cases of depressed fracture, except the saucer-like depressions in young infants (see p. 340), whether the fracture be simple or compound, and the sooner the operation is performed after the patient has recovered from the shock the better.

Simple depressed fracture.—The first procedure is to *shave the scalp*

over a wide area, and to disinfect it thoroughly (see p. 328). The fracture is then exposed by raising a semi-lunar flap, which should overlap the depressed area by at least half an inch. The flap should be cut so that the main vessels enter at its base, its convexity therefore being upwards. The incision should be carried down to and through the pericranium, and the latter should be raised by a periosteum detacher along with the skin flap. When the flap has been turned down, the fractured area is exposed to view, and the bleeding stopped temporarily by catching up the vessels with Ballance's or Spencer Wells's forceps.

Removal of bone.—The further procedure will depend largely upon

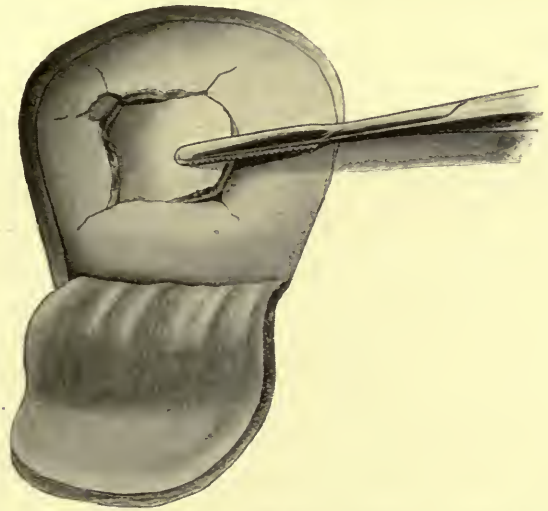


FIG. 145.—METHOD OF REMOVING A DEPRESSED FRAGMENT OF THE SKULL IN A DEPRESSED FRACTURE. A large flap has been turned down and a half-circle of the sound skull has been removed with a trephine. Through the aperture thus made the blade of a pair of forceps is introduced beneath the depressed fragment, which is then removed, the forceps being kept flat against the skull during the removal. In the case depicted above it was necessary to cut away some of the sound skull above the fragment with Hoffman's forceps in order to allow of extraction.

the amount of comminution and the presence of loose fragments. In some cases of badly comminuted fracture, loose portions of the bone can be lifted out and access thus obtained at once to the rest of the depressed area. An elevator should then be gently insinuated between the dura mater and the bone, and the remaining depressed portions elevated. If any of these fragments are completely detached, they should be removed so as to get a better view of the deeper parts, and any sharp projecting fragments of the internal table should be clipped away with punch forceps. It is important, in removing the detached fragments, to take care not to tilt them, otherwise their sharp edges may lacerate the dura mater; they should be drawn out very gently, and nearly parallel to the surface of the skull (see Fig. 145). This point is specially important

in cases of gutter fracture, in which, even though the dura mater may not be actually torn, fragments of the internal table are generally sticking into its outer surface. Forceps suitable for this purpose are shown in Fig. 146.

Should sufficient space not be obtained by the removal of the comminuted fragments, it is usually quite easy to punch out further portions of bone with a pair of Hoffman's forceps (see Fig. 147) so as to give enough room. It must be remembered that the chief object of the operation is to raise all the depressed bone and to remove any sharp edges of the internal table which may be projecting against the dura mater, and therefore sufficient space must be obtained in order to make sure that this object has been attained. When the fracture is not compound, the portion of bone removed by the trephine and any other large piece should be kept, in order that they may be replaced at the end of the operation. The best way of keeping the fragments of bone is to raise the flap a little at one side with the handle of the knife, and to push them under the flap until they are required. In this way the bone remains bathed in serum and blood at the temperature of the body, and the bone cells are less likely to lose their vitality than if the fragments were placed in warm boric lotion or warm salt solution, as is usually recommended. Of course, the latter procedure must be followed, should the circumstances of the case preclude the adoption of the former.

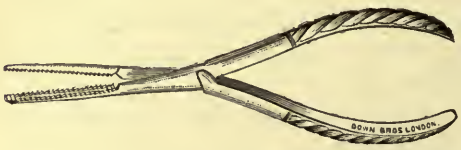


Fig. 146.—Forceps for removing depressed portions of the Skull. The blades are flattened and powerful; the teeth are directed backwards so as to ensure a good grip on the bone and to prevent slipping.

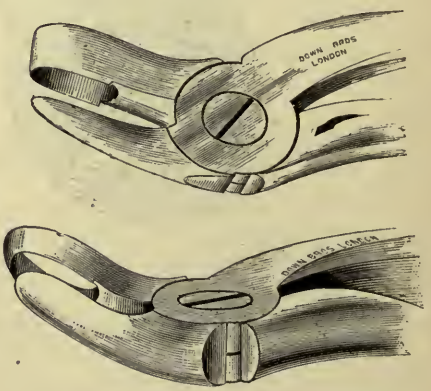


Fig. 147.—Hoffman's Forceps. These forceps are used for cutting away portions of the skull piecemeal. They are very powerful punch forceps, the lower solid blade fitting into the hollow of the upper hollow one. They are made in all sizes and degrees of strength, and the beaks of the instruments are variously curved so as to facilitate their application.

In some cases, however, it will be found on cutting down on the fracture that there are no detached fragments, and it will then be necessary to open up the depressed area, by removing a portion of the bone with a trephine. The pin of the trephine must be applied on firm bone close to the line of the fracture, and rather more than a half circle of the uninjured bone should be taken away (see Fig. 148). This gives free access to the deeper parts, and permits elevation of the depressed fragments and removal

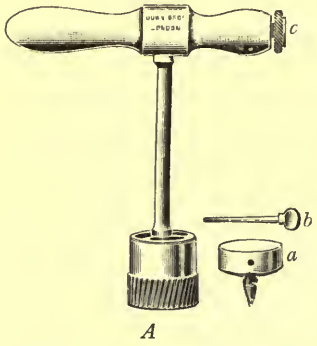
of any detached portions of the internal table. The bone removed with the trephine should be preserved and subsequently replaced in the wound.

In *trephining*, it is well to use a bevelled trephine with a loose pin (see Fig. 149) and a crown of about an inch in diameter; the trephine should

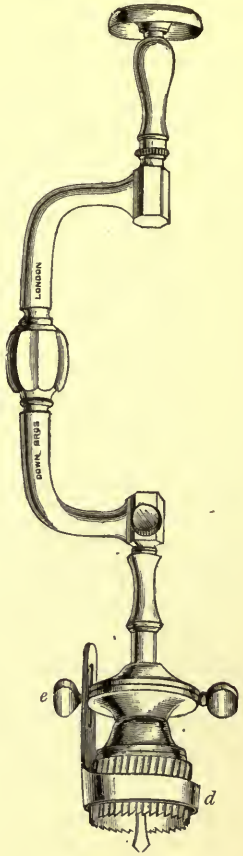
Fig. 148.—Trephining for a Depressed Fracture of the Skull. The solid line shows the portion of the trephine circle on the sound bone.

be attached to a centre-bit, so as to enable it to be worked quickly and smoothly. When a fairly deep groove has been cut in the bone, the pin is withdrawn and the division of the bone continued. The skull varies in thickness at different parts, and, as it is convex, the trephine is apt to bear more heavily on one side than on the other, and hence one part

of the circle may be cut through before the rest. Unless special care is taken, the result will be that the dura mater is lacerated on that side, and even the brain may be injured. Therefore, the trephine should be removed from time to time after it has got well into the diploë, and the end of a flattened probe or a quill should be passed around the groove in order to ascertain whether the bone is nearly or entirely cut



A



B

FIG. 149. — TREPHINES. *A* is the modern form in common use. The crown of the instrument is bevelled, and the pin is fixed to a solid metal block (*a*), which is kept in place by the pin (*b*), transfixing it and the crown. The handle is removed for cleaning purposes by unscrewing the nut (*c*).

B shows a somewhat similar instrument worked as a centre-bit. The crown and the pin are similar to those in the other figure, but, as the machine is here intended for rapid work, it is fitted with a guard (*d*), which, by the agency of the screw (*e*), regulates the depth to which the crown is allowed to penetrate. This is most useful when several circles of bone have to be removed near one another. The thickness of the first circle being ascertained, the guard is set to that, and very rapid work can be done.

through at any point. Should this be the case, the pressure must be made to bear on the thicker portions, and thus the skull can be cut through without injuring the dura mater. When the division of the circle is almost complete, the introduction of an elevator of suitable size will force out the circle of bone, which should be pushed under the scalp and kept there until the end of the operation. The depressed fragments of bone are then elevated, the internal table is examined, and any projecting portions are removed.

Arrest of bleeding.—Special attention must be paid to the arrest of hæmorrhage from the meningeal vessels; in some cases this is much more important and difficult than the treatment of the depressed fragments. Any blood-clot between the dura mater and the bone must be cleared away and active bleeding looked for. If blood wells up from the depths of the wound, an attempt must be made to arrest it, and this will usually entail the removal of further portions of the bone; this is most easily and rapidly done with a pair of strong Hoffman's forceps. The case at this stage very closely resembles one of extra-dural hæmorrhage after the clot has been turned out, and the further steps necessary to arrest the bleeding are identical (see Chap. XXXII.).

The replacement of the bone.—After having arrested the bleeding, the surgeon attends to the closure of the wound, and one of the chief questions is whether the portions of bone which have been removed should be replaced or not. That these fragments will unite and fill up the gap in the skull, provided they are kept aseptic, is amply proved, and apparently union occurs equally well whether the circle removed by the trephine is replaced entire or whether it is first broken up into smaller fragments. It is perhaps best on the whole to break up the fragments into smaller pieces, but they should not be cut up too small. In cases of meningeal hæmorrhage the brain may not expand immediately if the bleeding has gone on for any time, and unless it does, the bone will not have a proper substratum to rest upon. Hence the question depends to a considerable extent upon the expansion of the brain; if the dura mater bulges into the opening in the skull, the portions of bone may be replaced. The replacement of the bone is even more important when the dura mater has been lacerated and cannot be closed, because in these circumstances, the replaced bone may help to form an obstacle to the protrusion of the brain.

When the dura mater has been torn, the cerebral cortex is very apt to become adherent to the edge of the dura mater or to the bone itself, and these adhesions are known to be a potent cause of epilepsy or even of certain forms of insanity. With the object of avoiding such a complication, various substances have been placed between the brain and the skull. Lister's protective, sheet rubber, and other materials have been used. The best seems to be thin gold-foil, which is placed over the surface of the brain beneath the dura mater extending beyond the torn edges of the latter for a quarter of an inch or more. The problem, however, does not seem to have been satisfactorily solved yet. The bone is not replaced when gold-foil is used.

The flap may be stitched down with a continuous suture and in most cases it is not necessary to put in a drainage tube; if, however, there is much oozing from the cut surfaces of the bones, it will be advisable to insert one beneath the flap for twenty-four hours. As a rule it is better not to use a drain unless there is a risk of bleeding to such a degree as to reproduce the symptoms of compression.

After-treatment.—The patient should be kept in bed in a dark room, and noise and disturbance of all kinds should be avoided. The bowels should be freely opened by means of a purge (calomel, gr. iv.-vij.), stimulants should be avoided, and a liquid diet maintained for a few days. If a drainage tube has not been inserted, the dressing need not be changed for about ten days, otherwise it will require renewal at the end of twenty-four hours in order to remove the tube.

Compound depressed fracture.—When a depressed fracture is compound the conditions are not nearly so favourable, for there is certain to be septic material in the wound and the fractured surfaces may be extensively soiled. The first point, after having shaved the head and disinfected the scalp thoroughly, is to open up the wound so as to expose the injured area fully. The scalp, with the pericranium attached to it, is raised and held aside. Before proceeding to deal with the bone itself, the edges and deeper parts of the wound should be thoroughly disinfected (see p. 328), and undiluted carbolic acid should be applied to them. Any bleeding vessels are clamped and the entire fractured area is then opened up, either by removing loose fragments or by a preliminary trephining in the immediate neighbourhood (see p. 345). The fractured surfaces are cleaned from dirt and blood-clot and touched with undiluted carbolic acid or clipped away with punch forceps. It is best not to replace the detached fragments. The wound should be stitched up over the line of fracture, but an opening should be made for drainage at the most dependent part, because the disinfection may not have been entirely successful.

3. Of Punctured Fracture.—Cases of punctured fracture must always be operated upon in order to remove the detached portions of the internal table of the skull which project against and injure the dura mater. The same holds good with regard to 'gutter fractures.'

The best plan is to turn down a flap which has the hole in the skin about its centre, and the opening in the skin itself should be thoroughly disinfected as already described (see p. 328), or, better still, excised. The trephine is then applied with the pin just at the edge of the puncture in the skull so that the circle of bone removed includes the punctured portion; when the circle of bone has been taken away, the detached fragments of the internal table must be removed. If the dura mater has been injured, it will be advisable to enlarge the opening in it, because fragments of the internal table may have been pushed into the brain; these must be carefully sought for and removed. If possible, the opening in the dura mater should be closed by catgut stitches, and in most cases it is not advisable to put back the circle of bone or any portions of it. It will often be found that it is only necessary to cut through the external table with the trephine, the broken-up inner table being then exposed at once. The wound is stitched up and a drainage tube inserted at the most dependent part; a stitch should also be put in the puncture

through the scalp. In the case of gutter fractures it may be impossible to turn aside a flap, and the opening must simply be enlarged as much as may be necessary and the edges of the wound held aside. The fracture is then dealt with as described above, the trephine being applied on the side on which the depression is least marked.

After-treatment.—The chief danger is septic infection of the wound followed by suppuration either between the skull and the dura mater, or beneath the latter (*i.e.* lepto-meningitis), or in the brain itself; hernia cerebri is also a common complication. The avoidance of these conditions will depend on the care with which the disinfection of the wound is carried out; if this is successful, septic inflammation will not occur. When the dura mater is torn, however, even though the wound be aseptic, a certain amount of protrusion of the brain may take place and be difficult to deal with, because the wound in the soft parts probably lies directly over the rent in the dura. In aseptic cases, however, this protrusion rarely gives rise to trouble and diminishes as the wound contracts.

It is well to change the dressing on the day following the operation and subsequently according to the amount of discharge. The drainage tube should be removed about the fourth day, provided that there is no sign of sepsis. The bowels should be kept open from the first, and the patient should be restricted to a fluid diet without any stimulants. If there are no signs of cerebral irritation or inflammation—such as increased frequency of the pulse, persistent headache, elevation of temperature, or delirium—the diet may be cautiously increased in a few days, and the patient allowed to sit up; in the course of two or three weeks he may be allowed to get out of bed.

FRACTURES OF THE BASE OF THE SKULL.

Fractures of the base are generally fissured fractures, although, when the injury has been very severe, portions of the base may be completely loosened and very extensively comminuted. The fissures are generally widespread both about the base and also up the sides of the skull and may even extend well on to the vault. In almost all cases there is considerable hæmorrhage from the torn vessels, part of the blood escaping externally and part accumulating within the skull. When the dura mater is torn, as it usually is, cerebro-spinal fluid and sometimes also brain substance escapes from the subarachnoid space. These fractures are almost always compound in some part of their course, many of them opening into the ear or the nose. There is, therefore, a great risk of septic complications, and subdural abscess or suppurative lepto-meningitis may occur.

These fractures of the base are very serious injuries, chiefly on account of the damage done to important structures at the base of the brain, and also on account of the risk of septic complications; their gravity

is especially great, because the injured areas are inaccessible. The fractures are not necessarily limited to a single fossa of the skull, but it is usual to divide them into fractures of the anterior, middle, or posterior fossæ, according to the region in which the greatest damage has occurred. The line of fracture most frequently runs through the middle fossa, breaking the petrous bone at its weakest part, and usually opening into the middle ear; from this point the fissure runs forwards and inwards across the sphenoid. In fractures of the anterior fossa the roof of the orbit gives way; the line of fracture may run backwards into the middle fossa. In the posterior fossa, the fissure usually runs downwards behind the mastoid process.

Much discussion has arisen as to the way in which these fractures are caused. They usually follow falls upon the vertex or blows upon the side of the head. The original view was that in falls upon

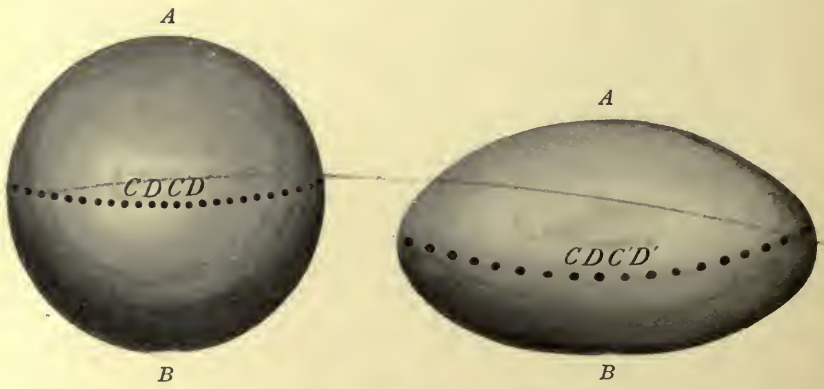


FIG. 150.—THE 'BURSTING' THEORY OF FRACTURES OF THE SKULL EXEMPLIFIED IN A TENNIS-BALL. The explanation is given in the text.

the vertex the fracture of the base occurred by transmission of the violence through the arches of the skull down to the base; this was called 'fracture by *contre-coup*.' It was, however, noticed that the fissures were not limited to the base, but extended up towards the vertex, and another view was suggested, viz. that fractures of the base were really direct continuations from fractures of the vault, and that, when the patient fell upon the vertex, a fissure was produced which radiated downwards to the base of the skull. While it is possible that fracture is produced in this way in a certain number of cases, this theory does not satisfactorily account for the majority of the cases, and of late the elasticity of the skull has been looked on as the chief factor in its production.

Take a tennis-ball (see Fig. 150) and mark two points, *A* and *B*, on it at opposite poles. Midway between these draw a line round the ball forming an equator, and on this mark a series of equidistant pairs of points, *CD*, *C'D'*, etc. Now if the ball be compressed between *A* and

B, it becomes flattened, its vertical diameter is diminished and its equatorial diameter increased, from which it follows that its equatorial circumference is increased also. The points *CD*, *C'D'*, etc., will therefore be farther apart from each other than they were before the compression, and in consequence there will be tension on the material between *C* and *D*, *C'* and *D'* and so on. If the material between *C* and *D* be the weakest part of the ball, a split will occur here, otherwise it will take place at some other point on the equator, *e.g.* between *C'* and *D'*. It is obvious that there is increased tension between any two points situated on any part of the ball, but the maximum tension occurs around the equator, and it is here that the split will start and will extend upwards and downwards towards the poles.

A similar condition exists in the skull when the patient falls upon the top of the head. The elasticity of the skull permits a certain diminution in the vertical diameter of the head, the result being that the bone in the lateral areas around the base is bulged outwards. If the bulging is carried too far, fracture occurs at this point, and fissures run thence downwards towards the base and also to a lesser extent upwards on to the vault. Thus these fractures start, not from the point of impact, but from the point of greatest increase of circumference, and thence run upwards and downwards. Fractures produced in this way are sometimes described as 'bursting fractures' (see Fig. 151).

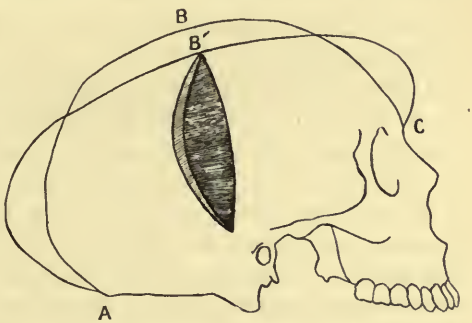


FIG. 151.—'BURSTING FRACTURES' OF THE SKULL. Diagram to illustrate how the normal skull ABC, when struck violently on the vertex assumes the shape AB'C and finally bursts, giving rise to a fracture indicated by the shaded area.

The **complications** of fracture of the base are the same as those which accompany fracture of the vault. The chief are compression of the brain and septic troubles.

The **diagnosis** can generally be made from a study of the various phenomena. In *fractures of the anterior fossa*, blood may accumulate in the fat and connective tissue of the orbit in sufficient quantity to cause proptosis; it then passes forward beneath the conjunctiva, and usually shows first over its lower segment. There is frequently some injury to one or more of the ocular nerves as they emerge from the cranial cavity. There is almost always epistaxis owing to the fracture of the cribriform plate, and later on there may be escape of cerebro-spinal fluid from the nose.

In fractures of the middle fossa, hæmorrhage occurs from the ear, if the membrana tympani has been ruptured. Blood may also run down the

Eustachian tube into the pharynx and appear in the nose. The amount of blood thus lost may be considerable. It must, however, never be forgotten that an uncomplicated injury to the tympanic membrane may produce bleeding which may simulate that due to a fracture of the base; in that case, however, the hæmorrhage is usually slight and transitory. Cerebro-spinal fluid also escapes freely from the ear, sometimes in large quantities; when this occurs there can be no doubt about the diagnosis. The amount of cerebro-spinal fluid lost is larger in fractures of the middle fossa than in the other situations; when the quantity of fluid is very small, it may be simply blood serum, or possibly fluid from the labyrinth. The escape of brain matter from the ear may also occur in very bad fractures, and in a few instances emphysema of the skin over the mastoid process has been noticed.

In fractures through the posterior fossa, extensive ecchymosis may occur about the mastoid process and in the neck. When the blood has escaped among the deeper cervical muscles, the ecchymosis may not be apparent for several days.

Treatment.—There are three main points in the treatment of cases of fracture of the base of the skull: To arrest the hæmorrhage; to diminish the inflammatory action; and to avoid sepsis.

Arrest of hæmorrhage and diminution of inflammatory action.—The patient should be placed in bed with the head slightly raised and fixed between sand-bags, and a Leiter's coil (see Fig. 136) should be applied to the head, the temperature of the water being about 40° F. The head need not be shaved; if the hair is thick it should be cut short. The room should be darkened and the patient kept absolutely quiet and free from noise. It is well to administer five grains of calomel immediately; if this does not produce a satisfactory action, one or two drops of croton oil mixed with powdered sugar may be given. The patient is generally in a state of shock when first seen, and should be covered with warm blankets, outside which hot bottles should be applied to his feet and sides. Alcohol should be avoided, as it tends to increase the hæmorrhage; subcutaneous injections of strychnine (gr. $\frac{1}{30}$) or pituitary extract are of value if the patient is collapsed. The treatment at this stage is that suitable for concussion of the brain (see Chap. XXXII.). Retention of urine is common, and a soft red rubber catheter, sterilised by boiling, should be passed as soon as there are any signs of distension of the bladder.

These measures are frequently insufficient to check the hæmorrhage, and as a result symptoms of compression of the brain set in. Unfortunately it is impossible to do much for the relief of the cerebral compression in these cases. In fractures through the anterior fossa, however, operations for the removal of the clot and the arrest of the bleeding have been successfully performed. This is especially likely to be the case when the bleeding is from the middle meningeal artery, and in cases of

fracture of the anterior fossa with compression from intra-cranial hæmorrhage, it is quite justifiable to trephine with the view of clearing out the clot and arresting the bleeding if possible. The trephine should be applied in the temporal fossa just in front of the ear and just above Reid's base line (see Chap. XXXVI.). This gives good access to the base of the skull, and by lifting up the dura mater it may be possible to wash out the blood-clot with a gentle stream of warm sterilised normal salt solution, or to turn it out with a scoop. If the bleeding comes from the middle meningeal artery that vessel can usually be secured after enlargement of the opening in the bone. It is not uncommon, however, to find that the blood is coming from a large venous sinus, such as the cavernous sinus, and if this be the case the best procedure, after removing the clot, is to introduce strips of gauze beneath the dura mater up to the bleeding point so as to exercise pressure on it ; these strips are removed at the end of about twenty-four hours.

Avoidance of Sepsis.—It is of the utmost importance to guard against the occurrence of sepsis as far as possible. This is a difficult matter because no proper disinfection of the wound in the soft parts or the bone can be carried out owing to the situation of the fracture ; at the same time there is not the same soiling of the fractured area as there is in a compound fracture of the vertex. Hence, if the subsequent entrance of sepsis can be avoided, the patient may escape septic complications.

In fractures of the anterior fossa, the nasal cavity should be washed out gently with warm boric lotion so as to prevent blood-clot accumulating and undergoing putrefraction ; the douching should be repeated several times daily for the first few days. No force must be used, otherwise the fluid may pass into the cranial cavity ; the object of the douche is not to disinfect anything, but to wash away material which might otherwise undergo decomposition. As a rule the bleeding will stop spontaneously, but it is well to introduce cyanide gauze into the anterior nares ; this should not be pushed up to the region of the fracture, but should simply act as a filter for the air, and should be changed frequently.

In fractures of the middle fossa, the external auditory meatus should be swabbed out with 1 in 2000 sublimate solution as far back as the membrana tympani, and all clots should be washed out of the ear with a fine-nozzled irrigator. Great care must be taken to avoid douching under pressure, because the fluid cannot escape freely. The meatus is then packed with sterilised cyanide gauze, which should be changed frequently ; the douching may be repeated two or three times a day.

Urotropine in doses up to twenty grains three times a day (provided it does not cause irritation of the bladder) is said to be of value in these cases, the drug decomposing to form an antiseptic substance which is secreted into the cerebro-spinal fluid.

After-treatment.—The after-treatment is similar to that already described for fractures of the vault.

GUNSHOT WOUNDS.

Gunshot and shell wounds of the head are met with both in civil and in military practice. The principles of treatment are the same in both cases, but the military surgeon labours under special disadvantages inseparable from war. In the majority of cases a considerable time must elapse before the patient reaches him, and there may be a further delay before conditions suitable for a surgical operation are obtainable. Even when an operation has been performed, the constant removal of the patient from place to place, necessitated by the movements of the army, considerably prejudices the result. In spite of these difficulties, however, the lines of treatment laid down for civil practice should be followed as strictly as circumstances permit.

The character of these injuries varies considerably, according to the nature of the arm with which they are inflicted, the size, shape, and velocity of the projectile, and the angle at which it strikes the skull. Gunshot wounds may affect the soft tissues only or may injure the bones as well.

INJURY TO THE SCALP ALONE.—In some cases the bullet may pass so superficially that it misses the bones altogether, or it may glance off the smooth surface of the skull, or its energy may be so slight that it only penetrates the scalp, flattening itself against the bone and remaining as a subcutaneous foreign body. In addition to the local injury, these patients frequently suffer from concussion.

These wounds are always contused and may be infected before they come under the care of the surgeon; the treatment differs in no way from that already described for ordinary contused scalp wounds (see p. 328).

INJURY TO THE BONE.—*Severe injuries* to the cranial bones are produced by fragments of shell, the irregular slugs used by savage tribes, and the old-fashioned, round leaden bullets discharged at close range. The modern conical bullet at close range produces an explosive effect in passing through the skull, which often kills the patient at once, while at long ranges this explosive effect may not occur, and the patient may survive the immediate injury. Remarkable cases have been recorded in which patients have recovered after the most extensive injuries of this character. In some cases, death is not instantaneous, the patient remains comatose and dies in a few hours; in others the symptoms of concussion and laceration appear and pass off, leaving the patient with an extensive wound, at the bottom of which the brain substance is exposed.

Treatment.—The first points to be attended to are the arrest of the hæmorrhage, and the disinfection of the wound. These are effected on the lines already laid down; in performing disinfection, there should be no hesitation about the employment of strong antiseptics, the chemical irritation being a small matter as compared with the risk of sepsis. All

foreign bodies and loose fragments of bone should be removed. An attempt should be made to cover the deficiency in the bone with flaps from the healthy scalp, so as to minimise the risk of hernia cerebri. It is impossible to give the details of these operations, but as a rule the best plan will be to slide a large flap of the scalp, with its base downwards, over the deficiency; this will leave a raw surface over the uninjured skull, which can be skin-grafted subsequently. These cases are specially liable to hernia cerebri (see Chap. XXXIV.).

The less severe injuries to the bone may be divided into gutter or saucer-shaped fractures, perforating fractures, and penetrating fractures. A *gutter fracture* is produced by a high velocity bullet striking the skull almost tangentially, cutting a groove in the outer table, and fracturing the inner table over a corresponding area. The *saucer-shaped fracture* is produced by the impact of a low velocity projectile, the energy of which is insufficient to penetrate the skull, but enough to fracture it and depress the fragments. In a *perforating fracture* the bullet passes through the skull and thus there are two fractures; in a *penetrating fracture* the bullet only passes through one side of the skull and lodges in the cranial cavity.

Treatment.—The injuries to the soft parts must be treated on the lines already laid down under scalp wounds. The treatment of the injuries to the bones is that of compound depressed fracture, and the skull must be opened in all cases so as to deal with the inner table. The need for this is evident in the case of saucer-shaped fractures, which differ in no way from those produced by a blow on the head with a blunt instrument such as a hammer. Even in gutter fractures the skull must be trephined, on account of the comminution of the inner table, although the injury to the skull may appear to be only a shallow groove in the outer table.

PERFORATING FRACTURES.—These are the most common results of the modern conical bullet fired at medium ranges. There is a small wound of entrance with punched-out margins, and a similar but slightly larger wound of exit. The holes in the skull are sharply cut, usually with a few short radiating fissures around the apertures. Connecting the two openings in the skull is the track of the bullet through the brain; the central core of this consists of the disorganised brain substance which has been actually crushed by the bullet, and surrounding this is a cylinder of brain tissue which has been severely injured; the closer the range the wider the destruction around the central track. The zone of damaged brain is not sharply marked off, its outer part being capable of recovery to a certain extent, its inner part being irretrievably injured. The results of such an injury will depend, of course, upon the part of the brain affected and the amount of damage done to the larger blood-vessels; thus a bullet may go transversely through both frontal lobes and the patient may make a complete recovery,

or it may pass towards the base of the brain, divide some important artery, or perforate some vital centre and cause instant death.

At long ranges the injuries produced may be more severe than those at medium ranges. This is due to the fact that the bullet has turned in its flight and struck the skull sideways instead of with its point, thus becoming, to all intents, a larger projectile. Furthermore, the regular spin, which the rifling of the barrel imparts, is converted into an irregular wobbling movement around a point just behind the shoulder of the bullet. This tends to cause more irregular wounds than the steadily rotating bullet.

Treatment.—In the early days of military surgery every head case was trephined, in an apparently haphazard manner; thus Philip, Count of Nassau, is said to have survived twenty-seven trephinings. This indiscriminate use of the trephine led to a reaction and, at a later period, bullet wounds were usually left alone. It must be remembered, however, that all bullet wounds of the skull are depressed fractures and should be treated as such. Actual trephining is not always necessary, but after the disinfection of the superficial wounds the openings in the skull must be enlarged and any loose or depressed fragments of bone removed. Superficial vessels are ligatured, and a way of escape made for any deeper extravasations; no attempt should be made to disinfect the channel through the brain, which will probably be aseptic, unless some foreign material has been carried in. When the injury does not affect a vital part of the brain or an important vessel, these cases may do well, although in military surgery they are specially exposed to septic complications.

PENETRATING FRACTURES.—As in many cases met with in civil practice, the injuries may be comparatively trivial, the bullet passing through the skull and lodging just within it, or they may be amongst the most serious types of gunshot wounds, with extensive fracture of the skull and laceration of the brain.

Treatment.—The fracture itself must be dealt with on the lines mentioned above for perforating fractures. While it cannot be doubted that removal of the bullet is desirable, a prolonged search for it may cause a severe injury to the brain. If it presents in the wound or at the opposite side of the skull, it should be removed; if it cannot be readily discovered, the surgeon should merely remove any depressed fragments of bone and disinfect the wound. Later on, when the wound has healed, an accurate localisation of the bullet may be made by radiograms, and from its position and the symptoms to which it gives rise, the question of its removal must be considered. In many cases it will be found lodged among the muscles of the neck, where it may be safely left, unless it is causing pain; or it may be lying immediately beneath the skull at a point exactly opposite the wound of entry, and can be removed without difficulty. If,

however, it is embedded in the substance of the brain it is usually better to leave it alone. Some surgeons have advocated keeping the patient with the wound of entry in a dependent position, in the hope that the bullet will gravitate towards the opening in the skull and come within reach. It is doubtful, however, whether this suggestion is of any value.

Apart from the immediate risks of hæmorrhage and sepsis, the subjects of gunshot injuries are liable to be mentally unstable for the rest of their lives, and in some cases this may amount to actual maniacal outbursts, terminating occasionally in sudden death.

CHAPTER XXXI.

DISEASES OF THE SKULL.

ACUTE PERIOSTITIS AND OSTEO-MYELITIS.

This disease usually follows a compound fracture in which there has been septic infection of the diploë, but it may also be due to extension from a septic scalp wound, from operations upon the frontal sinus, from middle-ear disease, or even from inflammations of the skin, such as boils, or carbuncles; sometimes, though very rarely, it may occur without an external wound.

The pathological characters are practically the same as those of the disease elsewhere. In the skull, however, the disease is even more dangerous than it is in the extremities, for it is especially prone to be followed by sinus phlebitis and pyæmia, by lepto-meningitis, or by abscess in the brain, and the great majority of these cases end fatally. The affection extends rapidly over the entire bone first attacked, but it generally stops at the sutures for a time, although eventually it may pass on to the periosteum of adjacent bones.

The disease is usually ushered in by a rigor and is followed by a very tender localised œdematous swelling—a condition described by Pott in connection with injuries of the skull and named after him '*Pott's puffy tumour*.' Such a condition in connection with a wound of the scalp should at once arouse a suspicion of acute osteo-myelitis. When the disease occurs in connection with a compound fracture there is generally a marked diminution in the amount of the discharge from the wound, the edges become everted, the granulations unhealthy, and the periosteum recedes from the bone and leaves it bare.

TREATMENT.—The diploë must be opened up at once, and if necessary, the whole thickness of the bone should be removed; the sooner and the more thoroughly the operation is performed, the better the chance of recovery. The wound should be enlarged or, if there is no wound, a flap should be turned down. The outer table of the skull is

then divided by a trephine and detached by means of a chisel. The diploë is thus exposed and should be thoroughly gouged out wherever it is found infiltrated with pus or reddened by inflammation. Should the whole of the inflamed area not have been exposed in the first instance there must be no hesitation in enlarging the wound and stripping off the requisite amount of the external table, even if it involves laying open the entire bone. After all the infected diploë has

FIG. 152.—REMOVAL OF THE DIPLOË IN ACUTE OSTEO-MYELITIS OF THE SKULL. The outer table has been cut away, partly with a trephine and partly with a gouge. The diploë has also been freely gouged away, and in the centre is seen the trephine hole through the internal table, made for the purpose of inspecting the condition of the dura mater. The original scalp wound is seen in the centre of the reflected flap.

been removed, undiluted carbolic acid is applied freely to the exposed bony surface, as in a compound fracture; when a wound exists, the acid is also applied to the whole surface after the granulations have been removed with a sharp spoon.

It is well to trephine the inner table, opposite the centre of the inflammatory area, taking great care not to injure the dura mater (see Fig. 152); the object of this is to see whether there is suppuration

between the dura mater and the bone. If no suppuration is found, the dura mater should not be stripped away from the bone, but the wound should be closed, after providing efficient drainage. When, however, pus is found beneath the bone, or when the dura mater is affected, the whole of the skull superficial to the affected area should be cut away with Hoffman's forceps. In bad cases the wound should be packed with gauze for two or three days. If the disease shows signs of recovery the gauze is removed, drainage tubes are introduced, and the flaps sutured.

TUBERCULOSIS.

Tuberculous disease of the skull is not common except in connection with the mastoid and petrous portions of the temporal bone. In the vault it is comparatively rare, and most often affects the frontal and parietal bones. In the frontal bone it usually occurs in the neighbourhood of the orbital margin and the external angular process. The disease chiefly affects young adults, and, as a rule, is secondary to tuberculous disease elsewhere. Indeed, tuberculosis of the flat bones of the skull usually only occurs in the course of similar disease in other bones. It may begin in several parts of the skull at the same time, but it usually commences at one spot, and is frequently preceded by an injury. When the condition is one of multiple tuberculosis of the skull, the prognosis is very bad, and in any case the disease is serious.

In the flat bones the disease most frequently commences in the diploë, either as a soft deposit or as a sequestrum. The sequestra are small, and usually involve the whole thickness of the skull, the inner table being more extensively affected than the outer. The dura mater is often separated from the bone over a considerable area by a mass of tuberculous material undergoing caseation. There is also a tendency to thickening of the dura mater—the condition known as tuberculous pachymeningitis. The gravity of the disease depends partly on the danger of infection of the membranes and consequent tuberculous meningitis, and partly on various septic risks, such as pyæmia, sinus thrombosis, acute osteo-myelitis, acute meningitis or cerebral abscess.

The disease usually commences with a severe dull, aching pain in the head, and tenderness on pressure over the affected part. The pain is presently followed by a soft swelling which very soon develops into a chronic abscess. After the abscess bursts or is opened, the bone is felt to be bare and soft, and in most cases small necrosed fragments may be found. Sometimes, however, the disease extends more towards the deeper surface of the bone, and then symptoms of cerebral compression may arise after the pain has lasted for some time, owing to the formation of pus between the dura mater and the skull.

TREATMENT.—As the condition is serious, it is important to take energetic operative measures as soon as the diagnosis has been made, for the chances of recovery without operation are small.

When tuberculous disease affects the vault of the cranium the operative measures must be on the lines already laid down for the treatment of tuberculous disease of bones in general (see Vol. II.). The affected area should be freely exposed, either by a flap carried wide of the diseased region in cases in which there is no external opening, or by excision of any tuberculous ulcer which may be present and enlargement of the wound. The periosteum over the diseased area should not be turned down with the flap, but must be left *in situ* and removed with the bone; all caseating material or granulation tissue between the scalp and the bone should be carefully dissected away. The whole area of the skull affected should then be cut away, either with a trephine or by any other suitable means, and in the majority of cases it is well to remove the whole thickness of the bone and expose the dura mater. This should be done even though large portions may require removal, otherwise there is considerable risk of extension of the disease. When the dura mater is healthy it should not be opened. The raw bone surface left should be touched with undiluted carbolic acid and the wound closed.

The dura mater, if affected, should be cut away, and any commencing disease in the underlying membranes should be removed. The removal of the dura entails a serious risk of hernia cerebri, but, if the wound be aseptic, this can generally be prevented, while it is of paramount importance to remove the whole of the tuberculous disease. The treatment of hernia cerebri is described on p. 407. With the view of obviating the risks of hernia in cases in which the skin is not involved, it is well to turn down an exceptionally large flap so as to carry the line of incision in the scalp well away from the opening in the bone, so that if the brain does protrude, the hernia will be prevented from increasing to any great extent by the pressure of the flap.

When tuberculous disease affects the base of the skull, the removal of the tuberculous tissue cannot, as a rule, be complete. When the disease occurs in the petrous portion of the temporal bone, it manifests itself as a middle-ear affection with discharge from the ear, which is usually foul and caseous, and it may be followed by disease of the antrum and all its sequelæ. The treatment consists in opening up the antrum and the tympanic cavity freely and clearing away the tuberculous material and any carious bone within reach. A considerable area of bone may be taken away if the surgeon bears in mind the anatomical relations of the part, more especially the situation of the lateral sinus and the facial nerve; it is always well to lay the antrum, the tympanic space, and the external meatus into one large cavity. This should be packed with gauze until its wall has become covered with granulations. The patient should be put under the best possible hygienic conditions, and sent to the country after the wound has healed. Tuberculin may be given.

SYPHILIS.

In the secondary stage, periosteal nodes are not uncommon and are chiefly found over the frontal bone, usually affecting the external surface only. Syphilitic periostitis may also be met with in the interior of the skull, most frequently about the foramina through which the various cranial nerves pass out; the resulting new material may cause pressure on the nerves and consequent paralysis.

In the tertiary stage, the skull is one of the favourite seats of syphilitic bone disease, and it may occur either in the form of a chronic osteitis or of gummatous disease, the latter frequently resulting in necrosis. In most cases, indeed, the two processes are combined, the original trouble being the formation of a gumma in the periosteum or the diploë, followed by osteitis round about. The necrosis is essentially a septic process, and is only found when the gummata have ulcerated and secondary infection has taken place.

Gummatous disease of the bones most often affects the frontal bone, and the condition used to be spoken of as 'corona veneris.' The whole thickness of the bone or only the external surface may be affected, and the gummata are usually multiple. The gummatous infiltration soon spreads to the soft tissues, which ultimately give way, forming characteristic tertiary syphilitic ulcers with dead bone at the bottom. Gummatous disease of the skull may be very serious on account of the risk of various complications, such as erysipelas, sinus thrombosis, or septic meningitis.

TREATMENT.—The treatment *in the secondary stage* is practically the same as that for secondary bone lesions elsewhere (see Vol. I. Chap. XI.).

In the tertiary stage, the treatment will be that appropriate for tertiary bone lesions elsewhere (see Vol. II. Chap. XXV.), but the septic factor must always receive careful consideration. Should the gumma be on the point of breaking down, the hair over it should be shaved, the skin carefully disinfected and an antiseptic dressing applied. If ulceration occurs, the wound should be dressed with full antiseptic precautions until it is soundly healed.

When the case does not come under treatment until definite necrosis is present, the question of operative treatment arises, as the necrosed fragment may remain adherent to the living bone for a very long time. It may therefore become advisable to remove the necrosed fragment with portions of the thickened bone in the vicinity, so as to leave a wound which will heal more readily under antisyphilitic remedies.

Sequestrotomy.—The removal of the sequestrum may be effected as follows: The scalp should be thoroughly purified in the usual manner, and it is well to scrape the ulcer and pare away its margins; after the

bleeding has been arrested, the raw surface is impregnated with undiluted carbolic acid, for it is very important to render the wound as aseptic as possible. The opening is then enlarged in any direction that may seem most suitable, flaps are turned aside, and the diseased area is exposed. A trephine larger than the necrotic area is then applied, the outer table of the skull divided, and the whole necrotic area gently chipped away with a chisel and hammer. Very frequently the sequestrum does not go deeper, and in that case it is advisable not to interfere with the internal table. Should the disease be found to extend deeper, however, the trephine can be reapplied and the internal table removed. The bone is often very dense and difficult to cut through and, should this opening not be sufficient, it is not at all easy to enlarge it with cutting forceps; it will generally be necessary to make additional trephine openings. Great care should be taken not to injure the dura mater on account of the danger of septic meningitis. The cut surfaces of bone should be sponged with undiluted carbolic acid.

As these operations are usually undertaken in cases of open wounds, it is not easy to close the wound again, and usually it must be packed with gauze. This is probably the best treatment when the internal table has not been removed, and it should be continued until the whole wound is covered with healthy granulations. Skin-grafting may then be employed (see Vol. I. p. 52), otherwise there may be great delay in the healing of the wound owing to the difficulty of contraction.

When, however, the whole thickness of the bone has been cut through, and the dura has been exposed, it is better to attempt to close in the exposed dura mater at once by some form of plastic operation. It may be necessary to make a curved incision outwards and downwards from one angle of the wound, so as to allow a portion of the scalp to be turned in over the wound (see Vol. I. p. 159). With this treatment the patient is much more likely to recover and to escape complications than when medicinal treatment alone is adopted.

The syphilitic bone diseases of infancy and childhood do not call for special mention. The treatment is that of congenital syphilis (see Vol. I. Chap. XI.), and, so long as the skin has not ulcerated, it will suffice to employ general antisyphilitic measures.

CRANIO-TABES.

Very little need be said about congenital defects in the skull, because there is practically nothing to be done for them. In some cases there may be so much atrophy of the skull as actually to lead to the formation of perforations in the bone. This condition is common in the skulls of aged people and cannot be averted.

In infants, a localised thinning of the skull occurs termed *cranio-tabes*, and is essentially due to rickets. Some authorities ascribe it to congenital

syphilis, but this view has few supporters. The condition shows itself either by imperfect ossification of the skull or by malformations of portions of the cranium in which ossification has already taken place. The result is that the cranial bones become thickened in some parts, while in others (especially where they are subject to pressure), they become extremely thin, and openings through the bone may actually form. The condition is most marked over the parietal and occipital bones where the head is subject to pressure, the result being that the skull is usually flattened posteriorly. Signs of rickets may be found in the bony skeleton elsewhere, and also various nervous symptoms, such as laryngismus stridulus.

TREATMENT.—The treatment of this condition is that of rickets (see Vol. II. p. 464). When an infant shows a tendency to rickets, care should be taken that the position of its head is frequently changed, so that there is no prolonged pressure on any individual cranial area; if the bone has actually become thinned, some arrangement, such as a celluloid or aluminium shield, or a ring-pad, must be devised to take off the pressure altogether.

LEONTIASIS OSSIUM.

This condition is the reverse of the preceding one; in it the bone becomes immensely thickened from causes which are not definitely determined. A somewhat similar condition of hypertrophy of the skull may also occur in osteitis deformans (see Vol. II. p. 475).

In leontiasis ossium the skull may be much distorted in appearance owing to the presence of local thickening of the bones; this may produce a sort of leonine aspect, hence the name, Leontiasis. These new-formed bosses of bone may occur on the cranial bones or in connection with the jaws, especially the upper; they give rise to remarkable deformities and to various pressure symptoms. When the bosses are on the upper jaw or the frontal bone, they may project into the orbit and lead to pressure on the optic nerve and loss of sight; when the vertex is affected, the pressure may cause various brain symptoms.

TREATMENT.—The disease is slow in its progress, and we know of no means of checking it. In some cases, however, surgery may be of value for the relief of the pressure symptoms. For example, when the growth is extending towards the orbit and interferes with vision, or when it presses on the brain, the removal of the particular boss of bone is indicated. At the same time it must be remembered that the operation is a purely temporary expedient to relieve the symptoms, and does not cure the disease.

NEW GROWTHS OF THE SKULL.

Tumours of the various types met with in other bones occur in connection with the skull.

EXOSTOSES.

Among the commonest tumours met with on the skull are exostoses which are generally of the hard or ivory form. They occur chiefly on the frontal bone, or in the bony auditory meatus. Usually they grow from the external table of the bone and do not cause any symptoms; sometimes, however, they may arise in the neighbourhood of the orbit and may lead to serious pressure on the optic nerve. If the exostosis is situated

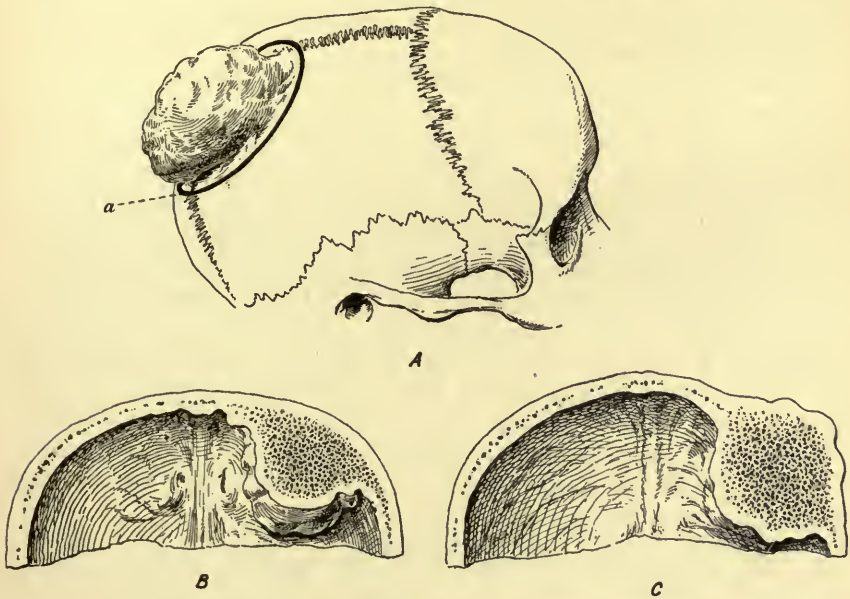


FIG. 153.—EXOSTOSES OF THE SKULL. *A* shows the ordinary form of the ivory exostosis affecting the outer table only; the thick black line (*a*) represents the incision in the skull necessary for its removal. This may be made with a gouge, a parting tool, or a circular saw. If the growth is small enough, the circle may be made with a trephine. *B* is the same form of growth springing from the inner table, while in *C* the growth (usually spongy) affects the entire thickness of the bone.

in the external auditory meatus, the latter may be blocked and thus hearing may be seriously interfered with.

TREATMENT.—These ivory exostoses grow very slowly, and need not be interfered with, unless they are causing deformity or pressure symptoms. Their removal is very difficult and not altogether free from risk owing to the extreme density of the growth. Any attempt to chisel away the mass, as is done in spongy exostosis, requires a force that may cause serious jarring of the brain and possibly also fracture of the skull. When the exostosis is quite small and can be enclosed in a trephine, a circle of the bone including the exostosis should be taken out. When, however, the tumour is large and irregular in shape, the best plan is

to remove it by means of a burr, or a saw worked by a dental engine, keeping just outside the area of the tumour so as not to have to cut through the very dense bone (see Fig. 153).

SARCOMATA AND CARCINOMATA.

When these tumours occur on the surface of the skull, they can rarely be completely removed, but when they originate in the interior of the bone, it may be worth while attempting an operation. To do this a large flap must be turned down, and the skull is cut through by means of a circular saw, or a wire saw (see Fig. 18), about an inch beyond the growth and the whole mass removed.

When the tumour grows from the diploë or the external table, this operation may be successful, and even when the inner table is thickened by the growth it is worth trying, provided that it be done before serious pressure on the brain has been caused, and before the dura mater has become involved. When, however, the skin over the tumour is so thinned or infiltrated that it has to be removed, the operation cannot be performed, because a large area of the dura mater would be left exposed without any likelihood of healing. No doubt when the defect is small, it might be possible to fill it in some cases by means of a flap from the arm, as in the method of repairing the nose (see ' Plastic Surgery of the Face '), but when the tumour has attained such a size as to involve the skin to any considerable extent, its complete removal is practically hopeless ; even then, however, excellent results may follow a combination of excision with the X-rays or radium. Coley's fluid may also be tried when the growth is a sarcoma.

Carcinomata of the skull are secondary to carcinoma elsewhere and cannot be dealt with by operative measures. Radium, however, may be of value.

CHAPTER XXXII

INTRA-CRANIAL INJURIES.

The effect of a severe injury to the head is not limited to the scalp; the contents of the cranium may also suffer. These intra-cranial affections vary acording to the force, the situation, and the nature of the injury, and also according to the presence or absence of fracture of the skull. The chief are: concussion, contusion, laceration and compression of the brain, and various inflammatory troubles, such as extra-dural, sub-dural or cerebral abscess, lepto-meningitis, and phlebitis and thrombosis of the sinuses.

CONCUSSION OF THE BRAIN.

By concussion of the brain is meant a state of unconsciousness into which a patient falls immediately after a severe injury to the skull, and before intra-cranial hæmorrhage has taken place to such an extent as to cause symptoms of compression. Concussion of the brain is practically a condition of shock resulting from disturbance of the nerve centres. There has been much discussion as to what happens to the brain in concussion. At one time it was supposed that the functions of the brain are disordered without any actual lesion of its substance. It has, however, been found that, in patients who have died during the stage of concussion, there is always some hæmorrhage into the substance of the brain, and in some cases distinct laceration of the cortex, and some hold that in all cases of concussion there is an actual lesion of the structure of the brain. On the other hand, it seems reasonable to suppose that when force is applied to the head, the delicate brain and the cerebro-spinal fluid will be forcibly thrown into commotion and that, as the result of these violent oscillations of the brain substance, temporary disturbance (ending in more or less complete suspension of function of the brain cells) may result without there being necessarily any gross lesion. The amount of cerebro-spinal fluid present in the skull at the

time of the injury may have a determining effect on the lesions that occur. According to Bouchard, if a blow is received during inspiration, when the brain is more or less completely surrounded by cerebro-spinal fluid, the condition of concussion is produced, whereas if it is received during expiration, when there is less cerebro-spinal fluid in the cranial cavity, the protection of the water-bed is diminished and the more serious condition of contusion results.

SYMPTOMS.—The symptoms resulting from this disturbance of the brain vary from drowsiness to complete unconsciousness. The respiration becomes shallow and feeble, and the pulse is small, not easily felt, and often unduly slow. After a period varying from a few minutes to some hours the pulse improves, the respirations become deeper, the reflexes return, and the patient begins to recover. During recovery, the patient generally vomits and may wander a little. He may also complain of noises in the head or disturbances of vision. In severe cases there is complete prostration; the surface of the body is cold, the breathing is shallow and quick, the pulse very feeble, and there is frequent vomiting; recovery is often accompanied by symptoms of cerebral irritation.

TREATMENT.—Measures must be adopted to diminish the shock, while care is taken to avoid too much reaction lest hæmorrhage should occur. The patient should be placed in the recumbent position, and the head raised on a small pillow so as to diminish the risk of hæmorrhage. Warmth should be applied to the feet and limbs by means of hot blankets and hot-water bottles. Strychnine (gr. $\frac{1}{30}$) or camphor may be administered subcutaneously, but alcoholic stimulants or the administration of ether should be avoided, except in desperate cases, on account of the great risk of increasing the reaction. The patient should be placed in a room free from noise, and a brisk purge should be administered; if he is still unconscious five grains of calomel, or one or two drops of croton oil mixed with powdered sugar, may be placed on the back of the tongue. In some cases of concussion there is retention of urine, especially during the stage of recovery, and, if necessary, the urine must be drawn off with a soft catheter. Most cases of concussion will recover under this treatment or even without any special treatment at all.

When reaction commences, it is well to apply cold to the head with the view of preventing hæmorrhage. The patient should be kept in a dark room and not allowed to see visitors or to talk, and an ice-bag, ice-cap, or Leiter's tubes (see Vol. I. p. 8) should be applied to the head. Even if the patient apparently recovers completely, there is no certainty that hæmorrhage will not take place, and to minimise this risk he should be kept in bed for a week at least, especially when the concussion has been severe. During this time quiet should be maintained, the bowels kept freely open by the daily administration of a saline purge, and the diet considerably restricted. As a rule the patient may be allowed to get up

at the end of a week, but the possibility of after-consequences (especially mental irritability) must always be borne in mind. A mechanic may be able to resume work at the end of a few weeks, provided that his employment does not entail climbing ladders, or working at a height; these are dangerous on account of the liability of these patients to suffer from attacks of giddiness. Such a patient would, therefore, be well advised to seek less dangerous employment for a few months, but after that time, if he has had no attacks of giddiness, he may be allowed to resume his former employment. In the case of patients whose work entails intellectual effort, the disability is often more pronounced, and the patient, although he feels quite well, may be unable to add up a column of figures accurately or without getting a headache, or to act in an emergency with his former judgment and decision. This applies also to engine-drivers, chauffeurs, and others, from whom rapid and almost automatic decisions are constantly demanded; such patients should lead a quiet life for six to nine months. There is no need to confine them to bed or even to the house. Mild out-of-door exercise may be permitted, and they may undertake light work which does not involve any severe mental strain. The diet should be light and nutritious, but alcohol should only be allowed in the very strictest moderation, and it is better to forbid it altogether. Smoking, on the other hand, may be permitted.

CONTUSION AND LACERATION OF THE BRAIN.

In some cases the laceration of the brain, of which we have spoken in connection with concussion, is very marked, and this may occur with or without fracture of the skull itself. The injury to the brain may be situated immediately beneath the seat of the blow, or on the opposite side of the skull ('contre coup'), and may vary from a small tear to an extensive laceration of the cortex. These lacerations are most frequent about the convexity of the hemispheres, but they are also met with at the base, when the brain has been violently jarred against the bony prominences on the floor of the cranial cavity.

The *symptoms* peculiar to severe lacerations of the brain are chiefly those of cerebral irritation. The patient, after recovering from the primary shock or concussion, exhibits abnormal irritability of temper, muscular twitchings, irregular movements, and extreme restlessness; the occurrence of these symptoms soon after an accident should lead to the conclusion that the brain matter has been damaged.

TREATMENT.—The treatment of this condition is the same as that just described for concussion, but especial care must be taken in the early stage to avoid excessive reaction and to diminish the risk of hæmorrhage into the brain. For some time the patient should be kept quite free from all disturbing influences, and in a good many cases the irritable condition gradually passes off and the patient recovers completely.

Cushing recommends that a sub-temporal decompression operation (see p. 438) should be performed in the majority of these cases. He claims that by this procedure the risks of after-complications are minimised, and that it is possible, by exploring the brain, to determine more accurately the extent of the injury, and to adopt appropriate measures for its treatment. This view has not yet received general acceptance, but the suggestion should be borne in mind.

COMPRESSION OF THE BRAIN.

After the symptoms of concussion have passed off, the patient may either remain well or he may again lapse into unconsciousness, from which it may be impossible to arouse him. This unconsciousness is due to compression of the brain, which may arise from various causes. When there has been no recovery from the concussion the compression may be due to a depressed fracture (see p. 341), usually complicated with intra-cranial hæmorrhage. When the symptoms of compression come on a few hours after the injury, they are probably due to intra-cranial hæmorrhage alone; if they supervene at a later period, they are usually the result of cerebral inflammation and suppuration.

The general symptoms of compression of the brain are profound loss of consciousness, stertorous breathing, and slow pulse. The pupils are usually dilated and fixed; in cases due to rupture of the middle meningeal artery the pupil on the side of the lesion is generally larger than its fellow. If the pressure is not relieved, the patient may remain unconscious for some hours and then die from gradual heart failure.

INTRA-CRANIAL HÆMORRHAGE.

Hæmorrhage occurring inside the skull may be either extra-dural or sub-dural; sub-dural hæmorrhage again may be beneath the dura mater, or into the pia mater, or into the substance of the brain. When the hæmorrhage occurs rapidly after an injury and in such amount as to give rise to marked compression after a lucid interval, it is probably extra-dural and most frequently results from rupture of the middle meningeal artery or one of its branches. In other cases it may be due to rupture of one of the vessels of the pia mater, or again there may be rupture of one of the large venous sinuses in the brain; here the symptoms are more gradual in onset, partly because the bleeding is slower and also partly because this condition is usually associated with fracture, and some of the blood may therefore escape externally.

Lumbar puncture is often of great diagnostic value in these cases. If the hæmorrhage is entirely extra-dural there will be no alteration in the cerebro-spinal fluid; in intra-dural hæmorrhage, on the other hand, the fluid will contain blood (see p. 444).

RUPTURE OF THE MIDDLE MENINGEAL.—This artery is the largest branch of the internal maxillary trunk and enters the skull through the foramen spinosum, running upwards in a groove on the greater wing of the sphenoid. About one centimètre above the foramen it divides into an anterior and a posterior branch, of which the anterior is the larger, and runs in a groove across the greater wing of the sphenoid and thence across the anterior inferior angle of the parietal bone. It then passes upwards almost parallel to the anterior border of that bone and sends branches forwards and backwards over the frontal and parietal bones. The posterior branch passes backwards over the squamous portion of the temporal bone and turns upwards near the posterior inferior angle of the parietal running just in front of the posterior border of that bone. It reaches as far as the middle line and its branches run as far back as the lateral sinus. Throughout their whole extent both branches of the artery lie in grooves in the bone, converted into channels by the dura mater, and are much more adherent to the latter than to the bone. The anterior branch is the one usually torn. The main branches of this vessel are in close relationship with various motor areas of the cortex, and thus hæmorrhage from them may cause direct pressure upon these areas and give rise to paralysis of various parts, according to the seat of the rupture and the extent of the hæmorrhage.

The following are the chief surface markings of the artery: The anterior branch passes beneath a point situated an inch and a half behind the external angular process of the frontal bone and the same distance above the zygoma. The posterior branch crosses the posterior inferior angle of the parietal bone beneath the point of intersection of a line drawn from the glabella[1] backwards to the external occipital protuberance, with another drawn vertically upwards from the posterior margin of the mastoid process (see Fig. 156).

Rupture of the middle meningeal artery generally occurs in connection with a fracture, the line of which traverses the groove in which the artery lies (see Fig. 154) or crosses the foramen spinosum itself. Rupture of the artery, however, may take place without any fracture, the probable explanation being, that the alteration in the shape of the skull produced by the blow is insufficient to fracture the skull, but enough to detach the vessel from its groove in the bone and tear it across. Hæmorrhage without fracture occurs most commonly in adults, probably because in children the dura mater is more closely adherent to the bone and, therefore, less easily separated from it when the skull is compressed.

The blood from the torn vessel is poured out between the dura mater and the skull, and rapidly detaches the former from the bone. This blood

[1] The glabella is the smooth space directly above the root of the nose, midway between the two superciliary ridges.

soon clots, and pressure is exercised upon the subjacent brain, varying according to the amount of the clot. When the amount of clot is small, the effects of the pressure are manifested in one hemisphere only, and may possibly be confined to particular centres. As the clot increases in size, however, the entire hemisphere shows the effects of pressure, and in

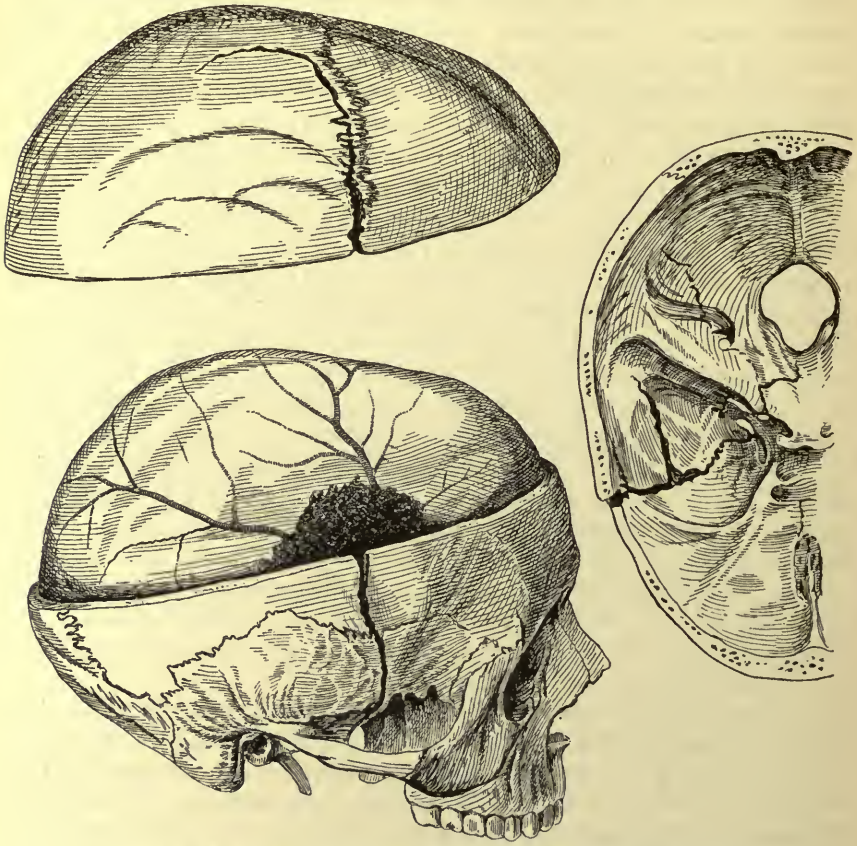


FIG. 154.—MIDDLE MENINGEAL HÆMORRHAGE. The fracture is seen to traverse both the vault and the base of the skull. The situation of the clot is that usually met with. The amount of clot present in the specimen from which the drawing was made is quite moderate; it often exceeds this considerably and gives rise to very extensive cerebral compression. (*Helferich.*)

extensive hæmorrhages the opposite hemisphere is affected as well. As a rule the tendency is for the blood to spread downwards towards the base of the skull, and one of the typical symptoms, namely, dilatation of the pupil on the affected side, is probably due to clot passing downwards and pressing upon the third nerve. Should the rupture of the artery be accompanied by fracture of the skull, some of the blood escapes beneath

the scalp and may form a distinct hæmatoma. When the fracture is compound, there may be free escape of the blood externally, in which case the pressure symptoms may be absent or very slight.

Symptoms.—When hæmorrhage from the middle meningeal artery follows a fracture of the skull there is usually a history of temporary concussion, followed by reaction and a lucid interval. This lucid interval varies from a few minutes to a few hours, and then gradually increasing drowsiness occurs, finally ending in coma. The duration of the lucid interval, and indeed its existence, depends, of course, on the rapidity with which the blood is poured out, and also on whether laceration of the brain is also present. When the hæmorrhage occurs rapidly or when there is also laceration of the brain, the patient may not have rallied from the primary shock before the amount of blood poured out has become so great as to produce compression.

When the compression is fully developed, the patient lies in a comatose condition characterised by a slow and usually full pulse, and by slow and often stertorous respiration. The pupils are dilated and fixed, the dilatation being most marked and sometimes, indeed, only present on the side on which the hæmorrhage has occurred. There may be spastic contraction of various muscles with twitchings or even epileptiform convulsions; when these occur, some laceration of the brain substance is generally also present. Following this period of irritation, there may be paralysis if the clot lies over one of the motor centres, the loss of power being limited at first to the muscles corresponding to the particular centre, but extending later, and sometimes involving the whole body.

Prognosis.—The prognosis is bad; unless operative measures are adopted it is almost hopeless. If left alone the patient usually dies in a few hours; when recovery takes place without operation, the patient generally suffers afterwards from some mental or physical disability or is subject to epileptiform convulsions. Hence the earlier the hæmorrhage is arrested and the clot removed, the better; for, if this is not done until some time has elapsed, the brain may not expand properly, even though the compression is relieved, or else fatal œdema of the brain may result.

Treatment.—The head should be shaved completely, and the scalp scrupulously disinfected (see p. 328). When the patient is comatose, no anæsthetic is necessary; when one is required, chloroform should be chosen in preference to ether, as it causes less cerebral congestion. Even when an anæsthetic is employed it is only required for the skin incision as a rule, an occasional inhalation being all that is necessary afterwards. The head is turned to the opposite side and steadied on a sand-bag, or a skull prop (see Fig. 155).

Unless the symptoms or the situation of the fracture point to rupture of the posterior branch of the middle meningeal, the anterior division

should be exposed first. This is found most conveniently about an inch and a half behind the external angular process of the frontal bone, and about the same distance above the zygoma. A large semilunar flap with its convexity upwards and its centre opposite this spot, and including all the tissues down to the bone, should be rapidly turned down. The bleeding vessels are seized with pressure forceps, or the whole thickness of the flap is clamped with Ballance's forceps; the weight of the forceps keeps the flap out of the way. A fissure should be looked for, and, if found, the trephine should be applied over it, the pin being inserted just to one side of it, and about an inch and a half above the level of the zygoma. Usually the presence of a fissure is indicated, as soon as the flap is turned down, by extravasation of blood into the temporal muscle. It is always best to trephine over the fracture first, because the blood may come from one of the smaller twigs and not from the main branch. When no fissure can be seen, the pin of the trephine should be applied over the anterior inferior angle of the parietal bone. The trephine should have a conical crown, so that it cannot slip into the cranial cavity after the bone has been divided (see Fig. 149). It should be remembered that in this situation the skull is usually very thin; if, however, the diagnosis is correct, there will be little risk to the dura, which is widely separated from the bone by the clot. The operation of trephining has already been fully described (see p. 345). The circle of bone removed should be placed temporarily beneath the scalp (see p. 344) in case it should be required afterwards.

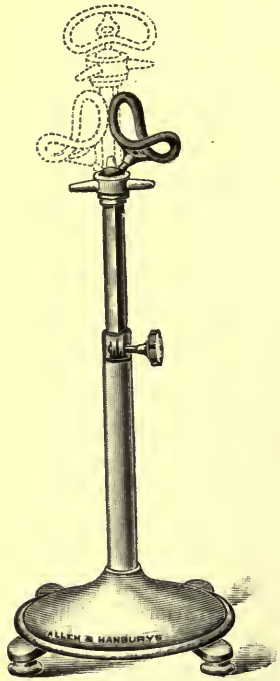


FIG. 155. — HEAD-SUPPORT FOR OPERATIONS UPON THE BRAIN. The form illustrated above is meant for use in operations upon both the cerebrum and the cerebellum.

As a rule, the clot is at once exposed and bulges into the opening, but does not usually pulsate; should it do so, it generally means that free hæmorrhage is going on, the pulsation being communicated not from the brain, but from the open end of the torn artery. The clot should be gently removed with a blunt scoop or an egg-spoon, and any débris may be flushed out with normal saline solution at the body temperature. Care should be taken that the irrigation is not applied under pressure, otherwise it might detach the dura still further; the escape of the fluid must be perfectly free. Should the torn vessel not be sufficiently exposed —which usually means that the rupture is lower down—portions of the

skull should be rapidly cut away with Hoffman's forceps in a downward direction along the course of the vessel. If the bleeding is free, it may be temporarily arrested by thrusting the finger between the dura mater and the bone in the direction from which the blood comes, while the skull is being cut away with the forceps. Except in cases in which the vessel is torn low down, it can generally be easily reached by the removal of sufficient bone. It is, however, often extremely difficult to apply a ligature to the vessel as it lies on the dura mater in the depth of the wound, and the best plan then is to under-run the vessel on each side of

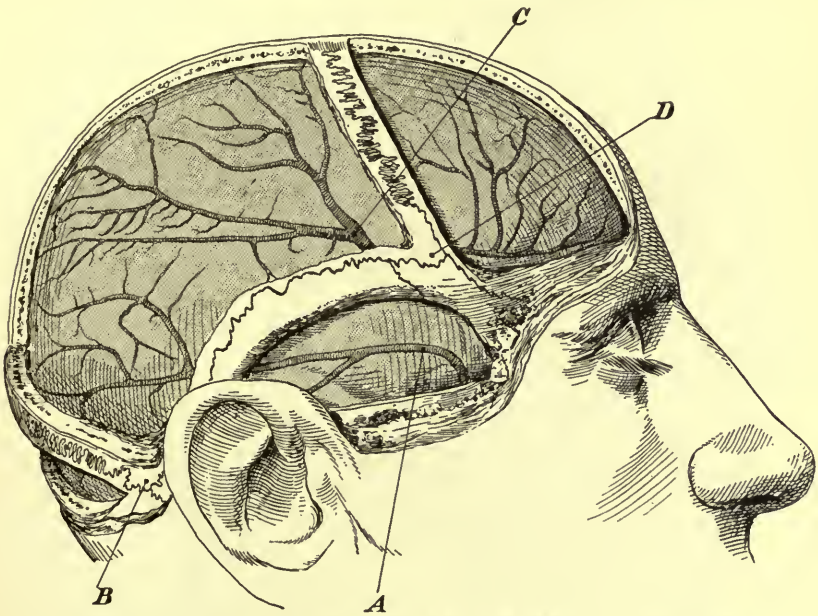


FIG. 156.—THE RELATIONS OF THE MIDDLE MENINGEAL ARTERY TO THE SUTURES OF THE SKULL. *A*, Posterior branch of the middle meningeal; *C*, anterior branch; *D*, anterior inferior angle of the parietal bone; *B*, posterior inferior angle of the parietal. (*From a preparation by Prof. Arthur Robinson, formerly of King's College.*)

the tear by a fully-curved Hagedorn needle threaded with fine catgut (see Fig. 157). Cushing (see *Trans. Amer. Surg. Assoc.* (1911), Vol. xxix. p. 406,) has introduced ingenious silver clips or small staples which are pinched on to the vessel above and below the opening in it, and are left *in situ* (see Fig. 159).

When the vessel is injured at a point where it is not quite free from the groove in the bone, it can usually be easily detached with a probe or, if necessary, more bone may be removed. In some cases, instead of a groove, a bony canal may extend upwards for some distance from the foramen spinosum, and it may then be necessary to chip the bone away gradually until the bleeding point is exposed. This should be done with

a sharp gouge rather than with a chisel, the advantage being that a hammer is not required; the jarring caused by the hammer is apt to be prejudicial. These measures are successful in most cases; but, if the artery be lying far down in the canal, the best plan is to pack in a small quantity of Horsley's wax,[1] forcing it down the canal with a plug of gauze and a probe; the plug of gauze is withdrawn after the wax has been

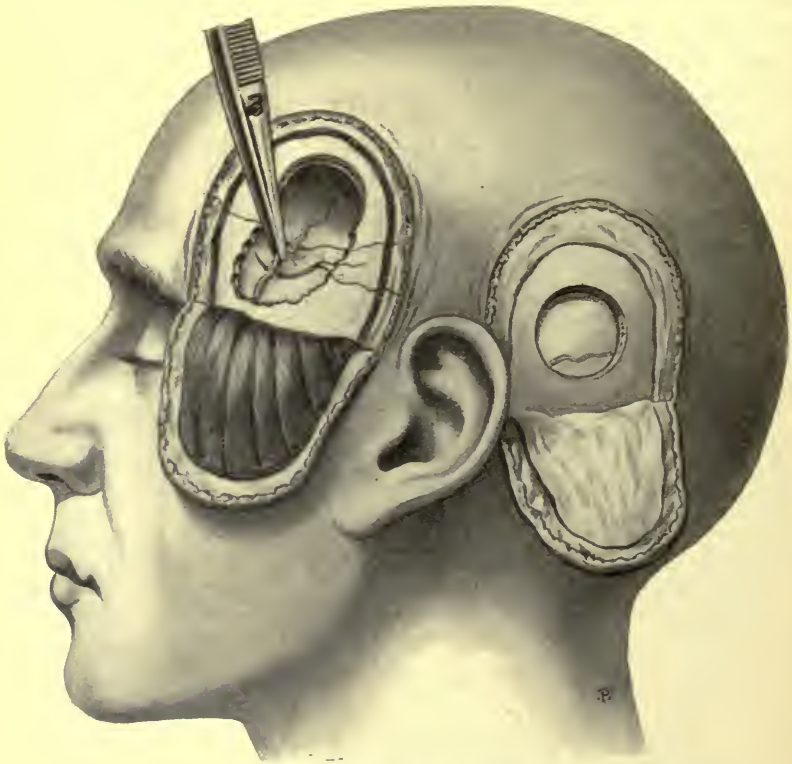


FIG. 157.—EXPOSURE OF BOTH BRANCHES OF THE MIDDLE MENINGEAL ARTERY. The landmarks for the exposure of the vessel are given in the text. The anterior branch is being under-run; one ligature has been passed above the laceration in the vessel and a second is being passed below it.

forced well down. It is only extremely rarely that such a measure as ligature of the external carotid artery will be required; at most a temporary compression of the vessel will be called for.

If the anterior branch of the middle meningeal artery is found to be intact, the posterior division should be exposed at the point of intersection of a line passing from the glabella backwards to the external occipital

[1] This is a mixture of bees'-wax 7 parts, almond oil 1 part, and salicylic acid 1 part. It should be kept under 1 in 20 carbolic solution in a wide-mouthed stoppered jar, and made ready for use by pinching off a fragment of suitable size and softening it by kneading with the fingers. It is left *in situ*.

protuberance, with one running vertically upwards from the posterior margin of the mastoid process. The steps of the operation are similar to those just described.

After the clot has been removed and the artery secured, the next questions that arise are, whether drainage shall be employed and whether

FIG. 158.—MIDDLE MENINGEAL HÆMORRHAGE. The artery has been exposed by trephining and the opening enlarged in order to follow the vessel downwards. The case shows how localised pressure may be exerted over portions of the motor area.

the portions of the skull shall be replaced. The answers depend essentially on the completeness with which the brain expands after removal of the clot. When the bleeding has quite ceased and the brain expands fully, so that the dura mater is again everywhere in contact with the bone, there is no need for drainage, and the bone removed may be replaced, either as one large circle or in several small pieces. When, however, the brain does not expand at once, a cavity is left between the dura mater and the

skull, into which oozing will take place; under these circumstances, therefore, it is advisable to insert a drainage tube, so as to allow the fluid blood to escape. Moreover, when the brain does not expand properly, it is not advisable to replace the piece of bone removed by the trephine. The drainage tube may generally be removed in two or three days. After the wound has been stitched up with a continuous suture, the ordinary antiseptic dressings are applied and the patient put back to bed and propped up in the semi-recumbent position; the ordinary after-treatment of a surgical operation should be carried out.

SUB-DURAL HÆMORRHAGE.—In the above operation the dura mater is not opened, the entire procedure being extra-dural. In some cases, however, after exposing the dura mater no blood is found between the membrane and the bone, but the dura bulges outwards into the wound, is of a dark bluish colour, and does not pulsate. This is evidence that hæmorrhage has occurred into the sub-dural space, either from the middle meningeal branches or from the vessels of the pia mater. In either case the dura mater must be opened in order to remove the clot and secure the bleeding vessels. It is well to employ a curved incision in the dura mater with its convexity downwards; this takes the line of incision in the dura as far away as possible from that in the skin. The incision should run about a quarter of an inch from the margin of the bone, and should be begun with a sharp knife, and then completed with a pair of blunt-pointed scissors, such as are used in eye operations. This exposes the clot (see Fig. 160), which is removed in the manner above described; the bleeding vessel is secured either by picking it up by forceps or by under-running. The wound in the dura is then stitched up and no drainage need be employed if the brain expands completely during the operation. In stitching up the dura mater, it is well not to use a continuous suture; it is better to put in a few interrupted stitches, leaving intervals between them through which blood and serum may escape outwards. If the brain does not expand properly, a fine horse-hair drain should be introduced beneath the dura mater and brought

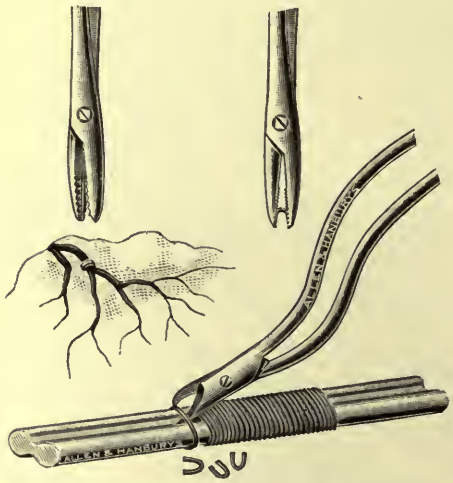


FIG. 159.—CUSHING'S CLIPS FOR THE MIDDLE MENINGEAL ARTERY. The sketch shows how the clips are held in forceps and applied to the wounded vessel. The lowest figure shows how the clips are made.

out at one corner of the flap. This is kept in position for two or three days.

HÆMORRHAGE FROM THE VESSELS OF THE PIA MATER.—In some cases the pia mater may be lacerated and hæmorrhage then takes place upon the surface of the brain, into its substance, or between the convolutions. Usually a force sufficient to tear the pia mater also lacerates the brain, so that the case becomes one of laceration of the brain with hæmorrhage on the surface, and consequently the symptoms are those of concussion and laceration of the brain, followed afterwards by symptoms of compression. The compression symptoms

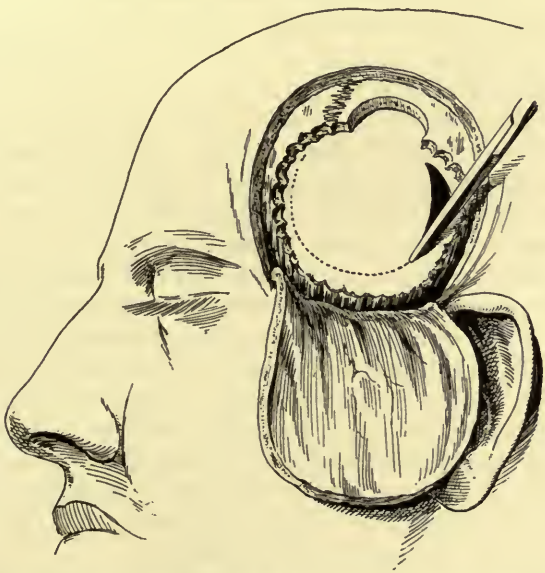


FIG. 160.—INCISION OF THE DURA MATER FOR SUB-DURAL HÆMORRHAGE. A small nick is first made in the dura with a knife and one blade of a pair of fine blunt-pointed scissors is inserted in it. The incision in the dura mater is indicated by the dotted line; it should be about a quarter of an inch from the bony margin of the aperture.

are, however, not so severe as those produced by hæmorrhage from an artery such as the middle meningeal, and they are more localised because the damage is confined to a portion of the cortex.

Treatment.—The question of operation is determined by the amount of compression. If there is distinct evidence of pressure upon a particular centre, even though there are no general symptoms of compression, it is well to open the skull over that point and remove the clot. If left, the pressure of the clot may cause softening of the brain beneath and permanent damage; or the clot may be imperfectly absorbed, when a blood-cyst is produced, leading to permanent pressure on the brain; or the organisation of the clot may cause adhesions between the

membranes, leading to violent headaches, epileptiform convulsions, or mental derangement.

After the skull has been opened and the dura mater divided, the clot should be removed by gentle irrigation with warm sterilised salt solution. Any bleeding points should be picked up and twisted or tied. As a rule the hæmorrhage from the smaller vessels can be easily arrested by gentle pressure with a hot sponge. After the bleeding has quite ceased, the opening in the dura mater should be stitched up, the portions of bone replaced and the wound sutured. Some surgeons place a piece of gold-foil or other material between the brain and the dura mater, in order to prevent adhesions. If there has been much hæmorrhage, it is well to put in a few threads of horse-hair to act as a drain.

HÆMORRHAGE FROM OTHER VESSELS.—Injuries of other vessels inside the skull are rare as compared with rupture of the middle meningeal artery. Small vessels on the outer surface of the dura mater may, however, be injured, or the internal carotid itself may be torn in fractures of the base, or there may be hæmorrhage from various cerebral sinuses, usually as the result of fracture of the skull. The longitudinal sinus is the one most commonly torn.

Symptoms.—The symptoms of bleeding from a sinus are similar to those of intra-cranial hæmorrhage from other causes, but, as a rule, localising symptoms are not present owing to the situation of the blood-clot. Compression symptoms do not appear so rapidly as in hæmorrhage from the middle meningeal artery, nor are they so severe, because the blood pressure in the sinuses is lower. Bleeding from the superior longitudinal sinus only occurs when the skull is fractured, and consequently it is usually accompanied by a diffuse hæmatoma of the scalp. The occurrence of a hæmatoma on the vertex, associated with symptoms of compression, is therefore a valuable diagnostic point, and may indicate where the rupture of the vessel has taken place.

Death does not necessarily occur in these cases, even when no operation is performed, owing to the slight pressure under which the blood is poured out. Various consequences, such as epileptic fits or mental disturbance, may however follow, chiefly as the result of adhesions.

Treatment.—When it is probable that the superior longitudinal or some other accessible sinus has been torn, the proper treatment is to open the skull over the seat of the injury. In the case of the longitudinal sinus it is well to make the trephine opening a little to one side of the sinus, and then, if necessary, to enlarge the opening in the bone by clipping away portions with Hoffman's forceps. In this way the risk of lacerating the sinus with the teeth of the trephine is avoided. On removing the bone, blood may be found between it and the dura mater, but it is generally advisable to open the latter, as there is usually sub-dural hæmorrhage as well. In some cases the opening in the sinus may be stitched up, or an attempt may be made to tie the vessel

between two ligatures after opening the dura mater. Neither of these procedures is easy, and the latter especially is apt to lead to further laceration of the sinus; hence, when it is impossible to stitch up the opening in the dura mater, the best plan as a rule is to plug the wound with gauze and to reapply the flap temporarily. After a couple of days the gauze may be removed and the bleeding will not recur.

After-treatment.—In these cases of hæmorrhage the patient may usually be allowed to sit up in about a fortnight. After three or four days there is little probability of recurrence of the hæmorrhage, and after ten days all risk of inflammatory troubles will probably have passed away. In a fortnight the risk of detachment of the clot which may occur when the sinuses are injured will be over. The precautions as to the resumption of active mental work, referred to on p. 369, must be strictly enforced.

CHAPTER XXXIII.

INTRA-CRANIAL SUPPURATION.

THE following forms of intra-cranial suppuration may follow injuries, especially compound fractures: (1) Suppuration between the dura mater and the skull (extra-dural suppuration); (2) localised suppuration beneath the dura mater (sub-dural suppuration); (3) diffuse lepto-meningitis; and (4) cerebral abscess. Intra-cranial suppuration may also arise as the result of suppurating wounds of the scalp or necrosis of the skull, or of suppuration in the frontal sinus, the middle ear, and the mastoid antrum. The processes are very similar whether they are due to injury or disease, but it will be more convenient, as far as treatment is concerned, to speak first of intra-cranial suppuration as it arises after an injury, and subsequently as it originates from disease, notably of the middle ear.

Although it is convenient to describe these various types of suppuration in separate sections, in practice the distinction between them is less marked, because the suppuration does not always remain limited to one situation or type. Considerable help in the diagnosis can often be obtained by the study of a sample of the cerebro-spinal fluid obtained by lumbar puncture. This method should never be neglected; lumbar puncture is a harmless procedure and may also have a distinct curative effect (see p. 442).

INTRA-CRANIAL SUPPURATION FOLLOWING INJURY.

EXTRA-DURAL SUPPURATION.

This condition rarely follows an injury unless there is an external wound, and most often occurs in connection with compound fracture. It may, however, result from an acute osteo-myelitis following an injury without an external wound. The affection begins as an inflammatory thickening of the outer surface of the dura mater with effusion of

fluid between it and the bone; this goes on to suppuration and the formation of an extra-dural abscess.

When there is no external wound, or when the inflammation occurs at a little distance from the wound, a swelling, known as 'Pott's puffy tumour,' may develop over the seat of the suppuration. This is a limited œdematous condition of the scalp, associated with symptoms of meningitis and subsequently of compression. The puffy tumour is due to the effusion of fluid beneath the pericranium accompanied by œdema of the tissues superficial to it. It almost always indicates the formation of an abscess between the bone and the dura mater, and usually also necrosis of the inner table, or, it may be, of the whole thickness of the skull. When there is a compound fracture, and consequently an open wound, this puffy tumour will not necessarily occur, but the wound becomes unhealthy, the granulations pale and flabby, the secretion diminished and foul, and the pericranium detached from the surface of the skull in the vicinity of the wound. A considerable amount of bare bone is frequently exposed, and the parts around are œdematous.

Associated with the local condition there is marked pyrexia, headache, and very rapid pulse; there may be rigors, and, when the pus cannot escape externally, gradually increasing drowsiness sets in, often accompanied by delirium or epileptiform convulsions, and ending in more or less complete coma as the collection of pus beneath the skull increases in size.

In compound fracture these symptoms usually commence two or three days after the injury; sometimes not until a later period. They are coincident with the breaking down of the blood-clot beneath the fracture and the commencement of suppuration.

TREATMENT.—The treatment consists in immediate and thorough opening up of the inflamed area. When there is no external wound, a flap should be turned down so as to expose the centre of the puffy tumour, and it is well to make this flap large, as it may be necessary to remove a considerable amount of bone. When, however, a wound already exists, and especially when a fracture is present, the wound must be enlarged in any direction that seems most desirable. The periosteum is usually detached from the skull, and a large circle of bone should be removed so as to allow the pus to escape freely. The cut surface of the bone must then be examined for the presence of suppurative osteomyelitis, and if this is found, the skull should be freely dealt with in the manner described on p. 358. Unless the collection of pus is large and the diploë healthy, it is well to make the opening in the bone almost co-extensive with the collection of pus beneath, so as to admit of proper drainage. By doing this time is also saved, for it is not uncommon for the bone over the area of suppuration to undergo more or less complete necrosis. The dura mater is usually thickened and covered with lymph, or even actually sloughing.

After the inflamed region has been thoroughly opened up the pus should be gently washed away with sterilised normal saline solution. The cavity should not be scraped, as is sometimes advised, partly because it might lead to perforation of the dura mater and infection of the sub-dural tissues, and partly because it is apt to open up fresh paths for the penetration of the bacteria. It is well to touch the cut surfaces of the bone with pure carbolic acid so as to shut off the Haversian canals; care must be taken that the acid does not run on to the dura mater.

When a flap has been turned down, one or two large drainage tubes should be introduced at the lower corners of the flap and the rest of the wound closed by sutures. When a wound has existed previous to the operation, it is best to leave it open and pack it lightly with cyanide gauze until granulation is progressing satisfactorily, when an attempt may be made to bring the edges together, leaving room for the drainage of the deeper parts. The risk in these cases, apart from general infection, is extension of the disease in the bone or infection of the meninges and suppurative lepto-meningitis.

SUB-DURAL SUPPURATION.

This may occur either as a localised collection of pus or as a diffuse lepto-meningitis.

LOCALISED SUB-DURAL SUPPURATION.—The inflammation of the dura mater usually causes adhesions between that membrane and the arachnoid, and thus, for a time at least, the sub-dural space may be shut off. Pus may then form among these adhesions, so that an abscess of considerable size may form without any general infection of the sub-dural space. As this abscess enlarges, it causes ulceration and superficial suppuration of the cerebral convolutions, or a fresh abscess may develop in the substance of the brain, not communicating with the sub-dural one. If the case is left to itself the dura mater may slough, and if there has been a compound fracture the pus may find its way externally; as a rule, however, the patient dies from cerebral compression, from extension of the affection to the general meningeal cavity, or from cerebral abscess.

The symptoms are practically the same as those already referred to under extra-dural abscess, but it is not uncommon to have more cerebral irritation than in the latter. As a rule, however, it is impossible to diagnose a sub-dural abscess from an extra-dural one until the parts have been fully exposed; not uncommonly both are present (see Fig. 161).

Treatment.—This is entirely operative and should be carried out as soon as a diagnosis of intra-cranial inflammation is made, especially in cases of fracture. The procedure in the early stages of the operation is the same as that just detailed up to the point of evacuation of the

extra-dural abscess. If there is no bulging of the membrane and the brain pulsates naturally when this is accomplished, a sub-dural abscess is probably absent, and the operation need go no farther. If, however, the dura mater bulges into the trephine hole and does not pulsate, it should be carefully examined to see whether there is any perforation. In some cases a portion of the dura mater will be found to be sloughing, or there may be an actual hole in it. Should such a perforation already exist, the opening should be enlarged and the sub-dural abscess drained. If no opening can be found, a small incision should be made through the dura mater at the centre of the exposed part and an abscess sought for beneath it. When there is no extra-dural abscess, this procedure is devoid of risk, provided that care is taken not to break down any of the adhesions which shut off the sub-dural and sub-arachnoid spaces. If an extra-dural abscess is present there is always the risk of infecting these spaces, but this is not great, as there will probably be adhesions between the brain and the meninges.

FIG. 161.—TYPES OF INTRA-CRANIAL ABSCESS. The upper figure is a diagrammatic sketch of sub-dural suppuration. *a*, Œdematous scalp; *b*, carious patch in the skull; *c*, extra-dural abscess; *d*, brain.

The lower figure shows the types of cerebral abscess. *a*, Infective osteitis of skull; *b*, extra-dural abscess; *c*, opening in the dura mater; *d*, sub-dural abscess; *e*, cerebral abscess.

Large drainage tubes should be inserted, the flap stitched up and an antiseptic dressing applied. Even when the case is one of compound fracture, it is well to bring the edges of the skin together if possible, after providing for free drainage, because there is a great risk of hernia cerebri.

The after-treatment is simply that of an abscess, and if all goes well, the patient recovers rapidly. If recovery does not take place, the cause is usually extension of the suppuration to the meninges (lepto-meningitis), the formation of an independent cerebral abscess, or the occurrence of hernia cerebri.

DIFFUSE LEPTO-MENINGITIS.—When the inflammation extends to the sub-dural space and no adhesions form, the disease rapidly spreads over the whole surface of the hemisphere; it is usually most

marked about the seat of infection and towards the base of the brain and along the spinal cord. After a short time the brain becomes covered with pus and lymph, and it is probable that its surface is also involved in the inflammatory process since there is usually some softening with or without hæmorrhagic infiltration.

Lepto-meningitis is always a disease of extreme gravity, especially when it results from infection following on injury. The idiopathic forms are less severe and recovery from them may take place. This difference is probably due to the fact that the organisms at work are not the same in the two forms.

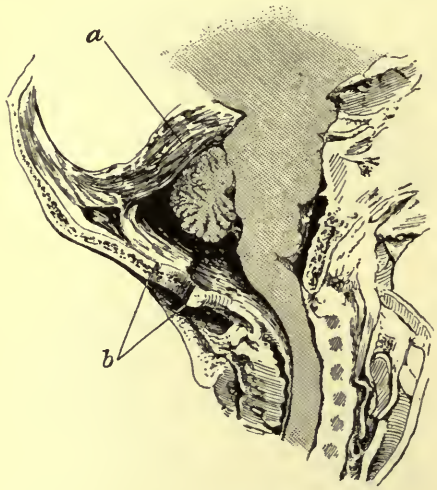


FIG. 162.—DRAINAGE OF THE SUB-ARACHNOID SPACE IN THE CEREBELLAR REGION. The drawing is made from a section of the skull of a fœtus just before birth, and shows how the cerebellar sub-arachnoid space is tapped by opening the skull below the inferior curved line. After birth the cerebellum becomes proportionately larger and the space smaller. *b*, The opening in the skull; *a*, the tentorium cerebelli. (*From a preparation by Prof. Arthur Robinson, formerly of King's College.*)

The disease is characterised by pyrexia, distressing headache, gradually increasing drowsiness, delirium and epileptiform convulsions. At first cerebration may be overactive and the intelligence unimpaired, but in the later stages the patient becomes more and more unconscious. The pulse is very rapid at first, but later on, when symptoms of compression appear, it becomes slow, full, and bounding. Rigors frequently occur, and the temperature, at first continuously high, may assume a hectic character later on. There may be various motor paralyses, especially affecting the cranial nerves. There is often a good deal of rigidity of the limbs and retraction of the head.

Treatment.—When the disease is once established there is very little prospect of effecting a cure. If there is a scalp wound with a fissure of the skull, the wound should be enlarged and the bone freely removed with the trephine and Hoffman's forceps. The dura mater is then laid widely open so as to permit free escape of the pus. The bone may also be trephined towards the base of the skull (see Fig. 162), and an attempt made to wash out the pus with a stream of sterilised saline solution or boric lotion. As a rule, these operations are seldom successful in the true diffuse form of the affection; success is only probable when there is a more or less localised collection of pus. The attempt to wash away the pus generally fails, because the brain is œdematous and swollen

and more closely in contact with the skull than usual, so that the fluid introduced will not diffuse itself over the surface sufficiently to wash away the pus. If irrigation is attempted in these cases, great care must be taken not to employ it under pressure, otherwise the fluid may find its way towards the base of the brain in such quantities as to cause fatal compression. Again drainage, whether by tubes or by horsehair passed between the openings, will only affect the immediately adjacent area and not the whole sub-dural space. Hence, while it is worth while to open up a wound if present, in the hope that the affection may be localised, the chances of doing good by any further operative measures are extremely slight.

If a *vaccine* can be prepared it may be worth while to employ it, but in these cases vaccine treatment is not so hopeful as in the idiopathic forms. *Lumbar puncture* repeated daily may also be tried; it is not likely to do any harm, and in some cases when the disease has been of otitic origin, good results have been reported.

INTRA-CEREBRAL SUPPURATION.

After a compound fracture, or intra-cranial suppuration, pus may form in the substance of the brain with or without intervening inflammation of the cerebral membranes or adhesion of them to each other. The result is an abscess in the brain, which is usually situated in the white substance underneath the seat of injury (see Fig. 161). The infection usually takes place by direct continuity, the membranes becoming adherent and suppuration taking place not only between the brain and the dura mater, but also deeper down in the substance of the brain itself. The abscesses of traumatic origin are most common in the frontal and parietal lobes, and in that situation they rarely give rise to definite localising symptoms.

SYMPTOMS.—The classical symptoms produced by suppuration in the brain are those of increased intra-cranial pressure, and are described in connection with those of cerebral abscess following ear disease. When the abscess occurs after an injury, the symptoms may be identical, but in some cases of compound fracture, they are not so severe because the opening in the skull allows of the protrusion of brain substance—the condition known as hernia cerebri—and this prevents the occurrence of marked pressure symptoms. As a rule, when hernia cerebri is not present, the pulse is slow and the pyrexia is slight; in fact, when there is considerable pyrexia with a quick pulse, the probability is that the case is one of meningeal inflammation rather than of cerebral abscess. Rigors are common and vomiting is not infrequent.

TREATMENT.—The treatment is to open and drain the abscess. If hernia cerebri is present, it will usually suffice, both for diagnostic and operative purposes, to introduce a pair of sinus forceps into the hernia and push them in various directions, expanding the blades from time to time

until pus is reached. When the pus is evacuated, the adjacent portions of the brain, which are much infiltrated with inflammatory material, may be scraped away sufficiently to establish a free opening into the abscess cavity. A drainage tube should be introduced, and the general treatment for hernia cerebri (see Chap. XXXIV.) carried out.

INTRA-CRANIAL SUPPURATION RESULTING FROM MIDDLE-EAR DISEASE.

Intra-cranial suppuration most frequently occurs in connection with suppuration of the middle ear and mastoid antrum. It may also, though more rarely, follow disease of the frontal sinus or of the various sinuses connected with the nasal cavity.

Before passing on to the consideration of the various complications of ear disease, we may briefly refer to the changes in the middle ear which lead to these troubles. For fuller details, works on aural surgery should be consulted.

Acute Suppurative Otitis Media.—This condition is usually due to infection which has spread up the Eustachian tube. It is common in the course of acute fevers, especially measles and scarlatina, but it may come on during the course of any acute infection of the naso-pharynx.

In *the acute form* the chief symptoms are severe, deep-seated pain in the ear, accompanied by a sense of fullness and throbbing; there is always some deafness and occasionally there is severe tinnitus. The constitutional symptoms are marked, the temperature is raised, running especially high in children, and in them the combination of pain and febrile disturbance may produce a clinical picture resembling diffuse meningitis. On examining the ear with a speculum the meatus is found to be extremely tender and swollen, so that it is often difficult to make a proper examination without an anæsthetic. The membrane itself is injected and bulging, and may even show a small yellowish area where the pus is actually pointing.

Treatment.—Any infection of the nose or throat should be attended to first. When pus has formed, free drainage of the middle ear should be established by *incision of the membrana tympani.* This operation, although trivial, is extremely painful and should be performed under a general anæsthetic. The meatus should be swabbed out with pledgets of wool soaked in 1 in 20 carbolic acid lotion, and, a good view of the membrane having been obtained through as large a speculum as possible, the point of a myringotome (see Fig. 163) is entered below and behind the handle of the malleus. An incision is then made upwards and backwards cutting the membrane right across and opening its postero-superior angle. The pus should be sucked out with a Siegel's speculum, the meatus

carefully cleansed and a small plug of cyanide gauze inserted into it. A large hot fomentation is then applied over the side of the head. The meatus should be cleansed night and morning with cotton-wool mops; there is less risk of forcing pus into the antrum with them than by syringing. If the disease is confined to the middle ear the patient's condition will improve rapidly, but if it has extended farther, little or no relief will be obtained.

Chronic Suppurative Otitis Media usually follows the acute suppurative form as the result of neglect, of insufficient drainage, or of repeated attacks. The chronic condition may follow certain affections of the nose, such as adenoids, and is often due to tuberculosis of the middle ear or the mastoid process.

In these cases there are perforations of the membrana tympani, adhesions and pockets of pus in the tympanic cavity, granulations (polypi) around the perforation, and often caries and necrosis of the ossicles or the temporal bone. The chief symptom is a purulent discharge from the ear, a little blood in the pus from time to time, and a varying amount of deafness. The condition may go on for a long time and may

FIG. 163.—MYRINGOTOME.

involve the antral cavity, and then from various causes may flare up and lead to one or several of the following complications.

COMPLICATIONS.—In connection with suppurative disease of the middle ear, the infection tends to spread rapidly in various directions. Commencing in the mucous membrane of the middle ear, it extends to the tympanic attic and mastoid antrum, invades the wall of the middle ear and antrum, and finally penetrates externally, leading to the formation of an abscess over the mastoid process, or internally giving rise to diffuse meningitis or localised abscesses which may be extra-dural, intra-dural, or intra-cerebral.

An *extra-dural abscess* situated over the roof of the attic is not at all uncommon; it may attain a considerable size, and may open into the middle ear or the antrum, if the bone is perforated. In some cases the inflammation of the dura mater may lead to adhesion of the dura to the arachnoid over the temporo-sphenoidal lobe, and the formation of a *localised sub-dural abscess* there. This is not infrequently accompanied by sloughing of the dura, so that the sub-dural abscess is in contact with the bone. In other cases, the adhesions between the membranes may not prevent wider infection of the sub-dural and sub-arachnoid spaces, leading to *diffuse suppurative lepto-meningitis*. Again, an *abscess*

may form in the temporo-sphenoidal lobe, either as the result of direct extension along adhesions between the membranes, or of infection carried along the peri-vascular spaces. These abscesses usually occur near the surface of the convolutions and may be found in any part of the temporo-sphenoidal lobe; when arising by direct continuity, they are generally situated about the middle of the lobe, but in other cases the infective material may spread along the peri-vascular sheaths and set up the abscess at some distance from the affected bone.

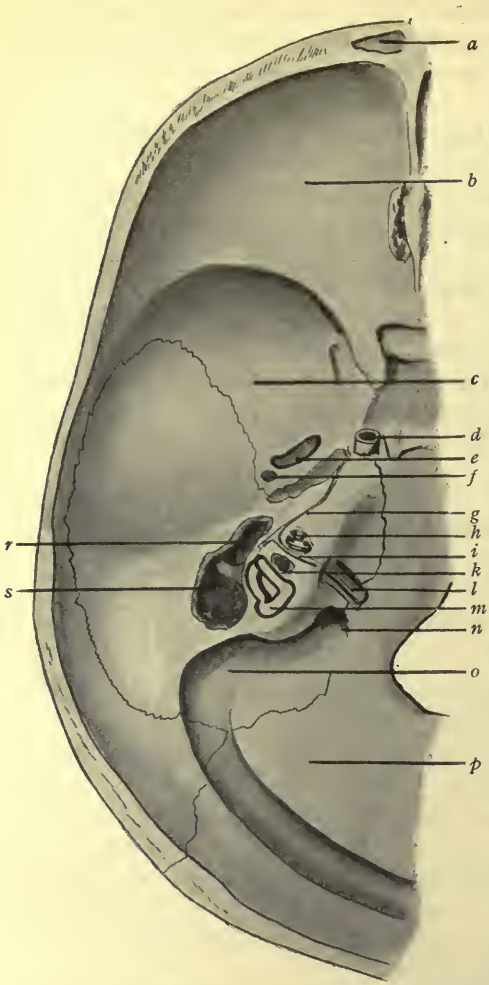


FIG. 164.—DIAGRAM TO SHOW THE DIRECTIONS IN WHICH INFECTION MAY SPREAD FROM THE MIDDLE EAR. *a*, Frontal sinus; *b*, anterior fossa of the skull; *c*, middle fossa; *d*, internal carotid artery; *e*, foramen ovale; *f*, foramen spinosum; *g*, great superficial petrosal nerve; *h*, cochlea; *i*, facial nerve; *k*, vertebral artery; *l*, seventh and eighth nerves; *m*, semicircular canals; *n*, jugular foramen; *o*, sigmoid sinus; *p*, posterior fossa; *r*, middle ear; *s*, antrum.

Cerebral abscesses are usually limited by a sort of pyogenic membrane and the pus is often fœtid, the most common cause of the fœtor being the presence of the *Bacillus coli communis.* Sometimes the pus is greenish in colour from the presence of the *Bacillus pyocyaneus*; in other cases, the coloration is due to the presence of blood. In the pus there are often sloughs which consist of the white matter of the brain. These abscesses are generally single, although smaller ones are sometimes found in the vicinity of the main abscess.

As the disease spreads, the *lateral sinus* is also very liable to become infected and thrombosed, the thrombus becoming disintegrated and giving rise to septic emboli and *pyæmia.* From the groove of the lateral sinus the inflammation may extend inwards and lead to an extra-dural abscess, a lepto-meningitis or a *cerebellar abscess.* The cerebellar abscesses may form by direct extension from the inflamed membranes, or without

any adhesions of the membranes at all. They are usually situated in the upper and anterior region of the cerebellum.

Hence in cases of long-standing suppuration in the middle ear—or, more rarely, in acute cases—one or more of the following conditions may arise: (1) Suppuration in the mastoid antrum; (2) disease of the bone over the attic or about the lateral sinus; (3) pachymeningitis and extra-dural abscess in either of these situations; (4) phlebitis and septic thrombosis of the lateral sinus, in addition to extra-dural suppuration in that region; (5) localised sub-dural suppuration or diffuse suppurative lepto-meningitis; (6) abscess, either in the temporo-sphenoidal lobe or in the cerebellum.

SYMPTOMS.—The diagnosis of the various complications of middle-ear suppuration is by no means easy, especially as several of them may be associated. Hence in any given case it is often difficult to say how far the infection has proceeded, and the surgeon has to feel his way step by step until the whole of the disease has been dealt with. The following are the chief symptoms:

In *acute suppuration in the mastoid antrum* the constitutional disturbance is even more marked than in acute otitis media, and the patient exhibits all the signs of severe septic absorption—the temperature often reaching 104° F. or 105° F. There is severe local pain in the ear, radiating over the side of the head, and acute tenderness over the mastoid process, especially at its tip. The skin in the region of the mastoid process is œdematous, and, as the disease progresses, fluctuation may be detected, indicating that an abscess has formed outside the bone. The ear is pushed forwards and projects from the side of the head. The meatus is swollen, especially in its postero-superior aspect, and, if the disease is of long standing, it may be filled with pus, granulation tissue, and all the evidences of chronic suppurative otitis media. In severe cases there may be facial paralysis, especially when the disease is tuberculous; sometimes patients apply for treatment for that condition, the accompanying discharge from the ear being regarded as of no importance. Suppuration in the mastoid antrum is practically always present before the infective process has spread to the cranial cavity, and, although the symptoms of antral suppuration tend to obscure those of deeper infection, various types of intra-cranial suppuration have special diagnostic features which may be distinguished in certain cases and afford some indication as to the extent of the disease. But it must be remembered that it is very difficult to arrive at an exact diagnosis in the majority of cases before an operation has been performed.

In *sinus thrombosis* the temperature is generally high with marked remissions, the pulse is rapid and feeble, there are frequent rigors followed by profuse perspirations, pain in the posterior triangles of the neck, tenderness in the sub-mastoid region and down the course of the jugular

vein, and later on there are symptoms of pulmonary embolism, diarrhœa, and a general typhoid state.

When *lepto-meningitis* occurs, the temperature rises and remains high without marked remissions, the pulse becomes more rapid, and there is general irritability. In lepto-meningitis also, the cranial nerves are more frequently implicated than is the case with abscess. Great assistance in the diagnosis is sometimes afforded by a lumbar puncture (see p. 442).

The chief symptoms of *abscess of the brain* are those due to pressure. The temperature is usually subnormal; in fact, if there is any marked pyrexia, meningeal complications may be suspected. The pulse is slow, sometimes only thirty or forty per minute; the respiration is also slow. Rigors may occur and vomiting is very common. The pain is often very marked, and may be continuous or intermittent; it is usually referred to the temporal region on the same side as the abscess and is aggravated by percussion over the temporal or cerebellar regions. Cerebration is slow, and there is difficulty in concentrating the attention. Convulsions may occur, but they are not characteristic; in fact, when convulsive movements with rigidity are present, the pus has passed into the subdural space. Optic neuritis is frequently met with; the pupils may be contracted at first, but before long they become dilated and fixed, and in the earlier stage this dilatation is most marked—or indeed may only be present—on the affected side. The coma steadily increases, and the fatal result is generally due either to gradual deepening of the coma or to the occurrence of lepto-meningitis. The temperature usually rises towards the end, the breathing becomes quick, and there is great prostration.

In some cases special symptoms may be present dependent on the situation of the abscess, but, as a rule, localising symptoms are absent because the abscesses usually form outside the motor area. It may happen that as an *abscess in the temporo-sphenoidal lobe* increases in size it may exert pressure on the lower part of the ascending frontal and parietal convolutions, and this pressure may gradually extend upwards until various motor centres are affected. An extending paralysis affecting first the face, then the arm, and finally the leg, without loss of sensation, indicates with great probability the presence of an abscess in the temporo-sphenoidal lobe. Paralysis of individual nerves—such as the facial or the third nerve—as the result of the pressure, is not common.

Cerebellar abscesses have few localising symptoms. There may be retraction of the head and neck, an increased knee-jerk on one side, or a hemiplegia due to implication of the lateral tracts; occasionally there is glycosuria, and there may be sudden paralysis of respiration from pressure on the respiratory centre.

TREATMENT.—The various complications which follow upon a chronic otorrhœa are so intermingled that it is not possible to consider the treatment of any one of them without the others; moreover, the middle-ear disease, upon which they all depend, must be treated first in

every case. The first point in the treatment of any given case is therefore to *open up the mastoid antrum and the middle ear.* Any softened and diseased bone beyond the limits of the antrum should be gouged away, and in most cases it is well to extend the incision in the bone backwards so as to *expose the lateral sinus* and thus ascertain the condition of the dura and of the sinus itself. The *roof of the attic* should also be examined. The further steps of the treatment will depend upon the conditions found. When *extra-dural suppuration* is present, the treatment in many cases may stop after the bone has been freely removed, provided always that the lateral sinus is unaffected. When there is pus in the sigmoid groove, the *condition of the lateral sinus* must be very carefully investigated. As a rule it is possible to make out by palpation whether or not it is thrombosed; but in case of doubt, it is quite permissible to puncture it with a needle. If it be healthy, it will bleed freely; if thrombosed, broken-down clot or pus may be found. Should free venous bleeding result, the sinus need not be further interfered with; on the other hand, should septic thrombosis have occurred, the sinus must be opened up and thoroughly cleansed, and at the same time all connection between it and the lungs must be cut off. Usually the operative procedures need not go farther than this, unless a cerebral or cerebellar abscess is obviously present. In cases of suspected abscess of the cerebrum or cerebellum, the symptoms often subside after opening up the mastoid antrum and the sigmoid groove, and therefore in indefinite cases, it is well to await developments for a day or two. Should symptoms pointing to *suppuration either in the sub-dural space or in the brain* continue, a further operation should be done.

We shall therefore consider the following operations in connection with these cases: (1) The operation upon the mastoid antrum; (2) the exposure of the lateral sinus and its groove; (3) the methods of dealing with a thrombosed lateral sinus; (4) the steps necessary for opening extra-dural abscesses over the roof of the tympanum; (5) the treatment of sub-dural suppuration, both localised and diffuse; and (6) the methods of treating cerebral and cerebellar abscess.

The methods of treatment appropriate to each of these conditions will be described separately; but it should be clearly borne in mind that in actual practice the surgeon may be called upon to adopt several of them in succession at the same operation. In many cases of middle-ear disease with symptoms apparently pointing to intra-cranial mischief it may be quite impossible to diagnose the actual lesion present, until more than one of these complications has been investigated.

We shall describe the steps of the procedure that should be carried out in these cases; it will be seen that the surgeon feels his way, as it were, step by step, and that his procedure is dictated by the conditions found. Of course, when the particular lesion can be accurately diagnosed, the appropriate treatment should be adopted at once.

The Operation upon the Mastoid Antrum.—In all cases of middle-ear

disease with symptoms of inflammatory intra-cranial mischief, the treatment must commence with the opening of the mastoid antrum, for the following reasons. In the first place, the focus of the disease is in the antrum, and must be removed before any good result can be expected; in the second place, the direction in which the mischief has spread can often be determined, and in any case can be more easily followed after the mastoid antrum has been opened; and in the third place, it sometimes happens that clearing out the mastoid antrum and the neighbouring cells suffices to effect a cure, even though the symptoms are grave. It is by no means always easy to diagnose the extent and situation of the mischief, and an acute inflammation in the antrum may give rise to symptoms which may be mistaken for those of grave intra-cranial mischief.

When exposing the mastoid antrum in cases accompanied by doubtful cerebral symptoms, it is often best to make a larger flap than that usually employed for the ordinary mastoid operation, as it may be necessary, not only to clear out the antrum, but to expose the lateral sinus freely, and even to explore the brain. The incision should commence about half an inch vertically above the external auditory meatus and be carried with a bold sweep backwards, so that its convexity is well behind the posterior margin of the mastoid process, curving forwards below to end just in front of that process. The incision should be carried directly down to the bone, and all the soft parts, including the pericranium, should be turned forwards. The pinna is loosened by detaching the cartilaginous from the bony meatus, and a strip of gauze is passed into the external auditory meatus and pulled out between the cartilage and the bone, and in this way a loop is formed around the pinna which serves as an efficient retractor.

When the surgeon thinks that the disease is limited to the antrum, the incision may follow the sulcus at the junction of the back of the pinna with the side of the head, access to the brain and lateral sinus being obtained later in the operation, if need be, by carrying another incision backwards from this over the middle of the mastoid process.

When there is a superficial abscess it is not uncommon to find an opening in the bone which leads into the antrum, and by enlarging this the antrum can be exposed. If, however, no such opening is present, the antrum must be reached by following the anatomical lines. The antrum is on a level with the upper margin of the bony meatus and slightly less than half an inch behind it (see Fig. 165, *A*, *a*); its cavity lies about half an inch from the outer surface of the skull. The outer wall of the antrum should be removed, if possible, with a hand gouge. In children this can always be done without difficulty, but in adults it is sometimes necessary to use a hammer and chisel. The latter implements have, however, the great disadvantage of producing a certain amount of concussion, which is obviated by using a gouge.

The removal of the bone should be carried out below the temporal ridge, which can always be identified, and the opening should be deepened especially at the upper and anterior part of the wound into the auditory meatus, so as to avoid the risk of wounding the lateral sinus or the dura mater. Less bone should be removed as the opening is deepened. When the antral cavity is reached, it can be identified at once by passing a

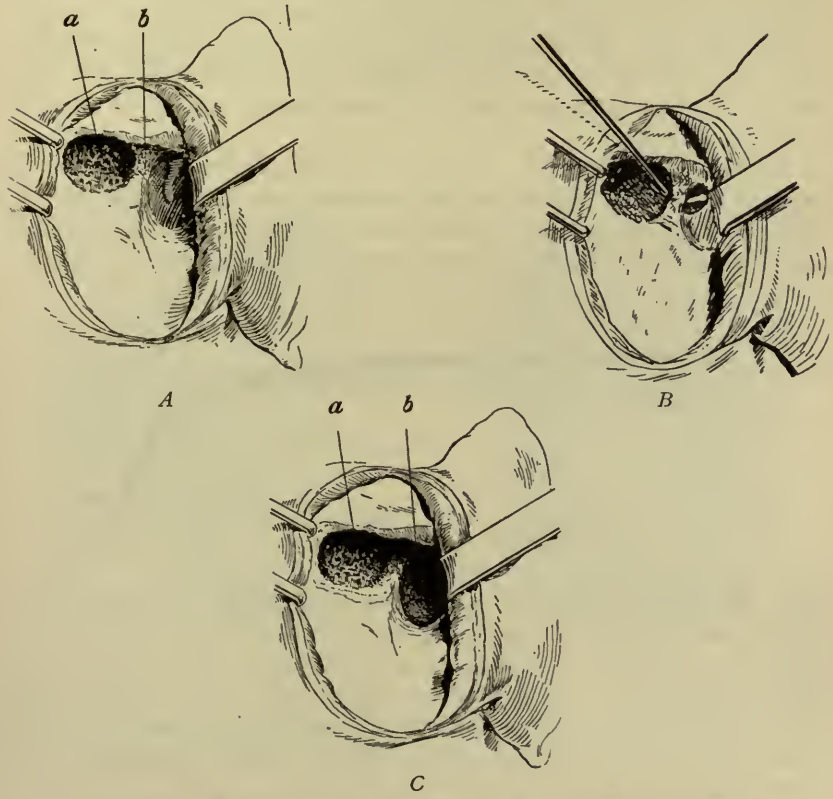


FIG. 165.—THE COMPLETE POST-AURAL OPERATION UPON THE MASTOID ANTRUM. The three stages of the operation of clearing out the mastoid antrum are here depicted. In *A* the antrum (*a*) has been laid open and gouged out, and the bridge of bone (*b*) between it and the external auditory meatus is seen. In *B* this bridge of bone is about to be removed, a bent probe having been introduced beneath it from the antrum to the middle ear. In *C* the operation has been completed by removing the ossicles, smoothing off all the rough angles, and scraping out the cavity.

bent probe into it; this should run forwards and slightly upwards into the middle ear (see Fig. 165, *B*). The opening should be enlarged sufficiently to allow the whole of the interior of the antrum to be scraped out and all overhanging edges of bone to be removed.

When the course of the disease has been acute, that is to say, when there has been no prolonged middle-ear suppuration, the operation can stop at this stage; the wound is packed to arrest hæmorrhage, the end

of the gauze being brought out through the incision behind the pinna. The packing is renewed daily until the suppuration is practically at an end, when the wound may be allowed to close, the sinus, which persists for some time, affording sufficient drainage.

When the acute symptoms have supervened upon prolonged suppuration, the complete operation must be performed, that is to say, the bridge of bone between the antrum and the external and middle ear must be removed, together with the ossicles and the membrana tympani. In addition, the cells in the interior of the mastoid process should be opened up freely so as to make a single smooth-walled cavity out of the irregular and tortuous passages of the external and middle ear, antrum, and mastoid cells.

The next step, therefore, consists in dividing the bridge of bone left between the cavity and the external auditory meatus (see Fig. 165, *C*). This is best done with a very fine chisel; it should be used extremely gently, a bent probe or Stacke's special instrument made for the purpose,

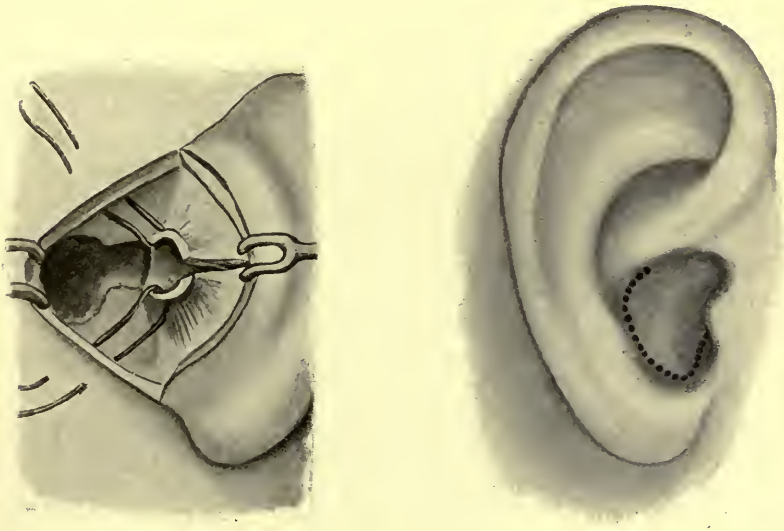
Fig. 166.—Stacke's Antral Protector. This is often used instead of the bent probe shown in Fig. 165, *B*.

being passed from the cavity of the antrum through the attic into the middle ear, to serve as a guide, and also to protect the facial nerve from injury (see Fig. 166). No force must be used when the granulations are being scraped out, as the roof of the attic may have been destroyed, and the granulations may spring from the under-surface of the dura mater; when that is the case, there is a risk of perforating the dura mater and causing septic infection of the sub-dural space.

Special care must be taken not to injure the facial nerve. It usually lies in a bony canal, but this is not uncommonly incomplete or may have been eroded by the inflammatory processes; in the latter case it is simply surrounded by a mass of granulations. If the nerve is exposed, it is generally easy to produce twitching of the face by touching it with a probe. The nerve runs no risk during removal of the outer wall of the antrum if care be taken not to deepen the opening unduly at the lower part; too low an incision will certainly damage it.

One of the principal difficulties in this operation is that blood wells up freely into the funnel-shaped cavity and obscures the view. This is best obviated by pouring a few drops of adrenalin chloride (1 in 1000)

or hydrogen peroxide solution (10 vols.) into the wound occasionally, or by packing a narrow strip of gauze into the cavity with sinus forceps, and removing it rapidly ; a special gauze tape is made for this purpose. After the granulations have been scraped away, the wound is dried, and the walls of the cavity are examined with a bent probe to see whether there are any large cells in the mastoid process communicating with the antrum, or whether there is a sinus leading into the sub-dural space or backwards to the groove of the lateral sinus. If a connection with the sub-dural space is found over the roof of the attic, the bone must be carefully removed so as to permit free drainage, and at the same



A *B*

FIG. 167.—FORMATION OF CONCHAL FLAPS AFTER THE COMPLETE POST-AURAL OPERATION UPON THE MASTOID. In *A* the meatus is split to form two flaps which are pulled outwards by the stitches, shown in the diagram. *B* shows the single conchal flap —denoted by the dotted line and described in the text.

time to ascertain whether there is any collection of pus between the dura mater and the bone. Should there be a communication backwards to the lateral sinus, the bone must be opened up, so as to expose the latter freely. The middle ear is then gently curetted, and the malleus and incus removed together with the membrana tympani; the stapes is left *in situ*.

When the cerebral symptoms are indefinite, the operation may end at this point. The cartilage and mucous membrane of the external auditory canal are split longitudinally along their posterior aspect (see Fig. 167, *A*) and a silkworm-gut suture is then passed through the upper portion of the split meatus near to the point at which the cartilage has been detached

from the bone ; [1] thence it goes through the skin, and emerges about half an inch behind the incision at about the level of its upper limit. The other end of the suture is then threaded on a needle and brought out at a point about a quarter of an inch from the first end of the suture. By tying these two ends together, the upper segment of the meatus will be pulled upwards and backwards. This manœuvre is repeated with the lower segment, so that at the end of the operation the deeper part of the meatus is widely open over the cavity in the temporal bone which has been made by the operation. Another method, which is in many ways preferable, is to split the meatus and then to carry a curved incision from the outer end of this cut around the periphery of the concha, cutting somewhat obliquely so as to avoid button-holing the skin over the back of the pinna ; in this way a semicircular flap is made, which can be turned up into the roof of the antrum and held in position by packing (see Fig. 167, *B*). If this flap is too thick, owing to inflammatory swelling, it may be pared down with scissors. The incision through the skin is closed with a few interrupted silk-worm-gut sutures, and the cavity of the antrum is packed from the external meatus with narrow strips of cyanide gauze impregnated with iodoform emulsion.

Exposure of the Lateral Sinus.—In many cases suppuration extends backwards, and when the antrum is opened, a channel may be found containing pus and communicating with the sigmoid groove. In that case the removal of bone must be continued directly backwards from the antral cavity to the sigmoid groove ; the latter lies much nearer the surface than the antrum, and therefore the bone must be removed very cautiously until the dura mater is exposed ; a sharp gouge is the most suitable instrument. The sinus must be exposed sufficiently freely to allow both its condition and that of the groove in which it lies to be accurately ascertained ; if pus is present in the latter, the groove must be cut away backwards and downwards until the infected area has been exposed. In most of these cases the vein will be thrombosed ; should it be patent, however—as is shown by free bleeding when it is punctured with a needle—the operation need not proceed farther. The wound is packed with iodoformed gauze and left open, and the dressing should be changed every twelve hours. Unless some further intra-cranial complication exists, the patient's condition will improve within forty-eight hours. When puncturing the sinus to ascertain whether there is thrombosis, great care must be taken not to carry infective material in with the needle ; the wall of the sinus should be disinfected with 1 in 500 sublimate solution or 1 in 20 carbolic lotion at the point at which the puncture is to be made.

[1] We are here speaking of the procedure when the second incision (see p. 394)—that close to the back of the ear—is employed. Where a large flap has been turned aside a free incision must be made in it over the opening into the antral cavity.

Treatment of Sinus Thrombosis.—When the lateral sinus is thrombosed, it is important to determine whether the thrombus is infected or not. In the early stages this is not always easy, but to some extent the general symptoms are a guide. The presence of rigors, an intermittent temperature, and other signs of pyæmia, are of great help; additional information is gained by ascertaining whether the clot in the sinus is firm and dark or whether it is softening and yellowish. When the clot is firm and dark, infection is probably absent or only in its initial stages, and the prognosis is comparatively good. When the clot is breaking down, the patient is in imminent danger of death from

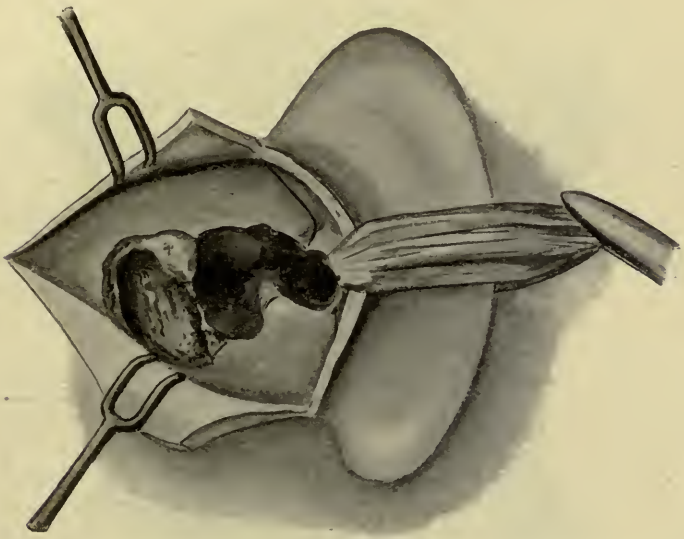


Fig. 168.—Exposure of the Lateral Sinus after the complete Mastoid operation. The post-aural incision has been prolonged backwards and the groove of the lateral sinus—in which is seen an extra-dural abscess—has been exposed.

pyæmia. In some cases the wall of the vein may have sloughed, so that the contents simply form part of a sub-dural abscess; and when this is so, the symptoms are characteristic of a breaking-down thrombus. Washing out the pus, with free exposure and drainage of the sub-dural space, may suffice for a cure under these circumstances. In all cases, however, in which there is thrombosis of the sinus, it is best to cut off the main communication between the sinus and the general circulation before dealing farther with the local condition. The wound is covered up with sterile cloths; fresh sterilised instruments, towels, and rubber gloves are taken, and the internal jugular vein is exposed in the neck well below the limit of the clot, ligatured in two places, and divided between the ligatures.

Ligature of the Internal Jugular Vein.—The incision for exposure of the internal jugular vein is similar to that for ligature of the common carotid artery above the omo-hyoid muscle (see Vol. II. p. 193). The most convenient place for the ligature is opposite the bifurcation of the common carotid artery; this point is easy of access and is almost always below the limits of the thrombus; it is most essential that the ligature should be applied to a patent portion of the vein. If the vein is not patent it is often reddish and roughened on the surface, and does not collapse when it is lifted up on the aneurysm needle. A double

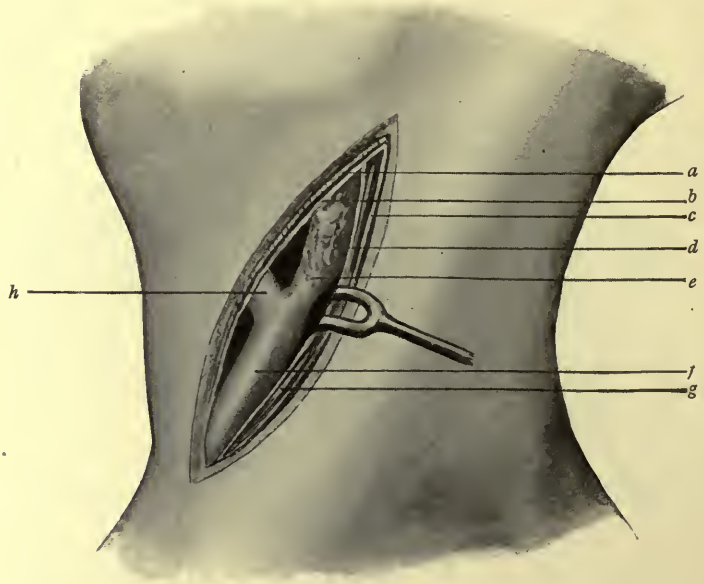


Fig. 169.—Exposure of the Internal Jugular Vein. *a*, Platysma; *b*, *c*, superficial layer of the deep cervical fascia; *d*, deep layer of the deep cervical fascia; *e*, lower end of the clot and inflamed vein; *f*, internal jugular vein; *g*, sterno-mastoid muscle; *h*, facial vein.

ligature is passed and tied in two places; the vein is then divided between the two ligatures. Any large tributaries exposed in the incision should also be tied.

After the vein has been tied, the wound behind the ear is uncovered, and the groove in the bone around the lower part of the sinus packed with gauze to prevent clot from being forced on during the further manipulations. The sinus is now laid freely open, and the clot washed out with saline solution. When the clot extends down beyond the foramen lacerum medium, it is well to remove the packing from the groove, open the upper part of the ligatured jugular vein, and wash

out all clot with a stream of warm normal saline solution. Should the mastoid vein be thrombosed, the opening in the bone should be enlarged and the thrombus scraped out with a small spoon. Any clot extending backwards along the lateral sinus should also be removed by scraping and flushing until the entire thrombus has been cleared out—in fact, until free bleeding from the sinus occurs. In order to lay the whole infected area freely open it may be necessary to continue the removal of bone backwards for some considerable distance. The cavity should be packed with gauze, which readily arrests the bleeding, and, as a rule, nothing further need be done.

It is now best to wait and see whether the symptoms are relieved by what has been done, or whether further symptoms indicating lepto-meningitis or cerebral abscess appear in the course of forty-eight hours. Should no such symptoms arise, the packing is renewed daily until granulation is complete, when the skin flaps may be brought together, a drainage tube being substituted for the packing. The internal jugular vein is not of course the only communication between the lateral sinus and the general circulation, but it is the main one, and, as a matter of practical experience, it is found that a good result often follows if that vein is ligatured early in the course of the case in the manner just described.

Treatment of an Extra-dural Abscess.—When the general symptoms are very grave, it is advisable to carry the treatment further before closing the wound and to ascertain whether sub-dural suppuration exists. If the lateral sinus and its groove are healthy, the most likely place to find pus is above the middle ear. The roof of the attic is not uncommonly diseased, and there may even be a perforation in it from which pus escapes. It should therefore be exposed and the dura mater lifted up from it; if diseased bone is found, as much as possible should be removed so as to provide free drainage. The best method of examining the condition of the dura mater over the roof of the attic and the adjacent part of the petrous bone is to enlarge the opening already made for exposure of the antrum directly upwards and a little forwards. The prominent ridge formed by the posterior or horizontal root of the zygoma, which is prolonged backwards as the commencement of the temporal ridge, is easily identified and serves as a landmark. It corresponds to the level of the under-surface of the temporo-sphenoidal lobe and the upper surface of the petrous bone, upon which the latter lies. The removal of the skull should therefore be carried well above this ridge (see Fig. 170), until the dura mater is exposed. The dura is now separated from the petrous bone with a suitable blunt spatula (see Fig. 171), and raised so that the bone may be examined and any pus may escape; any diseased bone should be cut or scraped away with a small gouge or sharp spoon. The semicircular canals must be carefully avoided. When there is pus in this situation, a strip of gauze should

be packed between the dura mater and the bone at the end of the operation.

Treatment of Lepto-meningitis.—The treatment of suppurative lepto-meningitis is extremely unsatisfactory and it is very seldom indeed that it is successful. Attempts have been made to wash out the pus by making two or three trephine holes and opening the dura mater at the base of the skull, but it is very doubtful whether anything more than mere temporary relief can be obtained by them. By opening the skull low down in the occipital region and lifting the cerebellum up from the medulla oblongata so as to allow the escape of fluid from the fourth ventricle, considerable, but usually only temporary, relief is obtained. The fluid that escapes is not necessarily purulent, and its escape should be facilitated by the insertion of drainage tubes beneath the cerebellum (see Fig. 172). Repeated lumbar punctures are of some value in these cases. For the method of performing lumbar puncture see p. 442.

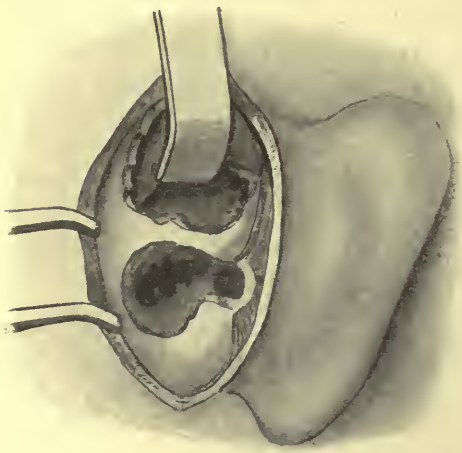


Fig. 170.—Exposure of the upper Surface of the Petrous Bone for Sub-dural Abscess. The complete post-aural mastoid operation has been performed. The cranial cavity has been opened above the temporal ridge and the dura mater lifted up by a spatula to expose the sub-dural abscess between it and the upper surface of the petrous bone.

Treatment of an Abscess of the Brain.—It is often very difficult to localise these abscesses. When the roof of the attic is carious, the probability is that the abscess is in the temporo-sphenoidal lobe, and this is the first region that should be explored; failing the discovery of an abscess there, the cerebellum should be examined. On the other hand, when suppuration occurs along the sigmoid groove, the abscess is probably in the cerebellum and that should be examined first. It sometimes happens that a communication is found passing directly from an extra-dural abscess into a superficial abscess of the brain in the vicinity. Any such opening should be enlarged, and the abscess treated in the manner to be described immediately; removal of more bone may not be necessary.

When the symptoms persist after exposure of the lateral sinus (*vide supra*), and lead the surgeon to suspect the presence of an abscess in the brain, the simplest plan is to enlarge the opening in the bone over the sinus sufficiently to enable both the temporo-sphenoidal lobe and the cerebellum to be explored. It will be necessary to carry an incision

horizontally backwards through the skin, to cut away bone above and below the sinus (the limits of which are known by the colour of its contents) and then to puncture the dura mater above or below it, according as it is desired to explore the cerebrum or cerebellum (see Fig. 173). The method of exploring the brain is described below; in practising it under these circumstances, great care must be taken to prevent the introduction of septic material into the brain with the exploring instrument (see p. 398 in reference to puncture of the vein). The forceps are carried horizontally forwards above the sinus to explore the temporo-sphenoidal

FIG. 171.—HORSLEY'S DURA MATER SEPARATOR.

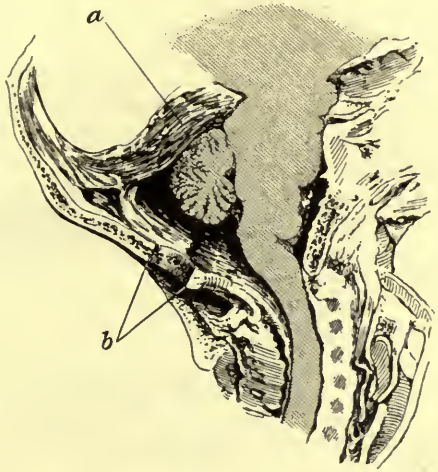


FIG. 172.—DRAINAGE OF THE SUB-ARACHNOID SPACE IN THE CEREBELLAR REGION. The drawing is made from a section of the skull of a fœtus just before birth, and shows how the cerebellar sub-arachnoid space is tapped by opening the skull below the inferior curved line. After birth the cerebellum becomes proportionately larger and the space smaller. *b*, The opening in the skull; *a*, the tentorium cerebelli. (*From a preparation by Prof. Arthur Robinson, formerly of King's College.*)

lobe, and forwards and inwards below that structure to explore the cerebellum.

In other cases, however, the symptoms may point so clearly to an abscess of the brain, that the abscess may be sought for at once after clearing out the focus of disease in the ear. The following methods may be employed:—

In operating for *abscess in the temporo-sphenoidal lobe*, the best plan is to apply the pin of the trephine about an inch and a quarter above Reid's base line and directly above the ear. The dura mater, which bulges into the trephine opening and does not pulsate, is incised and the temporo-sphenoidal lobe exposed. In incising the dura, any large vessels running across it should be avoided if possible, or picked up in

forceps as soon as the incision has been made. It is sufficient to make a slit in the dura mater just large enough to admit a pair of sinus forceps, and this need not be enlarged unless pus is found. The exploration of the brain is best effected with a pair of sinus forceps, introduced closed; the blades are separated from time to time, when any pus they reach will escape between them. If the exploration is made with a hollow needle or with a trochar and cannula, the channel is apt to become blocked with brain substance and the pus may not escape, even though the instrument passes into an abscess cavity. The forceps should be pushed directly inwards in the first instance; if they fail to

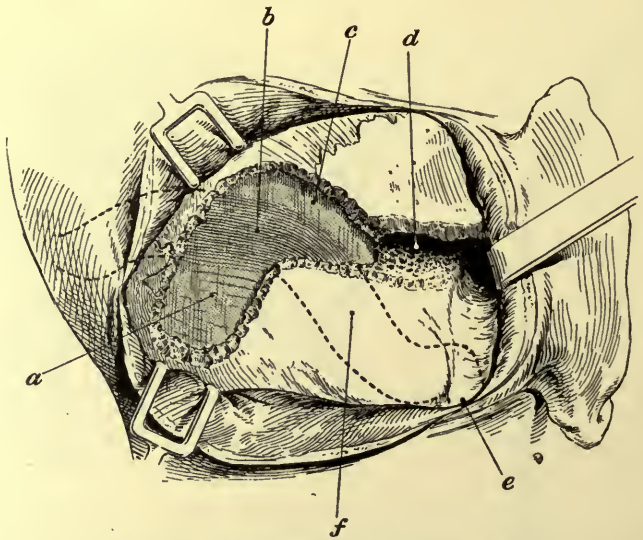


FIG. 173.—EXPLORATION OF THE CEREBRUM AND CEREBELLUM THROUGH THE SAME OPENING IN THE SKULL. By enlarging the incisions in the soft parts and the bone, as shown above, the dura mater can be exposed on both sides of the lateral sinus, and both the temporo-sphenoidal lobe and the cerebellum explored for an abscess. *a*, Dura mater over the cerebellum; *b*, lateral sinus; *c*, dura mater over the cerebrum; *d*, mastoid antrum laid into the auditory meatus; *e*, mastoid process; *f*, dotted outline of the lateral sinus.

reach pus, they may be directed upwards and backwards and finally downwards and forwards. In this way the three chief seats of temporo-sphenoidal abscess will be explored.

If pus is found, the opening in the dura mater should be enlarged and a pair of dressing-forceps substituted for the sinus forceps. Some surgeons then introduce the nozzle of a fine syringe into the abscess cavity, and flush it out with a stream of warm saline solution. If this is done, care must be taken not to use the fluid under pressure, but to make provision for the free escape of the fluid, otherwise serious damage may be done. When the abscess cavity has been cleansed, the forceps may be withdrawn and the cavity allowed to close without drainage. In our

opinion it is better not to wash out the cavity, and we always insert a drainage tube for at least two or three days, a hole being made for it in the centre of the flap, which is then stitched up with a continuous suture. At the end of two or three days, the discharge will generally have diminished so much that the tube may be left out. The disadvantage of a drainage tube is that the brain may become adherent to the edges of the opening in the dura mater and to the under-surface of the flap, and this may possibly be followed by epileptiform attacks. On the other hand, this by no means necessarily occurs, and, when no drainage is employed or when it is not efficient, the abscess may re-form, may extend more widely, and may not be so successfully dealt with on a second occasion. Indeed, it is often difficult to prevent the abscess from re-forming, even when a drainage tube is used.

When no abscess is found in the temporo-sphenoidal lobe, or when the symptoms indicate *cerebellar abscess*, the cerebellum must be explored. When the sigmoid groove has not been opened, this may be done by turning down a flap below the superior curved line on the side affected and then applying a trephine in the space bounded by the superior curved line above, the sigmoid groove in front, and the middle line behind. After the trephine hole has been made, the further procedures are identical with those just mentioned. The abscess is usually found in the anterior and upper part of the cerebellum—and that is the direction in which the forceps should be introduced first. These abscesses not uncommonly extend directly inwards from the lateral sinus, and when the sigmoid groove has been exposed, it may only be necessary to cut away a little bone below it, and then, after incising the dura mater, to introduce the forceps below the lateral sinus directing them towards the upper and anterior part of the cerebellum.

When the abscess has been successfully opened and the patient does well, the drainage tube may be removed in two or three days, and the wound usually heals in a week or ten days. It is seldom that any protrusion of brain takes place through the small opening left by the drainage tube ; if it does, the suppuration is still active and the drainage imperfect.

CHAPTER XXXIV.

HERNIA CEREBRI: SINUS THROMBOSIS: TUBERCULOUS MENINGITIS.

HERNIA CEREBRI.

As a result of operations or injuries—frequently accompanied by inflammatory processes in connection with the brain—there is not uncommonly a protrusion of cerebral substance through the aperture in the skull; this is termed a hernia cerebri. This condition is quite different from encephalocele, in which the protrusion of the brain is due to a congenital abnormality and the scalp is intact.

Clinically, two types of hernia cerebri can be distinguished. The first of these is not connected with sepsis, and the brain which protrudes is healthy. In the second type the brain substance is unhealthy, and has been exposed to septic contamination which may or may not as yet have become established.

CASES IN WHICH THE PROTRUDING BRAIN IS NOT THE SEAT OF AN ACUTE INFLAMMATORY PROCESS.

This form of hernia cerebri occurs after operations of two different types, namely, those performed merely to relieve pressure on the brain and allow it to expand, and those performed for other purposes, in which no cause of increased intra-cranial pressure is at work.

A hernia cerebri is deliberately produced when it is desired to relieve intra-cranial pressure—*decompression operations*. This is most commonly done when a patient is suffering from an irremovable growth inside the skull which causes severe pressure symptoms, and in it a large area of the vault of the skull is removed in order to allow the brain to protrude. In these cases the scalp is stitched up and the hernia occurs beneath it, and nothing further is required beyond protection of the hernia against injury (see Fig. 174).

In the other class of case the hernia cerebri follows *operations performed for purposes other than decompression.* Thus it may follow any operation in which a portion of the bone has been lost and the dura mater has been opened: for example, operations for the removal of a tumour or of blood-clot, or operations for epilepsy. In these cases, the healthy brain substance protrudes through the opening in the skull as the result either of œdema of the brain—as may happen when there has been sudden relief of pressure after the removal of a blood-clot or tumour—or of some temporary cause of increased intra-cranial pressure. These cases are often spoken of as *primary hernia cerebri* (see Fig. 175, *A*).

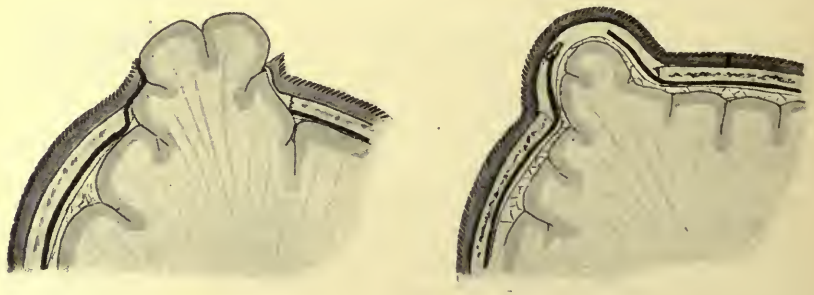
A primary hernia cerebri following an operation in which the cause of compression has been removed does not lead to any serious trouble. If the opening in the dura mater is large and the flap of skin has been replaced and completely sutured, the œdematous condition of the brain soon subsides and the protrusion gradually retracts within the skull as healing occurs. Sometimes, however, the case does not follow this favourable course, because complications may arise which prevent the return of the brain; for example, when the opening in the dura mater is small, the protruded portion of the brain may become constricted at its base, its circulation interfered with, and the œdematous condition of the protruded portion so much increased that it cannot return through the opening. A similar difficulty may also occur when the protruding brain contracts adhesions to the margin of the opening so that, even if the œdema subsides, complete recession of the protruded portion cannot take place; this, however, rarely happens to any serious degree unless inflammation has occurred (see Fig. 175, *B*).

FIG. 174.—HERNIA CEREBRI PRODUCED BY A 'DECOMPRESSION' OPERATION. The scalp has united and the increased intra-cranial tension produced by the tumour (shaded dark area), causes the brain to protrude through the large gap purposely left in the dura mater.

TREATMENT.—On account of the risk of hernia cerebri when the dura mater has been opened, all cerebral operations must be planned so as to prevent this accident. It is chiefly for this reason that the flap method of exposing the skull before trephining is employed; the cicatrix in the soft tissues is thereby removed from the vicinity of the opening in the skull, and this undoubtedly diminishes the risk of hernia. For this reason also, the dura mater is opened by a curved incision with the curve in the opposite direction to that of the flap in the skin (see Fig. 158), and the incision in the dura mater is sewn up closely with fine catgut. When it is not possible to bring the edges of the dura mater closely together, the gap in the membrane should be bridged with catgut somewhat in the way in which a stocking is darned, so as to present a barrier against the escape

of the brain. It is partly with this object that the bone is replaced after trephining. Some surgeons also introduce between the edges of the opening in the dura mater and the brain a piece of gold-foil, or other unirritating thin material, larger in area than the opening in the dura, so as to prevent the two surfaces from coming in contact and adhering. In operations carried out in this manner, hernia cerebri should not occur—especially if the dressing is arranged so as to form a support during healing.

When a hernia of this type has occurred, it is usually sufficient to wait for the subsidence of the œdema, keeping up pressure over the orifice in the skull in the meanwhile; as a rule the hernia will recede in the course of a few days. Should it not do so, the cause is usually too small an opening in the dura mater or adhesion between the latter and the brain.



A *B*

FIG. 175. ASEPTIC HERNIA CEREBRI. *A* shows the true primary aseptic form which occurs after an operation in which there is a defect left in both scalp and dura mater, which is represented by the thick line. *B* shows an aseptic hernia cerebri which is secondary to an increase in the intra-cranial pressure, *e.g.* from œdema. The scalp wound has healed, but the pressure has caused the incision in the dura to give way and the brain protrude beneath the scalp.

Under such circumstances it may be advisable to turn down the flap again—after the lapse of four or five days—enlarge the opening in the dura mater, and separate any adhesions between its margins and the brain, so as to allow the protrusion to recede into the cranial cavity. After the opening in the dura mater has been enlarged, it is well to incorporate in the dressing a plate of sterilised block tin, or other firm material, rather larger than the opening in the bone, and to keep it in place by an elastic bandage. This will support and prevent increase in the size of the protrusion and lead to its gradual return into the cranial cavity.

CASES IN WHICH THE PARTS HAVE BEEN EXPOSED TO SEPTIC CONTAMINATION.

(*a*) *In some cases the hernia cerebri occurs at the time of the injury.* This is practically a primary hernia cerebri because it occurs before septic

changes have occurred, and only differs from the preceding type in that there is a likelihood of the wound becoming septic.

(*b*) *In other cases, the hernia cerebri occurs two or three days after an operation or injury.* This is a much more severe form, and is sometimes spoken of as secondary hernia cerebri.

In this form of hernia cerebri the protrusion of the brain is due to its surface becoming infiltrated with inflammatory exudation and to increase in the intra-cranial pressure from the congestion of the brain beneath. The protruded portion usually contains little cerebral matter, and is mainly composed of granulation tissue with lymph and pus infiltrating it. Suppuration generally occurs on the surface of the hernia, and in some cases, especially when the swelling continues to increase, a collection of pus will be found in its interior, or even extending into the cranial cavity and forming a superficial cerebral abscess (see Fig. 176).

Fig. 176.—'Secondary' Septic Hernia Cerebri. There is a gap in the skull and the scalp, through which protrudes a mass of septic granulation tissue and brain matter forced out by the increased intra-cranial tension due to inflammation and suppuration (the dark area) in the brain.

These secondary herniæ vary in size and are generally somewhat mushroom-shaped, for they expand after emerging through the opening in the skull. They are usually very vascular, and have a somewhat constricted pedicle corresponding to the opening in the dura mater. They are covered with granulations which discharge pus freely, and are often gangrenous in patches. Pressure over them may lead to convulsions. A spontaneous cure sometimes results either from gradual cicatrisation of the whole mass, or from gangrene of the herniated portion and cicatrisation of the pedicle. As a rule, however, the condition is followed by septic inflammation of the deeper parts of the brain leading to cerebral abscess, by lepto-meningitis, or by pyæmia.

TREATMENT.—(*a*) *Of herniæ occurring at the time of the injury.*—In these cases two conditions favouring the occurrence of hernia cerebri have to be dealt with: namely, the opening in the skin is usually over the hernia, and the parts have, moreover, been exposed to infection. The treatment of a compound fracture of the skull has already been described on p. 342, and it is unnecessary to repeat what has been said there. When protrusion occurs, the best treatment is to see that the base of the hernia is not constricted, and then to cover the protrusion

completely with a piece of Lister's protective or gold-foil, and apply outside that the ordinary gauze dressings in which a piece of block-tin is incorporated and kept in position by means of an elastic bandage. This dressing will require changing daily; if infection does not occur, the hernia may gradually recede, and entirely disappear in a week or ten days. As soon as the hernia has receded sufficiently, an attempt may be made to close the wound; a flap of skin can usually be brought over the opening in the skull, and any raw surface left by raising the flap can be covered by skin-grafts (see Vol. I. p. 52).

(*b*) *Of herniæ occurring two or three days after an operation or injury.*—The object of treatment in this group of cases should be to render the hernia aseptic, if possible, and then to prevent further protrusion. The surface of the protrusion should be shaved off; there need be no hesitation in removing a considerable portion, seeing that it contains very little healthy cerebral substance. After the bleeding has been arrested by pressure and before any adhesions are separated, the raw surface is thoroughly swabbed with undiluted carbolic acid. It is important to disinfect the surface before separating adhesions, so as to avoid carrying septic material into the deeper structures. As a rule, all this can be done without an anæsthetic because the protruded mass is insensitive. The surface is then powdered with sterilised iodoform, and a piece of Lister's protective oiled silk or thin sheet-rubber applied over it; a gauze dressing which overlaps the protective widely in all directions is then put on. A piece of block-tin may be incorporated with the dressings and additional pressure exerted by means of an elastic bandage. If the sepsis has been got rid of in this way, and if no intra-cranial inflammatory mischief (such as an abscess in the brain) is going on, the surface of the herniated portion will often granulate, and the mass shrinks and disappears. An attempt should then be made to cover in the surface of the brain if it is large, and with this object the edges of the wound should be freed for some distance and stitched together, or a flap may be turned in over the hernia if there is much tension, and the space from which it has been taken may be skin-grafted.

In some cases the hernia is accompanied by intra-cranial suppuration; the prognosis is then very hopeless. The surface of the hernia should be removed in the manner described above, and sinus forceps should be introduced into the brain beneath the hernia, and their blades expanded so as to ascertain if any pus is present. If an abscess is found, the cavity should be dealt with as described on p. 402.

SINUS THROMBOSIS.

The venous sinuses in the skull are probably more predisposed to the occurrence of thrombosis than most other veins, owing to their anatomical characters and the peculiarities of the circulation through

them. Two forms of thrombosis are met with, namely, non-infective or marasmic thrombosis, and the infective form. Of these the latter is the more common, and is in fact the only one for which active treatment can be employed.

The marasmic form chiefly occurs in the longitudinal sinus and affects weakly people, especially children or old subjects, after prolonged and debilitating illnesses. In children, exhausting diarrhœa is one of the most common causes, and the thrombosis generally appears during convalescence, the result being cerebral congestion and œdema. In bad cases the ventricles may be distended with serous fluid, and there may be subsequent cerebral softening.

The *symptoms* are generally somewhat indefinite, but in young children thrombosis may be suspected if convulsions occur after exhausting illnesses, and more especially if the symptoms are unilateral and accompanied by muscular rigidity, or strabismus.

Treatment.—There is little to be done beyond ensuring absolute rest and administering nutriment in the most concentrated and easily assimilated form. Citric acid or citrate of potash may be given in large doses to check the spread of the thrombosis, but these drugs have no action on clot which has already formed. Any symptoms which arise should be appropriately treated, but there seems to be no scope for surgical intervention.

The infective form.—This condition is usually met with in the basal sinuses, especially in young adults. It is always secondary to some external lesion, and generally occurs at the point nearest to the source of infection. Among the causes which give rise to it are septic compound fractures, and infective processes such as erysipelas, diffuse cellulitis, carbuncle about the face or scalp, and middle-ear disease. The condition has already been described in connection with thrombosis of the lateral sinus occurring after disease of the ear (see p. 390). Among the other sinuses which may be affected are the cavernous and the transverse sinuses.

Symptoms.—*When the cavernous sinus is involved* there are disturbances in the eye on the affected side, such as congestion of the veins, compression of the oculo-motor nerves, pain, small pupils, cloudy corneæ, œdematous eyelids and exophthalmos. Later on, the pupil becomes dilated, and optic atrophy and corneal ulceration may result. There is pain in the supra-orbital and frontal regions, which is increased on pressure. *When the tranverse sinus is involved* the symptoms are chiefly connected with the vagus which is irritated at first and subsequently paralysed.

Treatment.—The principles of treatment have been discussed in connection with the lateral sinus (see p. 399). Unfortunately these principles cannot be fully carried out, either in the case of the cavernous or the transverse sinus, but they should be borne in mind in case it may be possible to carry them into effect.

TUBERCULOUS MENINGITIS.

In this condition there is a deposit of tubercles in the pia mater, especially about the vessels at the base of the brain. The result is inflammation and effusion, acute distension of the ventricles with fluid, and increased intra-cranial pressure. For the condition of the cerebro-spinal fluid, the reader should consult the section by Dr. Emery, (see p. 442).

TREATMENT.—Attempts have been made to relieve the intra-cranial pressure by draining the ventricles, or by inserting a drain through the condyloid foramen, but, although the immediate symptoms are often relieved by the drainage of the cerebro-spinal fluid, no permanent good can be expected from this procedure. One or two cases have certainly recovered after drainage, but it is doubtful whether the condition in them was tuberculous or merely a simple meningitis. Repeated lumbar puncture is probably quite as efficacious as direct drainage of the cranial cavity, and is a much less severe procedure.

The following is the best method of draining the posterior part of the cranial cavity (see Fig. 172). The head is shaved, purified in the usual manner (see p. 328), and placed on a suitable head-rest (see Fig. 155). A semilunar incision with its convexity upwards is made over the side selected for drainage. The incision should begin at the middle line well below the external occipital protuberance—which is often very slightly marked in young children—and reach as high as the superior curved line. The flap thus marked out is retracted, the inner portion of the complexus either cut through or detached from the occipital bone, and the inferior curved line exposed. The rectus capitis posticus major muscle is stripped from its attachment by a rugine, and the skull is then opened by a trephine or a gouge, just below the inferior curved line and to one side of the middle line so as to avoid the sinus. This exposes the dura mater which generally bulges into the opening and does not pulsate. The dura mater is opened at the lowest possible point by a mere nick of the knife, and then a fine blunt spatula such as the dura mater separator (see Fig. 171) is passed beneath the lower edge of the cerebellum and the latter lifted gently up. The result generally is a free gush of fluid, which continues to flow and to pulsate in the opening. The greatest gentleness must be observed in lifting up the cerebellum, and the spatula must not be thrust in too deeply lest the important structures in the floor of the fourth ventricle be damaged.

Drainage is effected by passing an india-rubber tube (No. 6) through the opening in the dura and beneath the cerebellum, and a hole is made for it in the centre of the scalp flap, which is then sewn up with a continuous suture and the usual dressings applied.

The drainage of the cerebro-spinal fluid for the first two or three days

is generally free and necessitates frequent change of dressings ; for a time the child's condition improves markedly. The great difficulty is to maintain the drainage, as the tube, if of medium size, soon gets blocked, and, if large, allows the semi-fluid cerebellum to escape.

The general treatment for tuberculosis must be carried out, and it is possible that *tuberculin* injections (see Vol. I. p. 522) may be of use.

CHAPTER XXXV.

MENINGOCELE AND ENCEPHALOCELE: MICROCEPHALUS: HYDROCEPHALUS.

MENINGOCELE AND ENCEPHALOCELE.

These congenital deformities are not uncommon. The protrusion may consist of the meninges alone, and contain cerebro-spinal fluid—*meningocele*—or it may contain brain substance as well, *encephalocele*. Its most frequent situations are the middle line of the skull, the occipital region, and the root of the nose.

The *diagnosis* is usually comparatively easy. The swelling may vary in size with respiration, and, when brain substance is present, there is also marked cerebral pulsation. It is generally partially reducible, but attempts at reduction frequently give rise to signs of irritation of the brain. The opening in the skull can often be felt; it may be quite small or it may be very extensive. The *prognosis* is usually unfavourable. The tumour may vary in size from quite a small swelling to one involving the greater part of the cranial contents. The latter cases are especially unfavourable, and the children seldom survive more than a few days or weeks.

TREATMENT.—In large tumours and those containing much brain substance, *palliative* treatment with the view of avoiding ulceration and spontaneous rupture of the sac is best; this consists in protecting the tumour with a suitable shield, as described in connection with spina bifida (see p. 284), and in the use of antiseptic lotions or ointments when the skin is abraded.

Many forms of *radical* treatment have been attempted, but much depends on the size of the tumour, the size of the defect in the skull and the nature of the contents of the tumour. For very small tumours it may not be necessary to operate at all. A large tumour, which has a small pedicle, may be successfully dealt with, especially if it is

a pure meningocele. The presence of much brain tissue contra-indicates an operation. The patient should be carefully examined for other congenital defects or abnormalities, which may make it undesirable to operate, such as hydrocephalus, spina bifida, and paralysis of the limbs. If operation is decided on, this should be carried out as soon as the condition of the child will permit.

In performing the operation, the skin is carefully disinfected and an elliptical portion is removed over the swelling, including any ulcerated or thin areas. The flaps, consisting of the whole thickness of the

Fig. 177.—Encephalocele. The large tumour contains brain matter in addition to the meninges. *a*, Dura mater; *b*, skin; *c*, pia-arachnoid; *d*, brain matter. (*From a specimen in the Museum of the Royal Free Hospital.*)

scalp, are dissected up until the pedicle is clearly defined as it passes through the hole in the bone, and should be separated from any attachments it may have to the margins of the opening. The pedicle is transfixed by a needle carrying a double catgut ligature, which is tied and the remainder of the sac is cut away; the flaps are then carefully sutured. When the pedicle is large, it is better to tap the meningocele, allow some of the fluid to escape slowly, and cut away the sac, leaving sufficient tissue to permit the edges to be accurately approximated and to prevent the further escape of cerebro-spinal fluid. If a small quantity of brain tissue be present in the sac, it may be replaced or cut away, any bleeding points being ligatured, or the hæmorrhage arrested by sponge pressure.

Various plastic procedures have been tried for the closure of the osseous defect, but have not been very successful and cannot be recommended. If the defect is large, some form of shield must be incorporated with the dressing.

As a palliative procedure, repeated tapping with a fine trochar and cannula may be practised. The usual antiseptic precautions must be taken and the instrument should always be inserted through the most healthy part of the skin. The head should be kept lowered and the fluid allowed to escape slowly. A collodion dressing is put over the puncture, and a mass of wool and a firm bandage applied outside it.

In some cases, lumbar puncture (see p. 442) may be a better method of relieving the pressure, but there is nothing curative in this procedure.

MICROCEPHALUS.

This condition has attracted much attention, but it cannot be said that any material benefit has resulted from treatment. In microcephalus the head is abnormally small, and this probably results from imperfect development of the brain. The disease has been supposed to be due to a premature ossification of the skull preventing the due expansion of the brain, and on this theory extensive operations have been undertaken with the view of loosening portions of the skull, and so allowing expansion of the brain to take place. It is most probable, however, that the disease is primarily due to interference with the development of the brain, and that the early ossification is the result of the non-development of this organ. The operations cannot be said to have been followed by any marked success, and it is questionable whether they are really justifiable; we cannot advise their performance.

HYDROCEPHALUS.

This is the term applied to abnormal collections of cerebro-spinal fluid within the cranial cavity, accompanied by marked enlargement of the head. When the fluid is present in the ventricles, the condition is known as *hydrocephalus internus*; when it is outside the brain, as *hydrocephalus externus*. The latter condition is probably very rare.

Hydrocephalus may be congenital or it may be developed during the early years of life. There is still a good deal of uncertainty as to its pathology. The congenital cases are ascribed to imperfect development of the brain, or to meningitis occurring during or soon after intra-uterine life, leading to the formation of adhesions between the cerebellum and the upper part of the medulla.

The most constant pathological condition found in connection with hydrocephalus is chronic basal meningitis, and it is probable that this is the main cause both of the congenital and the acquired cases. The meningeal inflammation is usually dependent either on syphilis or

on non-tuberculous posterior basal meningitis. Recovery from the attack of meningitis is followed by the formation of adhesions which block the passage of the cerebro-spinal fluid at the foramen of Majendie, or above or below it, and this is followed by distension of the lateral ventricles. It has been shown by various investigators, more especially by Dr. Leonard Hill, that the amount of cerebro-spinal fluid is regulated by exudation and absorption by the veins and lymphatics of the membranes of the brain, particularly towards the base, and if anything interferes with this normal regulation of the cerebro-spinal fluid, the result on the brain is very serious. The occurrence of a meningitis interferes with this regulation, and then cerebro-spinal fluid accumulates in the ventricles, giving rise to the condition known as hydrocephalus.

SYMPTOMS.—The result of the retention of the fluid in the ventricles is that the cerebral tissue is pressed against the cranium; when the skull is rigid this leads to atrophy of the brain and symptoms of cerebral pressure. When, however, the affection commences in infancy, the skull expands readily, and thus no marked symptoms of cerebral pressure arise, although the cerebral cortex becomes much thinned. The amount of fluid which may collect in the ventricles and in the posterior sub-arachnoid space in infants is sometimes very large, and the cortex of the brain may be reduced to an extremely thin membrane, the fissures and sulci being completely lost and the various ganglia being flattened out.

In the congenital cases and in those commencing during the first year of life, the head becomes enormously enlarged, and many of the congenital cases show also other developmental troubles, such as club-foot or hare-lip. The development of the child is interfered with in many ways; the digestion becomes imperfect, there is chronic constipation and emaciation, strabismus and nystagmus are common, the eyeballs are displaced downwards, the pupils are much dilated, the special senses are usually imperfect, and the child very frequently dies during the first or second year of life. As the disease advances there is often rigidity and retraction of the head, with convulsions.

In the acquired cases developed after the first year of life, the symptoms are more severe because the skull cannot expand with the same rapidity. There are usually severe headaches, cramps, or paralyses, crying out at night, emaciation, and, after a time, possibly some separation of the sutures and gradual expansion of the skull. Recovery is comparatively rare, and, when it does take place without operation, the brain power is generally greatly enfeebled.

TREATMENT.—Various methods of treatment have been employed, but, until recently, without marked success. Apart from the medical treatment, which consists mainly in the use of anti-syphilitic remedies and attention to the nutrition of the child, attempts have been made to prevent the expansion of the skull and to promote absorption

of the fluid by compression of the head with bandages. In other cases the cranial cavity has been repeatedly tapped, but very rarely with any beneficial result. Permanent drainage has been resorted to, but as a rule, even although care be taken to restrict the amount of fluid drained away, pyrexia and convulsions and, subsequently, death occur in a few days as a consequence of the loss of cerebro-spinal fluid. Injections of Morton's fluid have been tried without success.

Following the experiments of Dr. Leonard Hill as to the normal regulation of the cerebro-spinal fluid by absorption and exudation by the lymphatics and veins in the cerebral membranes, we have (at the suggestion of Dr. G. A. Sutherland)[1] attempted to restore this normal regulation by establishing an opening between the lateral ventricles and the sub-dural space on the view that, if such an opening could be established, the normal regulation of the cerebro-spinal fluid would be carried out by the portions of the meninges not yet affected by meningitis, and that there would thus be permanent relief of the pressure instead of the temporary relief which follows external drainage.

The operation we adopt is as follows: A flap is turned down and a small opening is made in the skull, usually at the anterior superior angle of the parietal bone close to the fontanelle. This piece of bone can be readily removed with a gouge: indeed, when the fontanelle is exceptionally large we make the opening at its lower angle without removing any bone. The dura mater is exposed, a small incision is made into it about the centre of the flap, and one limb of a rectangular tube of decalcified bone filled with catgut is introduced through the cerebral cortex into the dilated lateral ventricle. The tube is made by dividing a decalcified bone tube (about the calibre of a No. 10 English catheter) obliquely to its long axis with a sharp knife, after which a hank of catgut is threaded through the two portions, and the latter are then fastened together by stitches at the angles so that a rectangular tube is formed consisting of a longer and a shorter limb. The longer limb should be about three-quarters of an inch in length, the other half an inch (see Fig. 178). A pair of sinus forceps is thrust through the cerebral cortex into the distended ventricle about half an inch from the opening in the dura and about two ounces of the fluid allowed to escape. This permits the brain to fall away from the dura to a slight extent, and gives room for the introduction of the tube. The longer limb of the tube is then grasped in a second pair of sinus forceps and thrust through the cerebral cortex at the point where the puncture was made, the first pair of sinus forceps being opened to allow of its passage. The tube is pushed in until its angle is at the opening in the cortex; its shorter arm then lies in the sub-dural space. In this way one part of the tube projects into the lateral ventricle, while the other lies in the sub-dural

[1] On the treatment of hydrocephalus by intra-cranial drainage. By G. A. Sutherland and W. Watson Cheyne, *Brit. Med. Journ.*, Oct. 13, 1898.

space, and the fluid readily passes from the ventricle to the sub-dural space (see Fig. 179). Mr. Ballance has introduced bent platinum tubes for the same purpose; these act very well, and have a little ring at the angle by which the tube is stitched to the dura mater to prevent it from slipping about. The hole in the dura is closed and the scalp flap is sewn up tightly with a continuous suture so that there is no leakage of cerebro-spinal fluid.

As a rule, there is a rapid rise of temperature after the operation, even up to 104° or 105° F., but this gradually falls to normal in the course of a week or ten days, and in a very short time diminution in the size of the skull becomes evident. This diminution goes on steadily to a most

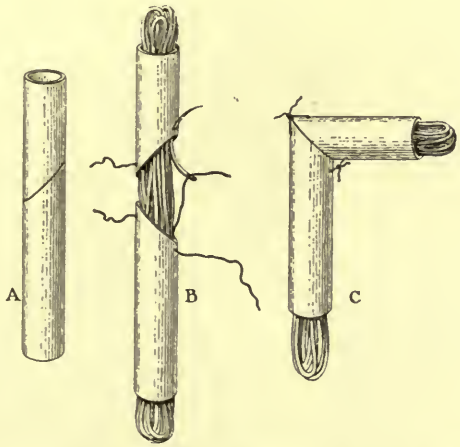


FIG. 178.—DECALCIFIED BONE TUBES ARRANGED FOR DRAINAGE OF THE LATERAL VENTRICLES. The method of preparation of these tubes is shown. A is the bone tube divided obliquely. In B the bank of catgut has been threaded through the two segments of the tube, which are then rotated as shown in the figure and a stout catgut suture is passed through the tube at each angle. When tightened, these sutures make the rectangled tube shown in C.

striking degree, the skull bones falling in and overlapping one another; at the base, where the bones cannot fall in to the same extent, a sharp line of rigid bone is left. The result, in the course of a few weeks, is the entire disappearance of the distension of the head and the production of a most curiously deformed small skull. If the drainage should show signs of ceasing too soon, a similar operation may be done on the other side.

We have found a marked difference between the *results* in the congenital and the acquired cases. In the former, in so far as the relief of the brain pressure and the restoration of the normal regulation of the cerebro-spinal fluid and the consequent diminution in the size of the skull are concerned, they have been encouraging; but in acquired cases, in which the brain is thick, it is a matter of considerable difficulty to keep up a channel

of communication between the ventricles and the sub-dural space for any length of time.

The results of these attempts clearly prove the truth of the views concerning the regulation of the cerebro-spinal fluid in the cranial cavity, and, in so far as the distension of the lateral ventricles is concerned, the operation described above has led to satisfactory results. Nevertheless in the congenital cases the children have usually died at the end of about

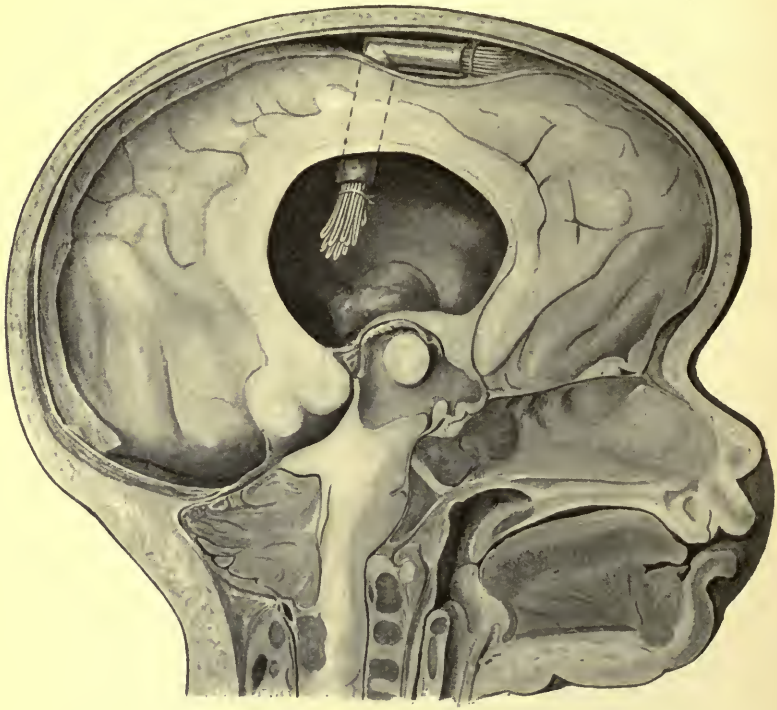


Fig. 179.—Method of drainage employed for Internal Hydrocephalus. The drainage tube shown in Fig. 178 has been placed in such a position that one end projects into the greatly distended lateral ventricle, while the other lies beneath the dura mater.

four months with symptoms such as retraction of the head and rigidity, indicating continued extension of the basal meningitis in spite of energetic anti-syphilitic treatment.

It is to be feared that congenital hydrocephalus is not remediable unless checked at quite an early period; even if the patients were to live, the brain is so badly developed and has been so injured by the pressure that no marked restoration of the cerebral functions could be expected.

When, however, the brain has developed properly and the condition of internal hydrocephalus supervenes later, the outlook is more hopeful if proper drainage can be established and maintained. The essential

damage in these cases is due to the distension of the ventricles, and the establishment of such a regulation of the cerebro-spinal fluid as is described above is evidently well worth attempting, provided that it is done at an early period.

Palliative operations.—Puncture of the lateral ventricle or lumbar puncture may be done for the temporary relief of the pressure ; about an ounce of fluid is removed at a time, and care must be taken to secure asepsis. These procedures are in no way curative. Mr. Ballance has also practised, with some degree of success, ligature of both common carotid arteries at an interval of about ten days between each operation.

CHAPTER XXXVI.

FOCAL EPILEPSY: TUMOURS OF THE BRAIN.

FOCAL EPILEPSY.

Various operations, such as ligature of the vertebral arteries or division of the sympathetic trunk in the neck, have been introduced for the cure of true epilepsy without any marked success. For focal or Jacksonian epilepsy, however, operation may be of great value.

Various *causes* may give rise to this condition; they may be situated in the motor areas or at some distance from them. Among them may be mentioned a depressed fracture, in which there is direct pressure by the displaced bone; an osteitis, especially after injury; a localised pachymeningitis, especially the condition known as pachymeningitis interna; hæmorrhages upon the surface of the brain; cysts or a cerebral tumour pressing on the brain; the presence of a foreign body such as a bullet; cicatrices on the surface of the brain after operations; adhesion of the brain to the dura mater or to the skull, as may occur after opening a cerebral abscess; or even adhesion of a cicatrix in the scalp to the bone. The spasms may often be provoked by pressure over the affected area.

In these cases the attack usually begins in a definite centre, and the muscular spasms commence in one group of muscles and extend in regular sequence to others. They may or may not end in a general convulsion, and in some cases consciousness is not completely lost. The fits may begin without the least warning, and after the immediate effects have passed off, the patient may feel quite well again. They may be few in number and occur at long intervals, or they may be quite frequent. They may be followed by a certain amount of stupor or coma similar to the ordinary post-epileptic coma, by temporary paralysis either of sensation or motion, by diplopia, or by various sensory phenomena.

It is very important to remember that the onset of Jacksonian epilepsy

may take place immediately after an injury has been inflicted or an operation wound has healed. On the other hand, a considerable interval of time, sometimes years, may elapse before the occurrence of the first fit; indeed, in some cases, the injuries have been so slight that the patient looked on them as quite trivial, and did not take much notice of them at the time, or indeed had forgotten about them. In the interval, perfect health may have been present.

TREATMENT.—The primary object of the treatment in this form of epilepsy should be the removal of any cause of irritation of the cerebral centres. The most favourable results are obtained when the attacks are few, and commence soon after the injury, and when the lesion is situated on the surface of the brain. When the fit remains localised, operation should be performed at once; the result of operative interference is generally satisfactory. In cases in which the fit, though local at the onset, becomes generalised, the operation is not likely to be followed by a cure, though temporary and possibly permanent alleviation may follow, both as regards the fits and the general health of the patient; in any case the immediate result is often extremely satisfactory. The relapse, which is not uncommon, is often due to the formation of adhesions or to the presence of fresh scar tissue, and until some certain method of preventing these adhesions is discovered, a guarded prognosis should always be given. It is important to place the facts before the patient or the relatives in all cases previous to operation.

When there is a tender and adherent cicatrix on the scalp, excision of the scar, followed by immediate union of the cut edges, may cure the patient; indeed, in some cases, its separation from the bone with a tenotomy knife has proved sufficient.

In most cases, however, the lesion is deeper and it is necessary to open the skull. The precise spot at which the operation should be performed will be determined by the symptoms present; by the presence of a scar on the scalp; by irregularity of the bone; by tenderness of the skull on percussion; or according to the group of muscles in which the symptoms commence.

The *operative procedure* will vary according to the conditions present. Removal of the bone with the trephine is always the first step. In some cases, it is well to keep the portion of bone removed, with the view of implanting it again (see p. 344). When the bone is thickened and inflamed, however, this is not advisable; in these cases the mere removal of the bone by the trephine will often arrest the condition. When the dura mater is thickened and adherent, the affected area should be excised without damaging the cortex. If the brain is adherent to the dura mater or to the bone, the adhesions should be separated.

If there is a blood-cyst in the sub-dural space pressing on the surface of the brain, it should be taken away. The blood-clot should be gently removed by a scoop, and the cavity irrigated with sterilised normal salt

solution. As much of the cyst wall as possible should be excised, but care must be taken not to injure the cerebral cortex. If there is much oozing during the operation it is advisable to introduce a drainage tube and leave it in for two or three days.

The most difficult cases are those in which there is a cicatrix in the brain over the centre in which the disturbance originates. In these cases, it is recommended that a portion of cortex should be excised along with the cicatrix. This will, however, be followed by formation of a cicatrix and possibly a recurrence of symptoms, and consequently many surgeons are averse to such a proceeding. Moreover, the excision, if extensive, may be followed by paralysis, and it becomes a question whether it is worth the patient's while to have a paralysed limb in place of the epileptiform attacks. It will generally be found that it is so, if the attacks are severe; and besides, it often happens that some substitution of function takes place, and the paralysis diminishes in extent. As a rule, the tendency is to do too little rather than too much in the way of removal of bone, cicatrices, or adhesions.

It is most important to avoid adhesion between the brain and the tissues over it after operation; this complication is apt to occur when portions of the dura mater have to be removed, and, if it does, the symptoms will probably recur. A favourite means of avoiding this difficulty is to introduce between the brain and the dura mater a piece of sterilised gold-foil or thin sheet-rubber; this seems to be non-irritating and to prevent adhesions between the brain and the margins of the dura. It remains permanently in position, and in operations for epilepsy or for the removal of tumours it is well to make use of something of this kind. Under such circumstances it is impossible to replace the bone, because the substratum is non-vascular.

TUMOURS OF THE BRAIN.

Tumours in the brain may be either true neoplasms or masses of tuberculous or syphilitic origin; the most common are tuberculous nodules, gliomata, sarcomata, syphilitic gummata, and cysts of various kinds (blood-cysts, echinococcus cysts, cysts in tumours). Endotheliomata are not infrequent; they are perhaps most often found in the cerebellum.

The presence of a tumour is not always easy to determine, and the differential diagnosis of its nature is often impossible. The presence of localising and pressure symptoms, the occurrence of optic neuritis and the existence of a localised tender spot on pressure on the skull will raise a strong suspicion of the existence of a tumour. As to its nature, the history or presence of other lesions elsewhere (syphilitic, tuberculous, carcinomata) will give a hint which may be strengthened by Von Pirquet's reaction for tuberculosis, Wassermann's reaction for syphilis, or the

result of lumbar puncture. It is usually impossible to predict the exact pathological nature of a neoplasm, but variations in intra-cranial pressure, indicating variations in the vascularity of the tumour, may sometimes lead to the suspicion of glioma.

A tumour growing in or upon the brain presents two completely distinct and definite sets of *symptoms*. The first are those common to all intra-cranial swellings, and are due to the *increased intra-cranial pressure* which is indicated by headache, vomiting, optic neuritis, and, later on, coma; these patients are liable to die suddenly, especially when the tumour is in the cerebellum or at the base of the brain. The second are *localising symptoms* due to the destruction or irritation of the part of the brain in the immediate neighbourhood of the growth. It is unnecessary to discuss the differential diagnosis of the various forms of cerebral tumour or the localisation of the growth. The latter would involve a long statement of the present position of our knowledge of the physiology of the brain, and for this purpose a separate text-book on the subject must be consulted. Figs. 180 and 181 indicate the various cortical centres sufficiently accurately for all practical purposes.

TREATMENT.—**Medicinal.**—As it is very difficult to be certain as to the exact nature of the tumour, it is usual to begin treatment with anti-syphilitic remedies which should be pushed rapidly. When the Wassermann test is positive, salvarsan should be given intravenously (see Vol. I. Chap. XI.); the blood should be tested again after three or four weeks, and if the reaction is still positive, a second smaller dose should be administered provided there is nothing to contra-indicate its use. If no improvement is found after a trial of this line of treatment for four to six weeks the disease is either not syphilitic, or, if it is syphilitic, it is not likely to benefit by anti-syphilitic treatment, and therefore the question of operative interference will arise.

Operative.—In the early days of localisation of function and brain surgery, great hopes were founded on surgical procedures for dealing with cerebral tumours. These hopes, however, have only been realised to a small extent because the great majority of tumours of the brain are not amenable to surgical treatment. *Post-mortem* examination has shown that, at most, only ten per cent. of tumours of the brain are removable, and that in a considerable proportion of these the operation required would be so serious that the patient would not recover. Hence the outlook is discouraging as regards the radical treatment of these tumours. The best results are obtained in cases of cysts, psammomata, single tuberculous tumours, and gummata; the latter, however, will usually disappear with salvarsan.

Indications.—The operative treatment may be radical or palliative. To fulfil the first indication, the tumour must be localised in an accessible position and single. It must also be a primary tumour

in the brain, of small size and of slow growth, and the more superficially it is situated the better will be the prospect of cure.

In the majority of cases of true neoplasms, however, the tumour is

FIG. 180.—THE RELATIONS OF THE VARIOUS CRANIAL SUTURES, CEREBRAL CONVOLUTIONS, AND CORTICAL CENTRES. The line AB denotes the main direction of the fissure of Rolando, and is obtained in the following manner. The asterisk (*) marks the bregma or central point of the line joining the glabella and the external occipital protuberance. A point (A) is then marked on the scalp 5 centimetres behind this spot, and corresponds to the upper end of the fissure of Rolando. The lower end of the fissure (B) is situated 1 inch behind the point C, which is the bifurcation of the Sylvian fissure, and is 2 inches behind and ¼ inch above the external angular process of the frontal. *L*, Lambdoid suture; *P.O.*, parieto-occipital fissure; *S*, fissure of Sylvius; *R*, fissure of Rolando; *Sq.*, squamous suture; *C*, coronal suture; *, bregma. (*From a preparation made by Prof. Arthur Robinson, formerly of King's College.*)

large, rapidly growing and diffuse, or deeply seated, and therefore is not suitable for a radical operation. The question then arises, whether operation may not be undertaken to relieve the severe symptoms (see p. 438) due to the increased intra-cranial tension. Much will depend

on the urgency of the symptoms and on the probable prolongation of life which will result. When the tumour, while apparently beyond the possibility of removal, is not causing very acute or painful symptoms, there is no real object in operating. On the other hand, when the patient is still conscious and is suffering acutely from the effects of pressure, his condition can be made much more comfortable by opening the skull freely, while the impending blindness—the result of the optic neuritis —may be averted for a time; and further it is always possible that the operation may disclose a tumour of such a nature or in such a situation that it may be removed. If it is decided to operate in these cases, a 'decompression' operation (see p. 438) should be performed.

Radical Operation.—The entire scalp should be shaved the night before the operation and disinfected in the manner described in Vol. I. p. 99. It is necessary to mark out on the scalp the supposed area of the tumour. This is done by ascertaining from clinical data the relation of the tumour to the convolutions, and then marking out the relations of those convolutions to the scalp. The most important convolutions are those in front of and behind the fissure of Rolando, and there are various ways in which the position of this fissure may be ascertained. The principal bony landmarks on the skull are the glabella at the root of the nose, the external occipital protuberance, the bregma half-way between these, the external angle of the orbit, and the mastoid process.

Localisation of the Fissure of Rolando.—The upper end of the fissure of Rolando is situated about five centimetres behind the bregma, and the fissure runs downwards and forwards, forming an angle of about 67° with the line connecting the glabella and the occipital protuberance; it is about three and three-quarter inches long. Any variation in its direction (which is not uncommon) is usually so slight as not to affect the operation because the area of bone removed is large enough to include these variations. Various methods of localising the fissure are used; one of the first was Reid's, in which a line (Reid's base line) is drawn round the head from the lower margin of the orbit through the centre of the external auditory meatus (see Fig. 181), and then two lines at right angles to this, up to the top of the cranium, one just in front of the external auditory meatus and the other along the posterior border of the mastoid process. A third line, indicating the horizontal limb of the fissure of Sylvius, is drawn from a point one and quarter inches directly behind the external angular process of the frontal bone to another point three-quarters of an inch below the parietal eminence cutting both vertical lines, and a fourth line is drawn from the glabella to the external occipital protuberance. These four lines enclose an irregular quadrilateral figure, and the line joining the postero-superior angle with the antero-inferior angle will indicate the fissure of Rolando.

One of the easiest methods of locating the fissure of Rolando is by using the so-called 'Rolandometer,' suggested by Sir Victor Horsley

(see Fig. 182), which is made of flexible metal so that it is easily sterilised and adjusted to the surface of the skull. When the long limb is placed

FIG. 181.—REID'S METHOD OF CEREBRAL LOCALISATION. AB is Reid's base-line, and runs from the lower margin of the orbit backwards through the centre of the external auditory meatus. From this, two lines are drawn upwards at right angles: one, CD, from the depression just in front of the ear to the middle line of the skull (from the glabella to the external occipital protuberance), and the other, EF, from the posterior border of the mastoid process to the same line. The line GK indicates the horizontal limb of the fissure of Sylvius, and runs from a point 1¼ inch directly behind the external angular process of the frontal, to another point ¾ inch below the parietal eminence (*). The point K, at which this line meets the middle line of the skull, localises fairly accurately the mesial end of the parieto-occipital sulcus. The fissure of Rolando corresponds mainly to a line drawn from F to H, the point of intersection of the fissure of Sylvius with the vertical line CD. The bifurcation of the Sylvian fissure lies about ¾ inch behind G on the line GK, and the vertical limb runs upwards from that point for about 1 inch. *L*, Lambdoid suture; *P.O.*, parieto-occipital fissure; *S*, fissure of Sylvius; *R*, fissure of Rolando; *Sq.*, squamous suture; *C*, coronal suture; *, parietal eminence. The drawing is from the same preparation as that used for Fig. 179.

over the antero-posterior line of the skull with the smaller angle (67°) looking forward, and the point of junction of the two limbs about five

centimetres behind the bregma, the shorter limb will indicate sufficiently accurately the direction of the fissure. The shorter limb is graduated so that the length of the fissure can be marked off on the scalp. Should this instrument not be available, an easy means of replacing it has been

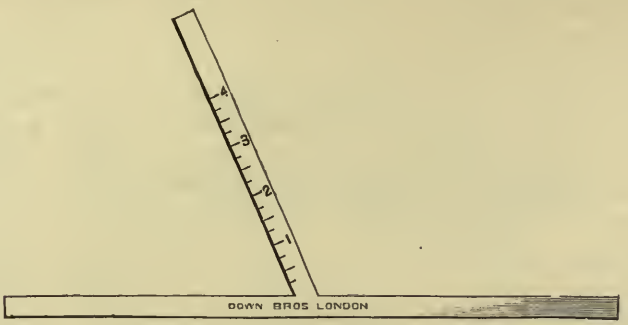


FIG. 182.—HORSLEY'S 'ROLANDOMETER.' The graduated limb is set at an angle of 67° to the other, which is placed along the vertical line of the skull from the root of the nose to the external occipital protuberance. The point of junction of the two limbs is applied five centimetres behind the centre of this line, so that the graduated limb slopes downwards and forwards; it then lies over the fissure of Rolando.

suggested by Professor Chiene. Take a square piece of paper and fold it diagonally so as to make a triangle, whose lesser angles are 45°. One side of this triangle is then folded back on to the base, so that its angle is reduced to $22\frac{1}{2}°$. This folded-down portion is cut away, and the remainder

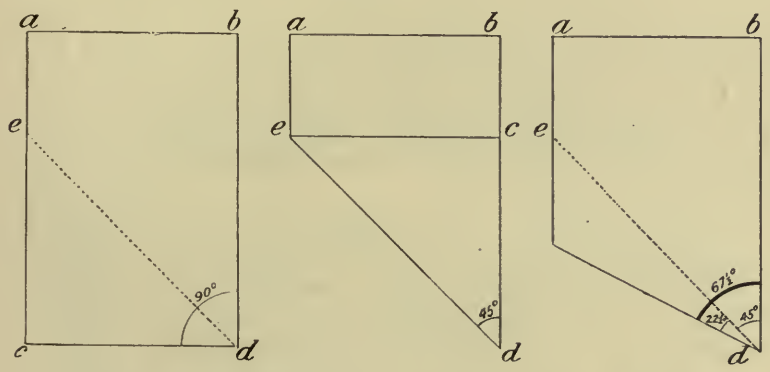


FIG. 183.—CHIENE'S METHOD OF LOCATING THE FISSURE OF ROLANDO. The method is fully described in the text; for the sake of clearness in drawing, a parallelogram is used here instead of a square. The side *dc* is first made to coincide with the side *db*. Then the side *dc* is folded back along the line *de*. This folded-back piece is cut away, and when the paper is then unfolded it has the shape of the right-hand diagram.

of the paper is unfolded and forms a trapezium, one of whose angles is $45° + 22\frac{1}{2}° = 67\frac{1}{2}°$ (see Fig. 183). The paper is placed with one side of this angle along the middle line of the skull, and its apex five centimetres behind the middle of this line—that is to say, it is applied over the upper

end of the fissure of Rolando. The other edge of the paper runs downwards and forwards at an angle of $67\frac{1}{2}°$, and indicates the line of the fissure. The fissure being three and three-quarter inches in length, the lower end of it can also be marked out.

It may also be necessary to indicate *the position of the fissure of Sylvius*. Its bifurcation corresponds to a point two inches behind and about a quarter of an inch above the level of the external angular process of the frontal bone, and is situated just beneath the point of junction of the parietal, the great wing of the sphenoid, the frontal and the squamous bones. The anterior branch runs upwards and forwards beneath the line of the squamo-sphenoidal suture and forms the anterior boundary of the motor region. Figs. 180 and 181 show the relation of the convolutions to these fissures as well as the relation of the various centres.

Before disinfection, it is well to mark out these lines on the scalp by painting them with a solution of thirty grains to the ounce of nitrate of silver; this is allowed to dry, and then the lines are lightly brushed over with a solution of pyrogallic acid (gr. v. to the ounce). An indelible silver stain is produced which is not effaced when the scalp is purified, as is the case with marks made with an aniline pencil.

The best *anæsthetic* is chloroform, because it causes least congestion of the brain, and it is advisable to administer a hypodermic injection of morphine ($\frac{1}{4}$ to $\frac{1}{2}$ gr.) with $\frac{1}{120}$ gr. of atropine, about half an hour before the operation. It is well also to give oxygen from time to time during the course of the operation. Some surgeons prefer ether given by the open method, but venous congestion must be most carefully avoided. It is essential to have the services of a skilled anæsthetist, who will see that no more anæsthetic is given than is absolutely necessary, particularly in the later stages of the operation. There is no doubt that the after-effects depend more on the amount of anæsthetic administered than on the particular drug used.

Position of the patient.—The head end of the operating table should be raised so as to diminish the amount of congestion, and a special head-rest is advisable. In operations on the cerebellum and occipital regions the patient is turned completely over on his face (see Fig. 185), the forehead resting on the head-rest and the shoulders being raised to allow free respiration to take place. The anæsthetic is administered from below.

These operations are likely to be followed by severe shock, and therefore the measures recommended in Vol. I. p. 117 must be employed to diminish it. Special care must be taken to avoid undue hæmorrhage. It is an excellent plan to apply a sterilised rubber tourniquet horizontally round the skull on a level with the glabella and the occipital protuberance (see Fig. 186). Ballance's forceps (see Fig. 139) will be found to be useful when a tourniquet cannot be applied or after it has been taken off.

After the skin has been purified, it is well to transfer the markings on the scalp to the skull, by driving a fine bradawl or drill through the

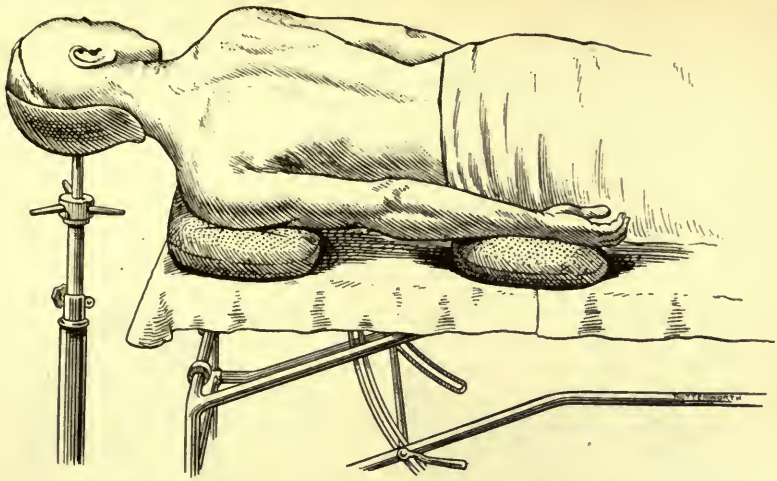


FIG. 184.—POSITION OF THE PATIENT IN OPERATIONS UPON THE CEREBRUM. In this case a special adjustable head-rest—similar to that shown in the following figure, but with a different head piece—is used. In practice, a sterilised towel is first thrown over the head-rest and the patient's head is then arranged upon it.

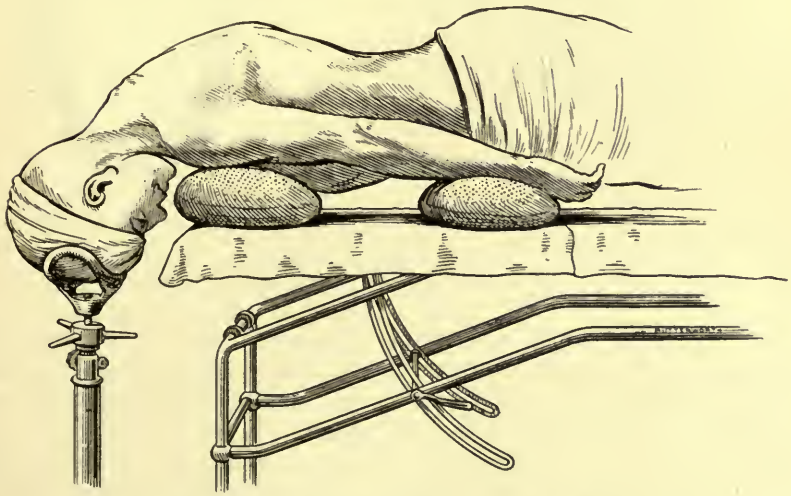


FIG. 185.—POSITION OF THE PATIENT IN OPERATIONS UPON THE CEREBELLUM. Here the patient is turned right over into the prone position. The forehead is received in the special rest here figured, which is covered with a sterilised towel. The sand-bags beneath the chest and the pelvis are to allow full play to the diaphragm and abdominal muscles.

former into the skull at various points along the lines marking out the fissures and the supposed area of the tumour. *A large omega-shaped*

incision, with the convexity upwards, is then made so that the opening in the bone will be beneath the centre of the flap; the opening in the bone must be large enough to expose the tumour fully. There is no risk to the vitality of the flap, because the base is large, but it is always well to plan it so that the main vessels enter at the base. After the flap has been turned down, the tourniquet should be released and the various bleeding vessels clamped.

Operation in two stages.—In almost all cases it is well to divide the operation for removal of a cerebral tumour into two stages; in the first, a sufficient opening is made in the skull to allow of free access to the tumour, and the opening of the dura mater and the removal of the tumour

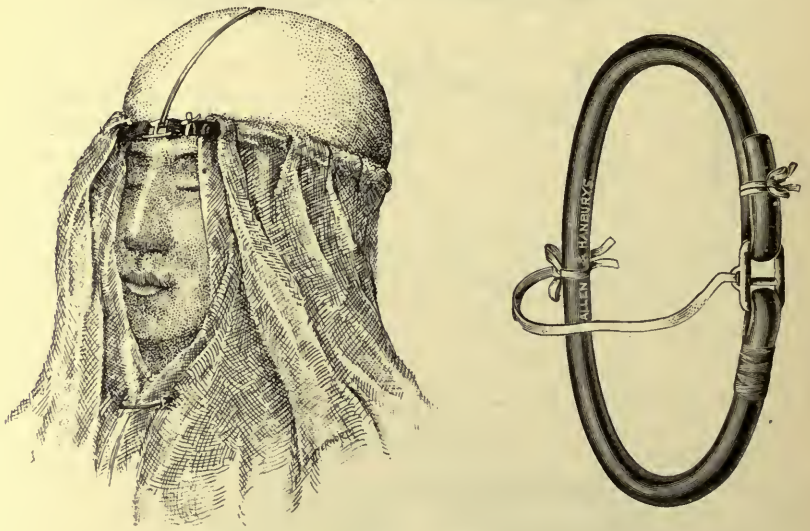


Fig. 186.—Cushing's Tourniquet applied to the Scalp. The rubber band is applied over a sheet of sterilised gauze or butter-muslin, stretched over the scalp. It is prevented from slipping down over the eyebrows by the tape passing from the glabella to the occipital protuberance. The tourniquet—the details of which are shown in the right-hand figure—is sterilised by boiling before use.

are postponed for about a week. If the second part of the operation follows immediately after the first, it not uncommonly happens that the patient is unable to stand the added shock and loss of blood entailed by opening the dura and removing the tumour. When the dura mater is opened it may be found that the tumour is larger or is in a different situation from what was expected, and as it is impossible to tell beforehand how great will be the difficulties of the case, we prefer, as a rule, to operate in two stages. Hence we are in favour of employing the 'osteo-plastic flap,' since the slight extra time that it takes is of little consequence when the operation is to be done in two stages, while the protection that it affords to the brain subsequently is considerable.

Formation of an osteo-plastic flap.—After the scalp flap has been

marked out, the soft parts (including the pericranium) are retracted for about half an inch all round the incision, and then a half-inch trephine-hole is made at each of the angles of the exposed surface of the skull (see Fig. 187). From the upper holes as starting points, the flap of bone, which is roughly quadrilateral, is marked out. In the first place, the two upper holes are joined by a horizontal cut which thus forms the upper limit of the bone-flap. After trying many plans, we find it easiest to make this incision with the cutting-forceps, introduced by De Vilbiss (see Fig. 189), which are exceedingly powerful and enable the surgeon to cut a narrow track without damage to the dura mater, or undue loss of time. When the horizontal incision has been made, a vertical one is carried down on each side as far as the holes at the base of the flap; all that remains to be done then is to divide the base of the bone so that the entire flap, consisting of scalp and skull, can be turned downwards (see Fig. 188). The simplest plan is to insert a blunt instrument into the horizontal incision and beneath the upper edge of the bone-flap, and to lever it gently outwards; the base of the bone-flap is thin and breaks without risk of fracturing the skull elsewhere. If there is any difficulty in effecting this, the base of the bone-flap may be narrowed a little by cutting inwards, and fracture will then occur quite easily. It is unnecessary to take elaborate precautions by bevelling the bone to prevent the bone-flap from falling into the cranial cavity after it is replaced at the end of the operation; the bone adheres firmly to the scalp and is kept in place by it. By adopting the above plan, there is no fear of the bone losing its vitality and requiring removal subsequently. Even should it be found necessary to enlarge the opening in the skull still further during the course of the operation, the osteo-plastic flap is useful as it affords a partial protection to what would otherwise be a very large gap in the skull.

If, however, the surgeon prefers not to cut an osteo-plastic flap, he proceeds to reflect the flap of soft parts immediately after the incision has been made down to the bone all round. All the structures superficial to the bone, including the pericranium, are turned off the skull with a raspatory as quickly as possible. The marks made by the bradawl are identified and the amount of bone to be removed is decided upon. In some cases it is sufficient to make a single large trephine hole and then to enlarge the opening with Hoffman's or Lane's forceps (see Figs. 147 and 190). This, however, is generally very tedious, especially when there is a large tumour; in that case four small trephine holes should be made at what will be the angles of the opening, and these are then connected by means of De Vilbiss's forceps (see Fig. 189), or by a Gigli's saw (see p. 33). If a Gigli's saw is used the whalebone guide and metal spatula (see Fig. 191) must be used also in order to protect the dura mater. Unless this is done, the under-surface of the wire, which cuts as freely as the upper, will wound the dura mater, as the intra-cranial tension is sure to press it up against the saw. The simplest

FIG. 187.—A METHOD OF FORMING AN OSTEO-PLASTIC FLAP IN OPERATIONS UPON THE BRAIN. The usual curved incision is made through the scalp. The square of bone to be turned down is then marked out by incisions through the pericranium along its superior horizontal and two vertical sides. The pericranium and the soft parts are retracted on either side of these lines, and trephine holes are made, one at each corner of the square. The upper holes on each side are connected by means of De Vilbiss's forceps (see Fig. 189), or by a Gigli's saw, which is shown with its guide (see Fig. 191). From the two upper trephine holes a vertical cut (made in the same manner as the horizontal one), is carried down on each side to the lower angle of the flap. It now only remains to divide subcutaneously the base of the osseous flap. This may be done with a Gigli's wire saw, or by levering the bone outwards and so snapping its base across.

FIG. 188.—THE OSTEO-PLASTIC FLAP TURNED DOWN. The base of the bone-flap has been cut across partially with a Gigli's saw (see Fig. 18), and then broken outwards.

instrument of all, if it be obtainable, is a circular saw worked by an electric or a hand motor; this has the additional advantage that the incisions are made with great rapidity; a flexible narrow spatula must be passed between the dura mater and the bone to prevent the edge of the saw damaging the former structure. If the operation is to be completed at one sitting, the portions of bone removed may be kept either under the scalp (see p. 344), or in sterile saline solution at a temperature of 100° F., with a view to replacing them at the end of the operation; but if the operation is to be divided into two stages, as is usually the case, this cannot be done.

After the bone has been removed, the dura mater will bulge into the opening and will be devoid of pulsation. The end of the first stage of the operation has now been reached; all that remains to be done, after seeing that the amount of skull removed is sufficient to ensure free access to the tumour, is to close the wound and proceed with the second stage some days later. The flap is put back in place and sutured

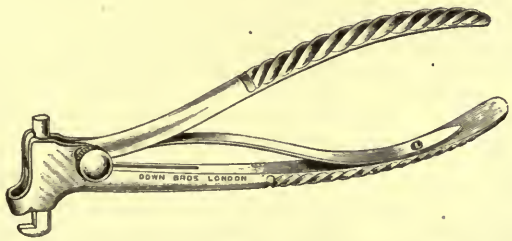


FIG. 189.—DE VILBISS'S SKULL-FORCEPS. These are very powerful punch-forceps and are useful for cutting a narrow track in the skull. The shank of the cutting arm is narrow and travels easily in the space cut out.

accurately with a continuous suture; no drainage tube is necessary unless there is difficulty in stopping the oozing.

Opening the dura mater.—After an interval of four to ten days after the first operation, according to the condition of the patient, chloroform is again administered, a preliminary injection of morphine and atropine having been given. The same precautions are taken as before with regard to asepsis, and every possible means of minimising shock is adopted (see Vol. I. p. 117). The sutures are removed, the flap is turned down, and the dura mater exposed. The latter should be opened so as to form a flap which is turned upwards; a small incision is made into the dura mater about half an inch from the edge of the bone, and is continued with a pair of blunt-pointed scissors parallel to the edge of the opening in the bone (see Fig. 160). Several blood-vessels will be divided, but if they are small they can be seized and ligatured as they are cut; when the incision runs across large vessels it is well to under-run them with a small fully-curved round needle, and tie them before they are divided (see Fig. 157). It is important not to

wound the large vessels on the surface of the brain when dividing the dura. They may be protected by slipping a dura mater separator beneath the incision in the dura (see Fig. 171); all hæmorrhage should be stopped before going farther.

Removal of the tumour.—The brain is now examined, and any tumour upon the cortex will generally be manifest at once. If there be one beneath the grey matter, the convolutions will be flattened and will present a characteristic dull yellowish appearance, while the affected area gives a distinct feeling of resistance to the finger as compared with the healthy brain around. The difficulty of removing the tumour varies according as it is situated in the cortex or beneath it, and also according as it is encapsuled or diffuse. If the tumour is not apparent at once, a blunt searcher should be passed into the brain in its presumed direction, and if it comes in contact with any firmer tissue the convolutions are split with a brain knife (see Fig. 192) or a spatula introduced at right angles to the surface, so as to minimise the amount of injury to the vessels which run in that direction. The tumour is then gently separated from the brain with the finger and shelled out. The bleeding, which is generally venous and due to tearing of the large veins which lie upon the surface of the brain, may be profuse at first; if it be severe, pressure for a few minutes with a hot sponge will generally arrest it. Any vessels of large size should be tied or under-run with a fine catgut ligature. In superficial and encapsuled growths, it is generally easy to make out the demarcation between the tumour and the brain substance, and the former may be enucleated without much damage to the brain. In the softer tumours it is almost impossible to decide, even with the aid of touch, which is tumour and which is brain. In any case the sense of touch is preferable to the use of an instrument.

FIG. 190.—LANE'S SKULL-FORCEPS. These are extremely powerful forceps, and with them portions of the skull can be rapidly broken away.

When the tumour is found to be irremovable, it must be either left alone or portions of it may be taken away. The latter procedure has little or no effect in retarding the progress of the disease, and may even cause serious danger from hæmorrhage, but in some cases it may be

advisable; for instance, the bulging of the brain after removal of the skull may be so great that the scalp cannot be properly stitched up unless portions of the tumour are removed. When a growth has been partially or entirely excised, a cavity is left which will fill up rapidly, partly by blood and partly by expansion of the very vascular brain substance. The bleeding generally stops on the application of pressure with a hot sponge, but in some cases it is advisable to pack the cavity for two or three days—in fact, some surgeons advocate that the cavity in the brain should always be packed with gauze, which is left in for forty-eight

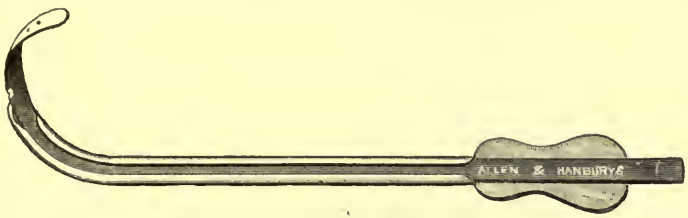


Fig. 191.—Whalebone Introducer and Metal Guard for Gigli's Saw in operations upon the Skull. The instrument, as shown above, is passed between the dura mater and the skull, from one trephine hole to the other (see Fig. 187). The saw (see Fig. 18) is then attached to the whalebone guide by means of silk, and the guide is withdrawn, pulling the saw into position along the groove in the metal guard which protects the dura mater.

hours. Sutures should be passed through the lips of the wound in the scalp where the packing emerges, and the ends knotted together; they are tied when the packing is taken out.

In the majority of these cases there is no question of replacing the bone unless an osteo-plastic flap has been made; when the operation is done in two stages, some days must elapse, and the bone removed cannot

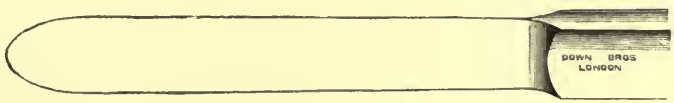


Fig. 192.—Horsley's Brain Knife. This is really a delicate spatula.

be kept alive unless 'cold storage'[1] is employed. When the conditions are such that there is every prospect of the recovery of the patient, the question as to the best method of guarding against the danger entailed by the large defect in the skull assumes importance. The mere implantation of fragments of decalcified bone over the surface of the dura mater is of little use, as that generally leads at best only to a little extra thickening of the fibrous tissue. Plates of aluminium, celluloid, gold, or silver have been applied over the orifice and have healed in, but as a rule the most that can be done is to apply a moulded plate of silver or aluminium outside the scalp after the wound has healed.

[1] It has been recently shown that the vitality of tissues can be preserved for a considerable time by this method.

After-treatment.—The shock resulting from the operation must be combated by appropriate measures, care being taken, however, not to employ alcohol. The patient must be kept perfectly quiet in a darkened room, and must not be disturbed by noises or by the visits of friends. Restlessness must be met by injections of morphine or heroin. The dressings should be changed and any packing or drainage tube removed after two or three days. As soon as possible the patient should be propped up in bed with pillows, so as to diminish the congestion of the brain and hinder the escape of cerebro-spinal fluid. Confinement to bed and absolute quiescence will be required for three or four weeks. The bowels must be kept regularly opened and light diet given.

Palliative Operations.—When it is impossible to locate the tumour or when circumstances render it inadvisable to attempt its removal, relief of the symptoms may be obtained by means of the so-called 'decompression' operations. The object of this operation is to lessen the general intra-cranial tension by the removal of a large portion of the skull. The temporal region is the one generally selected, but in some cases the occipital region may be preferred. These regions are the most suitable, because the thick muscles and dense fasciæ serve to restrain the resulting hernia cerebri, while at the same time a sufficient amount of bone can be removed to relieve the intra-cranial pressure efficiently. By operating in these areas also, the functions of the brain are least liable to be affected. The operation should be performed on the same side as the tumour when this is in the cerebrum, and, if necessary, it may be repeated on the opposite side. When operating on the cerebellar region, it is usual to remove the bone on both sides.

Fig. 193.—Cushing's Temporal Decompression. *The incision for the flap.* The incision only goes down to the temporal fascia.

Cushing's Temporal operation.—A large flap is marked out proportionate to the amount of bone to be removed (see Fig. 193). The incision involves the skin and subcutaneous tissues only, and the vessels entering the base of the flap must not be divided. The temporal fascia is then divided in the line of the muscle fibres, and these are separated down to the bone throughout their whole extent. The muscle is raised from the bone by a periosteal detacher, and the

FIG. 194.—CUSHING'S TEMPORAL DECOMPRESSION. *The temporal fascia detached and turned down.* In Cushing's original operation the fascia was merely incised vertically, but this does not give enough room. When the fascia is detached, as shown above, very good retraction of the muscle fibres can be obtained.

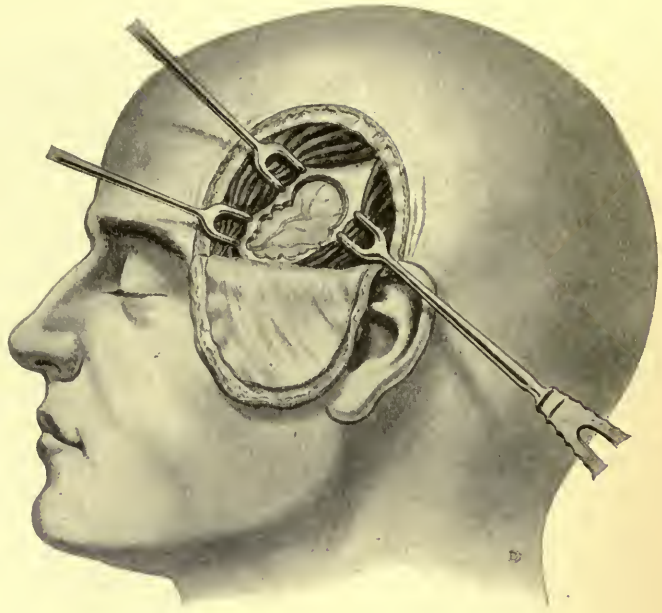


FIG. 195.—CUSHING'S TEMPORAL DECOMPRESSION. *The decompression effected.* The fibres of the temporal muscle have been pulled apart, the skull opened as widely as possible, and the dura is about to be incised. In these cases the dura should be cut away over an area equal to the opening in the bone.

fibres held aside by retractors. A three-quarter or one inch trephine is applied, and after the circle of bone has been removed, the dura mater is separated all round the opening, which is enlarged by suitable forceps in all directions until enough bone has been taken away. (see Fig. 195). An extensive incision is then made in the dura mater, any bleeding vessels being ligatured or under-run on its outer aspect. The muscle and fascia are sutured in position, and the skin flap is sewn up (see Fig. 196). A thick mass of dressing is firmly bandaged on.

FIG. 196.—CUSHING'S TEMPORAL DECOMPRESSION. *Uniting the soft parts over the herniated brain.* The fibres of the temporal muscle are united, and then the temporal fascia; finally, the skin is sutured accurately.

The Occipital operation.—In this region the muscles and skin flap are turned down together, a curved incision being made along the superior curved line of the occipital bone, extending from the posterior border of one mastoid process to a corresponding point on the other side. The occipital bone is trephined on each side of the middle line; in doing this the positions of the superior longitudinal, lateral, and inferior longitudinal sinuses, must be borne in mind. The portion of bone over the latter sinus may be removed by a Gigli's saw, after careful separation of the sinus from the bone by means of the special introducer kept close to the bone (see Figs 197 and 198). The subsequent steps are the same as in the temporal operation. This region is

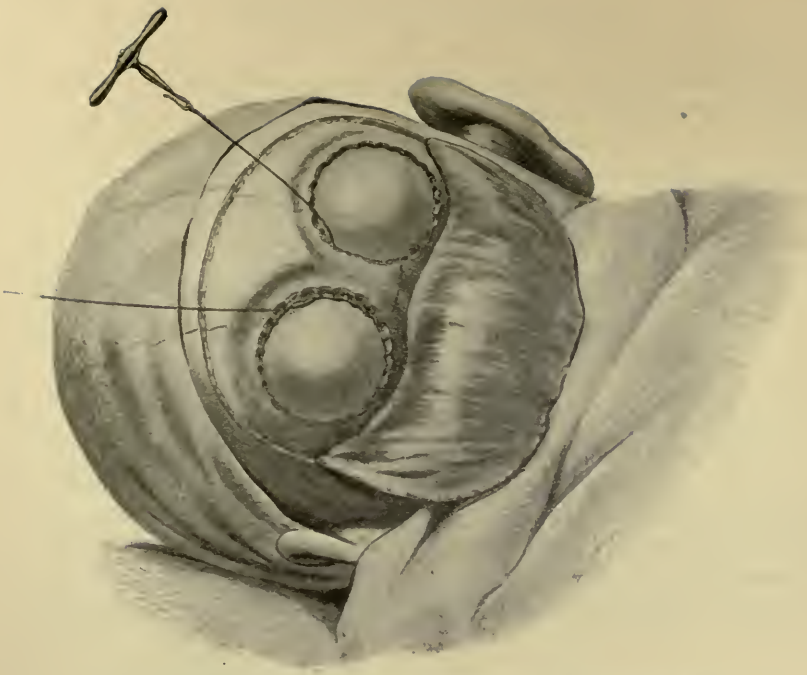


Fig. 197.—Occipital Decompression. *Exposure of the lobes of the cerebellum.* This is also the operation for removal of a cerebellar tumour. Gigli's saw is seen in position to remove the bone between the lateral openings. The introducer and guard shown in Fig. 191 are most valuable in this connection.

Fig. 198.—Occipital Decompression. *The bone covering the inferior longitudinal sinus removed.* This has been done by Gigli's saw. The inferior longitudinal sinus has been ligatured in two places and the intervening portion removed.

very vascular, and great pains must be taken to limit the loss of blood by the means described on p. 430.

Results.—Some patients are greatly benefited by these palliative operations and life is rendered much more tolerable; on the other hand, a good many cases do not improve.

LUMBAR PUNCTURE IN INJURIES AND DISEASES OF THE CENTRAL NERVOUS SYSTEM AND THE MENINGES.[1]

By Dr. W. D'ESTE EMERY.

In cases of injuries to the head or spine, in cases of cerebral disease, and especially in persons found unconscious, examination of the cerebro-spinal fluid may afford information of the utmost value. The operation is simple and easy, and the examination of the fluid does not, in many cases, require much special knowledge.

The only instrument required is a long and sharp needle. The needle should be at least three inches long, and not too fine, otherwise it may be

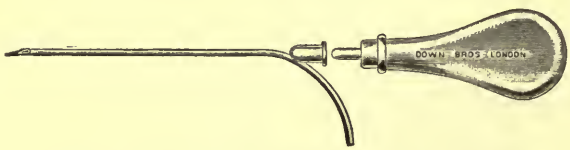


Fig. 199. Emery's Curved Needle for Lumbar Puncture.

broken in the tissues by spasmodic contraction of the muscles. An antitoxin needle will serve, if nothing better is at hand. The author's special needle (see Fig 199) is more convenient, especially if cultures have to be made. It is sterilised by dry heat in a test-tube plugged with cotton-wool.

The operation is best conducted with the patient in a sitting position, with his head bent well forward and his back arched. As this is often impracticable, the patient may be placed on his side with his back well curved forward. In either position, the laminæ of the lumbar vertebræ are separated as widely as possible, and the introduction of the needle is greatly facilitated. The point at which the puncture is made is slightly to one side of the middle line, in the interspace between the second and third or the third and fourth lumbar vertebræ. The guide to these points is a line drawn between the highest points of the iliac crests, which crosses the spinous process of the fourth lumbar vertebra. The direction of the puncture is forwards, with a slight

[1] For further details upon this subject the reader should consult a special manual—such as that of Dr. Emery, *Clinical Bacteriology and Hæmatology* (Lewis, London).

inclination upwards and inwards, and the spinal canal is usually reached at a depth of two and a half inches (in the adult). If necessary a local anæsthetic may be used, but the pain is not great.

The first few drops of fluid are often blood-stained, and should be rejected. Occasionally the fluid continues to be mixed with blood throughout, and the question arises whether this is due to the operation or whether there is a hæmorrhage into the brain or meninges. In the latter case, as a rule, the blood-stained cerebro-spinal fluid does not clot after removal from the body. When the blood comes from a vein which is wounded during the operation, and any appreciable amount is present, it usually clots on standing. This accident can generally be avoided by the use of a needle which has only a short bevel. When a long bevel is used, part may be in one of the meningeal veins and part in the spinal cavity.

The rapidity with which the fluid escapes is important and should be noticed. Normally it trickles out drop by drop (the rate depending, of course, on the lumen of the needle), but when the intra-cranial pressure is raised, it may run out in a continuous stream or be forced out in a rapid jet. This occurs in meningitis, in cerebral tumour, and occasionally in other conditions, and in such cases the symptoms are almost always relieved by the operation; fluid should be allowed to escape until the rate of flow is about normal.

The normal cerebro-spinal fluid is perfectly clear and colourless. It does not coagulate, or only does so after some hours and then in a very feeble manner. It contains a trace of albumen and of sugar, about 0·7 per cent. of sodium chloride, a trace of other salts, and a minute amount of urea. Cells are absent, or extremely scanty.

The main diseases and injuries, in which lumbar puncture may be of diagnostic value, are the following:—

Meningitis.—Here we must distinguish between (*a*) tuberculous meningitis, and (*b*) that due to other organisms.

(*a*) *Tuberculous Meningitis.*—The fluid is usually under abnormally high pressure, though late in the disease the foramina in the roof of the fourth ventricle may become occluded and the cerebral fluid unable to escape. It is slightly turbid, the turbidity being due to lymphocytes; occasionally some polynuclear cells are also present. It coagulates feebly, sometimes not until an hour or two have elapsed. The clot is often so transparent that it is only evident when the tube is gently shaken so as to detach the coagulum from the walls of the vessel; the contrast between the delicate clot and the clear fluid then becomes obvious. Tubercle bacilli may sometimes be found in the clot, but their detection is not always an easy matter.

(*b*) *Meningitis due to the Diplococcus meningitidis*, or to the ordinary 'septic' organisms, whether spontaneous or traumatic, is characterised by turbid fluid, the turbidity being due to polynuclear leucocytes; these

may be present in such large excess that the fluid is practically diluted pus, and it may be so thick as not to flow through a narrow needle. The fluid is usually under excessive pressure, and coagulates after withdrawal.

When turbid fluid is withdrawn, cultures should be made, because some cases do well on vaccine treatment, but as far as the identity of the micro-organisms is concerned (for an account of these a work on Bacteriology should be consulted) this is usually easily settled by the examination of stained films.

Injuries.—A fracture of the skull or spine, with tearing of the dura mater, will give rise to the appearance of blood in the fluid, and, as stated above, this does not usually clot. The same effect will be produced by a laceration of the brain, but, apparently, not by a simple concussion, though on this point not much information is available. A fracture of the skull or spine not involving the dura mater will not be followed by the appearance of blood in the cerebro-spinal fluid unless, of course, the brain or cord are injured.

Cerebral Hæmorrhage, even if deep in the brain, is apparently almost always followed by some amount of staining of the fluid. If recovery occurs in any condition in which blood is present in the cerebro-spinal fluid, a characteristic series of changes may take place as it clears up. The corpuscles become less and less numerous, and, as they do so, large cells (apparently endothelial) make their appearance and ingest them in great numbers; coincidently with this, the fluid assumes a yellow coloration. In a week or less the corpuscles have all disappeared, and the fluid has a straw or amber colour; this gradually gets less and less marked, and disappears in another week. The length of the process depends, to some extent, on the amount of blood exuded.

Cerebral Tumour.—There is generally a marked rise of pressure in the cerebro-spinal fluid, especially if the tumour be a rapidly growing one. The fluid is usually normal, but if the tumour be superficial and cause irritation or local aseptic meningitis, a few leucocytes, either lymphocytes or polynuclears, or the two mixed in varying proportions, may be present.

Cerebral Abscess.—This is associated with a rise of pressure, slight or great, according to the size of the abscess and the rapidity with which it has formed. When the abscess is deep-seated the fluid is quite normal; but when it is near the surface a few leucocytes (usually both kinds of lymphocytes) are present, but the number never approaches that seen in meningitis. The fluid rarely clots, and there is no increase of albumen. Organisms are rarely present, except when the abscess is quite close to the surface.

Uræmia.—In this condition the cerebro-spinal fluid is usually secreted under increased pressure, and the lumbar puncture may be followed by great relief to the symptoms. The fluid is perfectly clear, contains no cells, or only a few, and may coagulate feebly. The amount of salts in

solution is usually raised (as shown by a lowering of the freezing-point), and the sodium chloride in particular is usually increased above the normal (0·7 per cent.). The amount of urea also often shows a great increase. These facts may be useful in the case of a person found unconscious.

In doubtful cases of *poisoning* it may be useful to test the cerebro-spinal fluid for the suspected poison, which may at times be detected in this situation. Thus, in a person suffering from carbolic acid poisoning, in whom there was no other clue to the nature of the poison (the patient being comatose), carbolic acid was present in the fluid in considerable amount.

SECTION II.—AFFECTIONS OF THE FACE.

CHAPTER XXXVII.

WOUNDS, INFLAMMATORY AFFECTIONS, AND NEW GROWTHS OF THE FACE.

WOUNDS.

THE only special points in connection with wounds in this situation are the question of scarring, and the possibility of injury to important structures, especially the facial nerve and Stenson's duct.

Wounds of the face heal with remarkable rapidity and are not very prone to septic complications. They are, however, liable to be attacked by erysipelas, which may spread to the scalp and lead to very serious complications, such as thrombosis of the diploic veins or the cerebral sinuses.

TREATMENT.—Apart from the risk of infection common to all wounds accidentally inflicted, the chief point to be considered is the cosmetic result. Great care must therefore be taken to remove any dirt from the wound, lest suppuration and unsightly scarring result; it is important also to avoid stitch-marks as far as possible.

Under certain circumstances, even more care must be taken in the primary cleansing of the wound than is necessary for the mere avoidance of sepsis. Wounds on the face are not uncommonly caused by falls upon metallic or other substances, which may be ground into the tissues and cause discoloration or tattooing of the parts. In some cases this is so marked that it may be necessary to excise the discoloured scar at a later period in order to get rid of the disfigurement. Hence the greatest care must be taken not only to disinfect the wound, but also to remove any foreign body from it. If the edges are badly soiled it may be advisable

to pare them ; this not only removes any adventitious colouring matter, but also favours healing by first intention.

Suturing.—The question of avoiding stitch-marks has already been discussed (see Vol. I. p. 136). By employing the subcutaneous suture there described, reinforced by strips of gauze fixed on the skin with collodion, the edges may be brought into accurate apposition without any stitch-marks being left. Should it be advisable to use skin stitches, either because portions of skin have been lost or because the edges are much contused, the sutures should consist of the finest horse-hair introduced with a very fine round sewing-needle close to the margin of the wound. Only the fewest possible stitches should be used, the approximation of the intermediate portions of the wound being effected by strips of gauze (see Vol. I. p. 137).

When the wound is contused, it is often best not to introduce stitches at all, or at most to employ only one or two to keep the edges in fair apposition, the actual approximation being effected by the strips of gauze referred to above. Outside this, a small gauze dressing should be fastened on with collodion ; if there is much oozing, a large dressing may be applied for the first twenty-four hours, after which it may be left off and the small collodion dressing substituted.

Complications.—*Bleeding* from these wounds usually stops either spontaneously or after sponge pressure or douching with ice-cold lotion, and it is only necessary to apply ligatures when the larger vessels are wounded. *When the facial nerve has been divided* it is difficult to repair the injury unless the nerve has been cut before it breaks up into its branches. These branches are delicate filaments which it is practically impossible to find or to unite, and the best that can be done, under the circumstances, is to bring the edges of the wound as accurately together as possible, in the hope that some of the divided filaments may thereby be brought into apposition and may unite. The other important complication, namely, *injury to Stenson's duct*, is treated separately in connection with the injuries to the parotid gland (see Chap. XLIII.).

SYPHILITIC AFFECTIONS.

The face is a favourite seat of syphilitic lesions, which may be met with in all the stages of the disease. *Primary* sores may occur about the lips or the eyelids, while *secondary* syphilitic eruptions are common on the forehead in the neighbourhood of the hair. *Tertiary* syphilitic lesions are frequently met with about the forehead and the nose, either in the form of a nodular syphilide or gummatous disease. The gummata are most common on the frontal bone, and there is usually ulceration of the skin over them.

The nose is a common seat of both acquired and congenital syphilis. It may take the form of a nodular syphilide of the skin or a gumma of

the bones; in the latter case, necrosis of the nasal bones takes place, and the bridge of the nose is flattened, the tip is turned up, and a most unsightly deformity is produced. Gummata also occur in the tissues over the cartilage of the tip of the nose, leading to ulcers which generally yield readily to anti-syphilitic treatment, and leave only scars or some slight deformity about the margin of the nostrils.

Nodular syphilides may cause widespread destruction of the nose. They commonly commence about the tip of the organ, which is rapidly destroyed. The diagnosis is difficult in early cases; the affection is apt to be confounded with lupus, the chief points in the diagnosis being the more rapid spread of the syphilitic lesion, the absence of the characteristic apple-jelly nodules, the larger size of the nodules and the extension of the disease to the bones. In advanced cases the bony structures of the nose may be destroyed completely, so that nothing is left of the organ but an oval opening on the face. The disease also extends along the nasal cavity, destroying the vomer or the hard palate.

TREATMENT.—The treatment of the *primary and secondary lesions* presents no points of difference from that already recommended for the disease in general (see Vol. I. Chap. XI.). The *gummatous form of the disease affecting the frontal bone* is dealt with in connection with diseases of the skull (see p. 362). The *nodular syphilide of the nose* is more important in that it spreads with great rapidity and the deformity is irreparable; therefore the patient must be brought under the influence of anti-syphilitic remedies as rapidly as possible.

TUBERCULOUS AFFECTIONS.

These may occur as tuberculous ulcers of the skin, as lupus, or as an intermediate condition between the two, often described under the name of 'scrofuloderma.'

TUBERCULOUS ULCERS OF THE SKIN.

These ulcers usually occur in connection with tuberculous glands in front of the ear or as a secondary result of tuberculous disease of one of the facial bones, such as the malar or the orbital margin of the superior maxilla. In the latter cases, the skin becomes fixed to the bone when the ulcer heals, and the contraction may interfere with the movements of the lower eyelid, or may lead to ectropion.

TREATMENT.—Whenever an abscess forms it should be opened, scraped, injected with iodoform and glycerine emulsion (see p. 118), and stitched up. When there is an ulcer situated over diseased bone, the former should be scraped and the latter removed. As soon as the surface thus left is granulating and healthy, it should be skin-grafted (see Vol. I. p. 52). It will be necessary to put the patient under the best hygienic

conditions, and injections of tuberculin may do good (see Vol. I. p. 522). When there is eversion of the lower eyelid, the ordinary operation for ectropion should be performed after the disease has passed off; this is described under the plastic surgery of the face (see Chap. XLI.).

TUBERCULOUS LUPUS.

This is the most common tuberculous lesion of the face; it occurs chiefly upon the cheeks or the tip of the nose, and presents wide variations in virulence. The disease may last for years and is very intractable; unless its ravages are checked, it may cause the most distressing deformities. It begins with the deposit of one or two nodules in the skin, around which fresh nodules develop, and these may or may not ulcerate. On the face, the disease spreads in the skin, but does not penetrate for any distance into the subcutaneous tissues. On the nose, however, the tubercles penetrate deeper and destroy the cartilages, so that after a time the cartilaginous portion of the nose may be lost. The nasal bones are never affected and the bridge remains intact; this serves to distinguish the condition from syphilitic destruction of the nose. The disease may spread from the nose to the lips and into the nostrils. Apart from the unsightly sores and scars and the destruction of tissue, the ulceration gives rise to other deformities which are both unsightly and serious, such as ectropion, contractions about the lips which distort the mouth, and narrowing of the orifices of the nostrils, so that the patient is unable to breathe properly.

TREATMENT.—The various methods of treating lupus have been already referred to (see Vol. II. p. 15); we need therefore say nothing further on the matter here, especially as the remarks in the former volume refer appropriately to the affection as it occurs on the face.

INFLAMMATORY AFFECTIONS.

There are no special points concerning the acute inflammations of the skin and subcutaneous tissues of the face.

ERYSIPELAS.

The face is the most common seat of the so-called 'medical erysipelas,' in which no definite point of entrance of the micro-organisms can be made out. The chief importance of erysipelas of the face is that it has a great tendency to spread to the scalp, and there is always, therefore, the risk of acute inflammatory processes in that region.

TREATMENT.—This does not differ in any way from that already described for the affection in general (see Vol. I. p. 197).

TUMOURS.

SEBACEOUS CYSTS.

These are not uncommon; in the case of the cysts situated on the face, the wall is much thinner than in those which occur on the scalp.

TREATMENT.—The method of removing these cysts has been already fully described (see Vol. II. p. 20). To avoid unnecessary scarring, the incision should be planned so as to lie as far as possible in the natural folds of the cheek. Injury to the facial nerve is not likely to happen, if the superficial part of the cyst wall is properly defined, and the soft parts separated from the rest of the wall with a blunt dissector.

DERMOID CYSTS.

Dermoid cysts occur chiefly about the outer angle of the orbit, in the line of the inter-maxillary cleft, in the middle line in front, or sometimes in the substance of the cheek (see Fig. 200). The cysts about the external angle of the orbit, which are the commonest, may communicate with the interior of the skull through an aperture in the frontal bone, but they are always external to the dura mater.

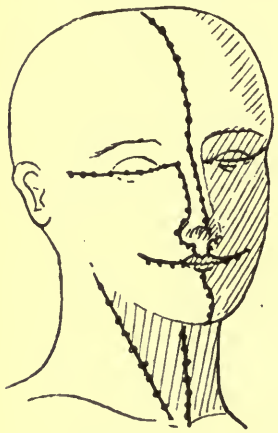


FIG. 200.—LINES ALONG WHICH DERMOIDS OCCUR.

TREATMENT.—In removing these cysts more care is required to avoid the branches of the facial nerve than is necessary in the case of sebaceous cysts, because dermoid cysts are more deeply situated. The incision over the tumour should be parallel to the branches of the nerve, and, as soon as the cyst wall has been reached, the rest of the separation should be done with a blunt dissector, and the cyst removed entire.

NÆVI.

These are very common on the face, and naturally call for treatment both from the discoloration they cause when the nævus is superficial and from the swelling when the tumour is of the venous variety.

TREATMENT.—When the nævus is quite small and fairly superficial, *excision* will probably give the best result and leave the smallest scar. The incision should, if possible, be made parallel to the branches of the facial nerve and along one of the natural folds of the skin. If the tumour is large, it is best to treat the superficial portion by freezing it with CO_2 (see Vol. I. p. 262), and the deeper part by electrolysis.

For the large, deep-seated venous nævi of the cheek, *electrolysis* is

by far the best method of treatment, as excision or cauterisation cannot be employed, on account of the risk of injury to important structures and of the scarring which would result. The method of electrolysis is detailed in Vol. I. p. 256.

'*Port-wine Stains.*'—Perhaps the most troublesome nævoid condition on the face is that produced by the so-called 'port-wine stains,' and the disfigurement may be so great as to call for treatment. Exposure of the stain to radium or the X-rays until a dermatitis is set up, may cure the affection by producing thrombosis, but the best method is to freeze the surface with solid CO_2 (see Vol. I. p. 262).

MOLES.

Moles are frequently met with on the face and are often very disfiguring. They vary in size from that of a small pea up to a pigmented area larger than the palm of the hand. They may be partially or entirely covered with hair.

TREATMENT.—This has already been fully described (see Vol. I. p. 251). Should the patient desire to be relieved of the pigmentation, the only method is to *excise* the patch. If the mole is small and the incisions are suitably planned, the edges of the wound may be brought together by buried sutures (see Vol. I. p. 136), and the resulting scar may be quite unnoticeable. When the wound is too large to allow of this, Thiersch's skin-grafts, cut as large as possible, should be applied to the raw surface. The slight scarring resulting from this will be far less noticeable than the pigmentation due to the mole. If the raw surface can be covered by one or two large grafts the scarring will be quite inconspicuous in a short time.

In other cases the patient especially desires to be freed from the presence of hairs upon the mole. Temporary depilation may be obtained by exposure of the hairy part to the X-rays or radium, but in the course of time the hairs grow again. Permanent arrest of the growth of hair can only be secured by destroying the hair bulbs. The most efficacious method of doing this is by *electrolysis*. Although very effectual, it is very slow and tedious, since each follicle has to be treated separately. It was much used at one time for the removal of superfluous hairs on the upper lip in females. Both methods leave the pigment unaltered in the case of pigmented hairy moles.

For the following details of electrolysis we are indebted to Dr. Arthur Whitfield, Physician for Diseases of the Skin at King's College Hospital:

'The battery should consist of dry or Leclanché cells coupled in series. It is seldom that more than ten cells are required for any operation, but if there are eighteen, the battery may also be used for the production of anæsthesia by cataphoresis when necessary. A galvanometer reading in milliampères is also necessary. The needle used varies with the taste of the operator; the platino-iridium needle has the obvious

advantages that it may be easily sterilised in the flame, it may be bent to any angle that may prove convenient at the time, and it is not likely to be broken by the sudden movement of a nervous patient. For all purposes a needle bent at an angle of 45° at a distance of one-third of an inch from the free end is most convenient. The base of the needle may be an octagonal, hollow, metallic cylinder fitting directly on to the terminal of the lead as recommended by Brocq. This arrangement obviates the use of a heavy needle-holder, and is far the most convenient for manipulation in awkward situations such as beneath the chin. The indifferent electrode is usually a large metallic cylinder covered with wash-leather and moistened with salt solution. A lens is usually of advantage and none is more efficient than an ordinary watchmaker's glass.

'The patient should be in a semi-recumbent position on a couch in a good light. The positive electrode may be laid on a piece of mackintosh on the patient's lap, so that she may grasp it when required. Five cells are then put in circuit and, while the indifferent electrode is lying loose on the patient's lap, the needle, attached to the negative pole, is introduced into the neck of the follicle. The direction of the needle should be parallel to that of the hair. In this position, with no current flowing, the sense of touch will inform one, after a little experience, whether the needle is entering the follicle or attempting to pierce the skin. The patient is then instructed to grasp the positive electrode firmly, and the strength of current as indicated by the galvanometer is noted. For the first trial, a strength of about one milliampère is sufficient. After a few seconds, bubbles of hydrogen will be seen issuing from the mouth of the follicle, and shortly afterwards a somewhat yellowish transparent zone will appear around the mouth of the follicle. This is the zone of total necrosis; immediately it appears the patient must be instructed to drop the positive electrode. This yellowish zone should never be allowed to gain a diameter larger than that of a small pin's head, otherwise the scar left will be manifest to the naked eye. The needle is now withdrawn, and after a moment or two the hair may be pulled very gently with epilation forceps. If the operation has been successful, the hair will slide out of the follicle without offering the slightest resistance, and will bring with it the macerated and gelatinous-looking inner root-sheath. If the hair is not loosened, the current must be increased for other hairs, but it must never pass four milliampères for even the stoutest. A medium strength for the chin is about two and a half milliampères, while one and a half will usually suffice for the upper lip. As regards the time during which the current should be passing, from five to fifteen seconds will generally suffice. On no account must hairs be taken during one sitting, which are so close that their respective zones of necrosis must touch.

'It is better never to introduce the electrode for a second time into a follicle, when the first application has failed to loosen the hair. The needle is sure to run down the false passage made on the first introduction,

and it is practically certain to leave a visible scar. The number of hairs which may be taken on one occasion naturally varies with the coarseness and distribution of the hairs ; one may, however, take forty as an average number.

'After the operation is finished the patient may be given some lead or calamine lotion to cool the part, but nothing will hasten the healing of the damaged areas. The natural sequence of the after-effects is as follows: Immediately on the completion of the operation the part is somewhat red and shiny to the eye and hard to the touch, while there are numerous little yellowish dots indicating the mouths of the follicles. The œdema passes off in one or two hours, and the yellow dots dry up into scabs within the first twenty-four hours, forming dark brown crusts which show rather more than the original marks. These crusts fall off in about three days and the process is practically complete, with the exception of possibly a little redness. Patients differ a good deal in the rapidity with which their skins recover the normal appearance, and for those who have a tendency to pustular acne it is a safe plan to prescribe frequent dabbing with a 1 in 4000 perchloride of mercury lotion to prevent infection of the destroyed follicles. It is wiser not to exceed this strength, as sublimate lotions have a tendency to stimulate the growth of hair.

'From this it will be seen that the same area may usually be gone over twice in one week, but on no account oftener.

'If the electrode is not grasped until after the needle is well engaged in the follicle and is dropped before the needle is withdrawn, the pain is not great, and is usually described as irritating rather than severe. The chin is usually far less painful than the upper lip, and the centre of the latter is much more sensitive than the outer parts.

'It should be remembered that the patient would prefer to have a hair return, and let it be destroyed on another occasion, to being marked with a permanent scar. It is therefore wise to err on the side of too weak rather than unnecessarily strong currents. With care and experience, however, relapses should not be more than one per cent., even with the use of very moderate currents.

'It is, however, advisable in the case of young women, in whom the growth of hair is obviously progressive, to be careful in explaining that the treatment does not prevent the growth of hair in other parts of the skin, and that, until either all the hair is destroyed or the progressive growth stops, the treatment will have to be renewed from time to time.

'For the destruction of small hairy moles the method of procedure is almost identical. Owing to the fact that the hair is almost invariably stronger and that a scar must necessarily result from the destruction of the mole it is usual to work with a stronger current (five milliampères). All the hairs in the mole should be first carefully removed, and after a few days, if the mole has not been entirely effaced in the process of destroying the hairs, the needle may be run through it in various directions, and the

current passed until the whole growth looks white and distended with the gas. The result is a perfectly even, white scar, somewhat smaller than the original growth.

'When the patient demands an anæsthetic for these small operations, the following method of introducing cocaine through the unbroken skin by cataphoresis may prove useful.

'A ten per cent. solution of cocaine (the alkaloid itself, not the hydrochlorate) in pure guaiacol is used. A piece of clean blotting-paper is soaked in the solution and placed on the area to be anæsthetised, and a suitably shaped incorrodible electrode is placed on the top of it. This electrode is connected with the positive pole, and a current of about four or five milliampères passed for five minutes or so. Fifteen cells will probably be required at first, but the resistance soon diminishes, and then some may be switched off. A pricking sensation is felt at first, but this soon passes off, and is followed by complete anæsthesia to pain. The anæsthesia passes off in about a quarter of an hour. The only objection to this method is the penetrating odour of the solution. In rare cases anæsthesia is not produced at the end of five minutes, and it has been found to be advantageous in such cases to reverse the current after this time.'

MALIGNANT TUMOURS.

These form the most important group of tumours on the face, and may be either sarcomatous or carcinomatous in nature. The former present no special points of interest, and do not differ in any way from sarcomata elsewhere.

CARCINOMATA.—The face is one of the common seats of the slow-growing *flat epithelial carcinoma* so frequently met with in elderly people. This generally commences in some small pigmented seborrhœa patch or in a pigmented mole, but it may occur without any antecedent disease of the skin. The treatment is very satisfactory; if it is removed freely, a perfect recovery may ensue with an insignificant scar. Glandular infection occurs very late in the disease.

Another form is the *tuberous epithelial carcinoma*, which usually starts at the junction of the mucous membrane with the skin, most frequently in connection with the lower lip. This form is referred to more in detail in connection with affections of the lips (see Chap. XXXIX.).

A third form of epithelial carcinoma frequently met with on the face is the so-called *rodent ulcer*. The characters of this growth have already been referred to (see Vol. I. p. 241). Its growth is usually extremely slow, but it may ultimately lead to widespread destruction of the bones, and cause the death of the patient by affecting the dura mater and so setting up septic meningitis, or by leading to hæmorrhage or to attacks of erysipelas. The treatment of this affection is dealt with in Vol. II. p. 23.

CHAPTER XXXVIII.

FRACTURES OF THE NASAL BONES.

These injuries are practically always caused by some form of direct violence; sometimes, however, they may be due to extension from a fracture of the anterior fossa of the base of the skull. Fractures occur more often in adults than in children, in whom the nose is more yielding; they are usually compound through the mucous membrane and not uncommonly comminuted. One bone alone may be broken, but usually both are fractured and may be separated from each other. The fracture may involve the nasal processes of the superior maxillæ and in badly comminuted cases usually also runs through the perpendicular plate of the ethmoid or the lachrymal bones. Lastly, the cartilages may be detached from the nasal bones, and it is not uncommon for bending or even dislocation of the cartilaginous septum to occur.

The deformity is greatest in cases of comminuted fracture, in which the bridge of the nose may be so depressed that it is difficult to replace the bones and to keep them in position. In many cases the nose is displaced laterally, while in others there is comparatively little displacement of any kind. The swelling is often so great as to mask both the displacement and the crepitus.

As a rule, these fractures are unaccompanied by complications, but when there is severe damage the following conditions may be met with:

1. *Epistaxis.*—Bleeding from the nose is constant, but is usually only slight. If, however, one of the larger vessels is ruptured, there may be considerable and persistent hæmorrhage, which sometimes necessitates plugging of the nostrils.

2. *Emphysema.*—Escape of air into the tissues about the orbit or the forehead and bridge of the nose is not uncommon, and is due either to injury of the nasal duct or to a free opening from the interior of the nostril to the cellular tissue outside. The emphysema is usually developed when the patient attempts to blow his nose. It generally subsides spontaneously and seldom gives rise to any trouble.

3. *Epiphora.*—Epiphora, or overflowing of the tears, usually occurs in connection with fractures of the lachrymal bone accompanied by injury to the lachrymal sac; it may also arise from fracture and blocking of the nasal duct.

4. *Cellulitis* and suppuration about the nose: this only rarely follows fracture of the nasal bones.

TREATMENT.—Apart from the question of the complications, fracture of the nasal bones calls for careful and immediate treatment, because, if left to itself, considerable deformity may result either from flattening of the bridge of the nose, or from lateral displacement of the organ: nasal obstruction may also be produced. These deformities are difficult to remedy at a later stage, the worst being the displacement of the cartilaginous septum.

Of the Fracture.—In cases unaccompanied by displacement, little treatment is required; the application of an ice-bag externally, or even syringing the nose with ice-cold water to check the bleeding and effusion, will suffice. The patient must be cautioned against touching his nose or attempting to blow it; he often finds it difficult to resist doing this, because of the irritation set up by the fracture and the accumulation of blood.

If there is depression of the bridge or lateral displacement of the nose, it is essential to replace the bones as soon as possible, and for this purpose it is well to administer an anæsthetic. It is not advisable to wait for the subsidence of the swelling or even for the hæmorrhage to cease, because repair takes place with extreme rapidity, and the deformity may be very difficult to correct unless it is treated at once.

Lateral displacement of the nose is readily remedied by pushing the nose back into position. A little manipulation over the bridge will usually get the nasal bones into their proper relative positions, after which the nose must be examined to see that the septum is in place; if not, it must be put right. When the bones have been replaced, there is no great tendency to subsequent displacement, and no appliance for keeping the bones in position is required as a rule. The patient should lie on the side opposite to that towards which the displacement has occurred, and a small ice-bag should be placed on this side of the nose; this will check the effusion of blood, and its weight will tend to keep the bones in position. The patient should be seen daily at first, and if the displacement should recur, it must be remedied at once. In five or six days the bones will be fairly firm, but the patient should still be forbidden to handle or blow the nose.

When the septum has been displaced, every effort must be made to remedy the displacement, but this is sometimes very difficult; as a rule, it does not occur in connection with lateral dislocation of the bone. In some cases the septum can be pushed into position by introducing a narrow, thin spatula into the nose. In others, it is necessary to use

special forceps (see Fig. 201), by which the cartilage can be seized and forcibly twisted into position. In these cases the deformity is apt to recur, and means must be taken to prevent this. In some cases Lake's flat rubber splint (see Fig. 202) may suffice. In others, however, it is necessary to introduce rolls of gauze into the upper part of the nostril, and to keep

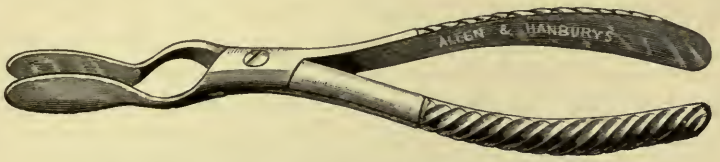


FIG. 201.—FORCEPS FOR STRAIGHTENING THE SEPTUM. One blade is inserted into each nostril.

them in place by hollow vulcanite plugs through which the patient can breathe (see Fig. 203). At the anterior ends of the plugs are holes for threads, which are fastened on the cheek with strapping. The packing must be renewed daily for the first four days, when it may be discontinued. The plugs should be taken out twice a day for cleansing, the nose washed

FIG. 202.—LAKE'S NASAL SPLINT. The splint is made of rubber and is flat and of various sizes.

FIG. 203.—HOLLOW VULCANITE NASAL PLUG.

out with saline solution, and the plugs covered with boric ointment and replaced. Should this method fail, it may be necessary to perform submucous resection of the septum at a later date, in order to remedy the deviation.

In comminuted fractures with depression, the restoration of the bones is much more difficult, and their retention in position requires a great

deal of care. External manipulation may first be tried, but it is generally necessary to introduce some instrument into the nostril to push out the bones. It must be remembered that the space between the nasal process of the superior maxilla and the septum is very narrow, and therefore only a very fine instrument can be used in order to push out the bones properly; to attempt to do it with ordinary dressing forceps is quite futile. A pair of fine sinus forceps, a curved probe-director, or, still better, a fine spatula should be employed. This is introduced into each nostril alternately, and the fragments gradually pushed up into position with the assistance of the fingers applied externally. The fragments may be retained in position by packing the upper part of the nostril with very narrow strips of cyanide gauze, applied with a fine firm probe; below this the nasal plug shown in Fig. 203 is inserted, in order to keep the packing in position and allow the patient to breathe.

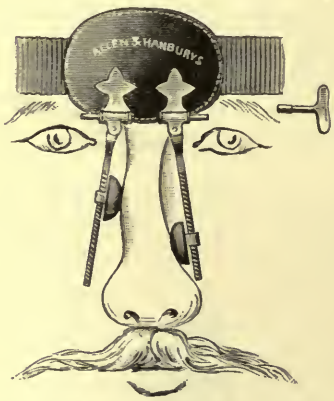


FIG. 204.—WALSHAM'S SPLINT FOR FRACTURE OF THE NASAL BONES.

The objection to this method is that the packing is difficult to apply owing to the narrowness of the nostril; that in a short time it becomes foul, and must therefore be frequently renewed; and that this renewal is apt to be followed by recurrence of the displacement, and may cause great pain. When, therefore, the fragments will not remain in position of themselves, it is better to use some external appliance, such as a metal band round the forehead, from which two arms project furnished with pads, which can be applied, one on each side of the bridge of the nose, and tightened up so as to keep the nasal bones in position (see Fig. 204). Mason suggested a simple method of keeping up the bridge in bad cases by passing one or more hare-lip pins from side to side through the nose beneath the fragments. These pins project on each side for about half an inch, and a good firm cork is pushed over each projecting end (see Fig. 205). The two pieces of cork on each pin are then pressed together, so as to exercise lateral pressure on the nasal bones, while the pin prevents the bridge from falling back. In many ways this is a more satisfactory arrangement than the apparatus just mentioned, because, while applying lateral pressure, it prevents the bones from falling back. No apparatus need be continued for more than three or four days, for by that time so much lymph and new material will have been thrown out, that the fragments will remain in position if care be taken not to blow the nose or to disturb it in any way.

Of Complications.—The treatment of the various complications of these fractures presents few features of importance. The *bleeding*, even when severe, can usually be checked by affusion of cold water to the face, by syringing the nostrils with ice-cold water, or by the application of a small ice-bag to the side of the nose. When the bleeding is really alarming—as it may be if the nasal artery has been torn—it may be advisable to plug the nares. The plugs must be carefully introduced into the upper part of the nose and packed in place with a firm probe, taking care not to push in too large a mass at a time. They should be impregnated with adrenalin chloride (1 in 1000); and they also help to support the bridge of the nose.

If *emphysema* is present, no special treatment is required beyond keeping the nostril on the affected side clear by repeated syringing with warm normal salt solution; the patient should be cautioned

FIG. 205.—MASON'S METHOD OF SUPPORTING THE BRIDGE OF THE NOSE AFTER FRACTURE. The lateral pressure of the pieces of cork help to keep the nasal bones inclined at the proper angle to one another. If the cork becomes loose a figure-of-eight silk suture will keep them from slipping.

not to blow the nose. The emphysema will subside readily and give no further trouble. The treatment of *epiphora* will be mainly directed to careful re-position of the fragments, the nasal duct being kept open by the regular introduction of suitable probes. If there is any *cerebral injury*, the case must be treated on the lines laid down for fracture of the base of the skull (see p. 352), the fracture of the nasal bones being of secondary importance; nevertheless, care should be taken to remedy the deformity.

Compound fracture in this situation is not usually accompanied by serious symptoms. Healing takes place readily, septic infection seldom gains a foothold and necrosis of the fragments very rarely occurs. When the fracture is compound through the skin, the wound should be purified in the ordinary manner, special care being taken to prevent the strong lotions from getting into the eyes. The edges of the wound should be brought together as accurately as possible with fine horse-hair sutures. *Should the wound become septic*, large boric fomentations should

be employed, combined with frequent douching of the nasal cavity with warm normal saline solution.

Of long-standing Deformity.—The surgeon is sometimes consulted with regard to old cases of fracture of the nose, in which there has been considerable loss of substance or marked depression of the bridge, or in which coal-dust or other material has been ground into the soft parts, leaving an unsightly or pigmented scar ; the latter condition has already been referred to on p. 446. The possibility of remedying the permanent deformities of the nasal bones frequently requires very careful consideration. At an early period the bones may be loosened at the line of fracture by introducing a narrow chisel through small incisions in the skin, and they may then be brought into position by lateral pressure, either by the hare-lip pins or by the pads on each side of the nose mentioned above. Sometimes, however, the fracture is of such long standing and consequently so firm that the deformity cannot be remedied in this way. When the bridge of the nose is much depressed, the tilting forward of the nostrils is in itself so unsightly that a more elaborate operation must be performed, similar to that employed for cases in which the bridge of the nose has been lost from disease ; in some cases the subcutaneous injection of paraffin may suffice. These operations are described in connection with the plastic surgery of the face (see Chapter XLI.).

CHAPTER XXXIX.

AFFECTIONS OF THE LIPS.

WOUNDS.

THERE are only a few points of special interest in connection with wounds of the lips. Healing is rapid and satisfactory.

TREATMENT.—A most important point in closing these wounds is to see that the red line of the lip is brought into accurate position. Buried sutures cannot be used when the wound has been inflicted accidentally, on account of the soiling and consequent risk of sepsis. The sutures should be inserted with a round sewing-needle; fine horse-hair should be used for the skin, whilst catgut may be employed for the mucous membrane. It is well to suture the whole of the wound on the mucous surface with catgut. No dressing is required; the line of incision is dusted with boric acid powder, and a scab forms, under which healing takes place readily. When there has been much loss of substance of the lips, some form of plastic operation will be necessary (see Chapter XLI.).

INFLAMMATORY AFFECTIONS.

There is little of importance to say concerning these affections. *Gangrene* of the lips may occur, and is usually the result of cancrum oris, a disease already described (see Vol. I. p. 85), and seldom seen nowadays.

CRACKS AND FISSURES OF THE LIPS.

These rather painful affections are not uncommon in cold weather and cause great inconvenience from their constant liability to be torn open. They may also become infected, and acute inflammation or erysipelas may result.

TREATMENT.—The lips should be kept moist with glycerine jelly, and a piece of goldbeater's skin should be placed over the fissure to protect it from irritation. The fissure generally heals quickly under these circumstances.

HYPERTROPHY OF THE LIPS.

In weakly children of the tuberculous type, it is not at all uncommon to meet with considerable thickening and overgrowth of the lips—especially the upper—with eversion of the mucous membrane. This is usually due to chronic inflammation, especially of the lymphatic vessels, following cracks and fissures of the lip. It may also follow the excoriation of the skin of the upper lip, which occurs in children suffering from chronic coryza. Although it is commonly met with in tuberculous children, there is no evidence of any actual deposit of tuberculous material.

TREATMENT.—The first point is to treat the excoriation and cracks so as to obtain healing as quickly as possible (*vide supra*). When the fissure is deep, and has existed for some time, it may be advisable to excise it and bring the edges together with fine catgut stitches. The general condition of the patient must also be attended to, the food should be light and nourishing, and the child should be placed in good hygienic surroundings. As regards medicines, cod-liver oil and iron are often of great value.

In some cases the thickening of the lip may be so marked and permanent that the surgeon is called upon to remedy the deformity. This is done by excising a horizontal strip of the mucous membrane and submucous tissue from the inner surface of the lip. An elliptical incision is made through the mucous membrane, enclosing a piece varying in breadth according to the amount of deformity. The upper border of the incision should run parallel to the red line, enough of the mucous membrane being left between the two to represent the normal thickness of the lip. In depth the wound is made wedge-shaped, so that the piece excised resembles a segment of an orange, the outer surface of which corresponds to the mucous surface of the lip. The bleeding is usually slight and is readily arrested by torsion. The edges of the incision are brought together by two or three fine catgut stitches, and healing is rapid.

TUBERCULOUS AFFECTIONS.

Tuberculous ulcerations may be met with either on the mucous membrane or the skin, and may take the form of lupus or of the ordinary tuberculous ulcers.

LUPUS.

Lupus of the upper lip is usually an extension from disease of the nose or cheek. The treatment is discussed in Vol. II. p. 15.

TUBERCULOUS ULCERS.

Tuberculous ulcers are occasionally met with upon the mucous membrane of the lips (generally the lower) and resemble in all respects those occurring on the tongue. They may occur as a primary disease unaccompanied by tuberculous mischief elsewhere, but they are more commonly secondary to advanced tuberculous disease, either of the lungs or the larynx. As a rule, they are excessively painful.

TREATMENT.—The most satisfactory method of treating these cases is to *excise the ulcer* and bring the edges of the mucous membrane together with fine catgut. This can generally be done under local anæsthesia, a mixture of eucaine and adrenalin (see Vol. I. p. 484) being injected under the ulcer. Should the wound left be too large to suture, it may be touched with undiluted carbolic acid. A mouth-wash of sanitas (three drachms to the pint) or chlorate of potash (ten grains to the ounce) should be used frequently, and the primary tuberculous disease should be attended to ; injections of *tuberculin* may be of service.

When the ulcer is secondary to tuberculous mischief in the lungs or larynx, and when a raw surface must be left after excision, this is liable to become infected again, and, under these circumstances, it may be better to treat the ulcer by means of local applications. In some cases a twenty per cent. solution of *lactic acid* painted over the surface of the sore once a week is of great service ; it relieves the pain and promotes rapid healing. The value of this treatment is still further increased if the sore is previously scraped with a sharp spoon, which may be done after injection of a local anæsthetic. When the ulcer is very painful, relief will often be obtained by powdering the surface freely with *orthoform*. It is well to avoid the use of cocaine in case a habit should be established. The patient should avoid irritating foods, too hot or too cold substances, and particularly acid or alcoholic liquids.

SYPHILITIC AFFECTIONS.

These may be met with in all stages of the disease, but the most common are either a primary sore or secondary mucous patches.

PRIMARY SORES.

It is, of course, of the greatest importance to diagnose these cases as soon as possible, as they are a source of great danger to other persons by infection from kissing, or from the use of the same cups, spoons, or other utensils. They have been mistaken for malignant growths and removed under that impression.

TREATMENT.—As soon as the diagnosis is made, salvarsan should be given and this leads to rapid healing of the ulcer. Whether it should

be followed by mercurial treatment is a matter which is in dispute at the present time, but there can be no doubt of its great value in the first instance (see Vol. I. Chap. XI.).

MUCOUS PATCHES.

The chief secondary affections of the lips are mucous patches, which occur most frequently about the angles of the mouth and on the mucous surface. In the former situation especially, these patches are apt to ulcerate and give rise to irregular ulcers which are extremely painful. These sores are also highly infective. An intravenous injection of salvarsan should be given at once.

TUMOURS.

Tumours of the lips may be either innocent or malignant.

NÆVUS.

The lip is sometimes the seat of an extensive subcutaneous venous nævus causing great swelling and deformity, which is difficult to treat. It is more common in the upper lip than in the lower.

TREATMENT.—The best method of treatment is electrolysis; this is dealt with in Vol. I. p. 256.

LYMPHANGIOMA.

The condition known as macro-cheilia, or congenital hypertrophy of the lip is most probably lymphangiomatous in nature. One or both lips may be affected, generally the lower. The deformity is considerable; the lip is much everted and pendulous, and its surface is frequently ulcerated. This ulceration leads to further thickening.

TREATMENT. — This is a matter of great difficulty. The deformity can be corrected by an operation similar to that recommended for hypertrophy of the lip in tuberculous patients (see p. 462); but in lymphangiomatous cases there is a grave risk of septic complications, and excision should therefore be avoided, if possible. Electrolysis (see Vol. I. p. 256) will suffice in a considerable number of cases and, if it fails, excision will then be less dangerous, because the lymphatic spaces will be more or less blocked, as the result of the previous treatment. Before the excision, the teeth should be attended to and scaled if necessary, and during the operation arrangements should be made to prevent saliva running freely over the wound. The wound should be accurately stitched up with fine catgut, and it is well to paint it over with Whitehead's varnish, made by adding 1 vol. of turpentine to 9 vols. of a saturated

solution of iodoform in ether. During the after-treatment the mouth should be frequently rinsed out with lotions of sanitas or boro-glyceride (a teaspoonful of each to a small tumbler of water). Condy's fluid is not so good, because it stains the skin if it is strong enough to act as an efficient mouth-wash.

CYSTS.

Cysts in connection with the muciparous glands are not at all uncommon. Usually they form small isolated tumours, but sometimes the condition may extend over the whole lip, causing eversion and a very unpleasant deformity.

TREATMENT.—In the case of single cysts it is usually sufficient to clip away the portion of the cyst-wall projecting into the mouth, which is easily done by painting over the mucous membrane with cocaine, seizing the prominent part of the cyst in catch-forceps and clipping it away with scissors, making sure that the cyst-wall is removed as well as the mucous membrane covering it. Any portion of the cyst-wall left may be touched with undiluted carbolic acid, care being taken to avoid cauterisation of the surrounding mucous membrane. The after-treatment consists in the use of a mouth-wash of chlorate of potash or sanitas.

When there is a diffuse cystic condition extending along the lip, the best plan is to excise the projecting mass containing the cysts, so as to restore the lip to its proper shape. The operation is very similar to that for hypertrophied lip (see p. 462). The edges of the wound are brought together with catgut and a mouth-wash is employed subsequently.

EPITHELIOMA.

The lower lip is a common seat of epithelioma, which generally occurs towards one side of the lip and is often attributed to irritation in connection with smoking; it frequently occurs, however, in non-smokers. Both the flat, slow-growing, and the more rapid tuberous forms may be met with, and the cases vary considerably in malignancy. On the whole, the growth, which occurs generally in old people, is not very malignant, and not uncommonly there is no recurrence after early and free excision. If left alone, the disease gradually destroys the lip, causing constant dribbling of saliva, and difficulty in taking food and in talking. It may spread from the lower lip to the upper, and it often extends to the lower jaw. The glands in the submental, and especially in the submaxillary, regions become infected sooner or later. Its point of origin is generally at the junction of the cutaneous with the mucous surface. When it arises on the latter, the growth is generally more rapid

in its course, and glandular infection occurs earlier than when it begins on the cutaneous surface.

TREATMENT.—The treatment is early and free *excision*. As a rule a triangular portion, with its apex downwards, should be removed from the entire thickness of the lower lip. When the disease is very superficial and has spread for some distance along the lip, it may be possible to remove only a portion of the surface of the lip, but imperfect closure of the mouth is apt to result if the incision has to be carried deeply, and saliva is constantly running out. When the growth is situated near one angle of the mouth, it is well to prolong the V-shaped incision downwards and outwards in the direction of the submaxillary glands, so that the lymphatic vessels running from the lip to the glands may be included in the portion removed. The edges of the wound can usually be united without the necessity for any plastic operation. Care must be taken to see that the red line of the lip is brought into accurate apposition on the two sides of the incision. When a considerable portion of the lip has been removed the angle of the mouth may be pulled towards the middle line on suturing the wound, but in the course of time this deformity rights itself and becomes hardly noticeable. When the greater part of the lip is removed, a plastic operation must be performed (see Chap. XLI.).

Removal of the growth.—The following is the method of excising a small cancer of the lip by a V-shaped incision: An assistant grasps the lip firmly close to each angle of the mouth and as far away as possible from the growth. When the growth is close to one angle of the mouth, he must pass his finger well under the cheek so as to compress the facial artery or, at any rate, the coronary artery near its origin. This controls the coronary arteries and fixes the lip. The surgeon now takes hold of the growth and makes his incisions from above downwards well wide of the tumour. The incisions are somewhat concave inwards so as to allow for the contraction of the scar afterwards, and they gradually meet just above the point of the chin. The bleeding is rapidly arrested, the coronary vessels being first picked up and twisted, and then the other bleeding points attended to.

The wound should now be stitched up. The first stitch, which should be of silkworm-gut, unites the red line and is inserted deeply through the thickness of the lip, and the ends should be left long. A second silkworm-gut stitch should be inserted deeply at the centre of the cutaneous part of the incision and at some distance from the edges of the wound in order to relieve tension. The remainder of the skin incision is then brought together accurately by stitches of fine silkworm-gut or stout horse-hair. When these skin stitches have been inserted, the lip is everted by pulling upon the first stitch in the red line, and the edges of the mucous membrane are united by catgut stitches. These wounds practically always heal by first intention. When the two concave sides of the incision

are sutured together there will be a slight projection upwards of the free edge of the lip (see Fig. 206) ; the contraction of the scar will eventually obliterate this.

In the case of small cancers of the lip, especially those commencing on the cutaneous margin, this operation, if carefully performed, is often very satisfactory ; if recurrence takes place it is usually in the glands in the submaxillary region, but it very seldom occurs along the course of the lymphatic vessels leading from the primary growth to the glands. This is a remarkable point in all epitheliomata of the skin ; for example, in epithelioma of the leg, recurrence after amputation is usually in the glands of the groin, and practically never in the lymphatic vessels of the thigh. This is important, because if it were necessary to take away the lymphatic vessels intervening between the primary disease and the glands, as is the case in epitheliomata of the mucous membrane or in cancer of the breast, the operation described above would not be sufficient,

Fig. 206.—Incisions for the removal of a small Epithelioma of the Lower Lip. The concave limbs of the incisions when brought together give a slight projection on the free margin of the lip, which is obliterated by the contraction of the scar.

and the greater part of the chin as well as the lip would have to be removed. Indeed Mr. Lenthal Cheatle has introduced an operation on those lines in which the incisions, instead of converging towards the chin, diverge so as to include the lymphatic vessels ; a plastic operation is necessary to fill the gap. For the reasons given above, this seems to be unnecessary.

If the greater part of the lower lip has to be removed, the incisions should be carried wide of the growth down to the point of the chin, and should be straight and not concave as described above. One of the best forms of plastic operation is to continue the incisions beneath the jaw, ending in a curve which reaches up nearly to the angle of the bone on each side (see Fig. 222). The flaps thus formed must be dissected up on each side, and in front as much of the mucous membrane must be taken up as possible. The plastic operations on the lips are fully described on p. 491.

In early and very small cancers of the lip, and in cases in which the

nature of the ulcer is doubtful, it may be justifiable to apply *radium* freely. We have seen cases in which the disease has disappeared and no operation has been necessary after the application of 100–150 milligrammes of radium for twenty-four hours.

Removal of the glands.—The question of the removal of the lymphatic glands, which receive the lymph from the infected region (viz. the submaxillary and submental glands), arises here, as in all other cases of carcinoma. *When the glands are enlarged* there is no difference of opinion as to the necessity for removing them, the only questions in that case being, whether they should be removed at the same time as the primary disease or on another occasion, and whether all the intervening tissue, likely to contain the lymphatic vessels, should be taken away, as is always done in the case of many other cancers, such as cancer of the breast. Further, if both are removed at the same operation, which should be done first?

FIG. 207.—INCISIONS FOR THE REMOVAL OF AN EPITHELIOMA OF THE LOWER LIP AND THE SUBMAXILLARY GLANDS. The ordinary incision for the removal of the tumour is prolonged downwards and backwards, and a submaxillary flap is thus raised.

As regards the question of infection of the lymphatic vessels it has been pointed out on p. 467 that it is unnecessary to take away the tissues intervening between the growth and the glands in many cases where cancer originates in the skin, and that it generally suffices to take away the primary growth and the affected glandular area. On the other hand, when the primary tumour is large or when it affects the mucous membrane, it is well to take away a large area, including the lymphatic vessels and the nearest lymphatic glands.

The question as to the period at which the affected glands should be removed is governed largely by the risk of sepsis occurring in the planes of the neck. It is naturally best to complete the whole operation at one sitting, and when the incisions for the lip and the glands do not communicate, there is no objection to this course. In that case it is well to remove the glands first, and then to deal with the affected portion of the lip; there is thus less risk of soiling the wound in the neck. The submaxillary salivary gland should always be taken away if the submaxillary lymphatic glands are enlarged, as the latter lie close to it and may escape notice unless the salivary gland is removed as well.

The best incision for removing the submaxillary glands is a curved one commencing beneath the symphysis, passing downwards and back-

wards towards the hyoid bone, and finally upwards to the angle of the jaw. This flap is dissected up, the deep fascia divided, and the glandular area exposed and removed. In removing the submaxillary gland the facial artery and vein will be divided, but care must be taken to push up the branch of the facial nerve going to the lower lip. Through this incision the submental glands can also be removed by retracting the wound well, but if necessary the incision may be prolonged along the lower border of the chin towards the opposite side.

Should the submental glands alone be enlarged, the best incision for their removal is a curved one beneath the chin parallel to the lower border of the jaw and somewhat nearer to the latter than to the hyoid bone (see Fig. 208). The enlarged glands are generally superficial to the genio-hyoid muscle, but they are sometimes found between and even beneath these muscles, so that a careful search must be made to see that all are removed before the operation is finished. If necessary, any enlarged glands can generally be made more prominent by having the floor of the mouth pushed well downwards by an assistant, so as to make the submental region project.

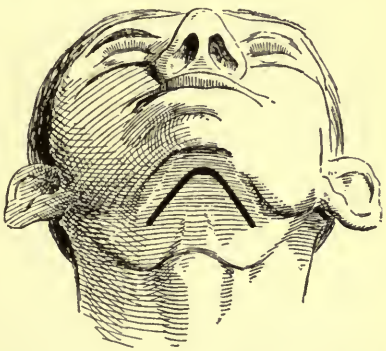


Fig. 208.—Incision for the removal of the Submental Lymphatic Glands.

When the primary disease is more advanced and the incision for the disease in the lip would join that for the glands, and especially when the glands in the anterior triangle are also affected, it is often best to operate on separate occasions. In that case the glands should be removed, in the first place, unless the primary disease is advancing rapidly, and then the operation on the lip performed about a week later; the wound in the neck will then have practically healed before it is exposed to septic infection. When, however, the primary disease is so advanced that no time must be lost in dealing with it, the order of operating must be reversed.

When the disease is so extensive that a plastic operation is required after removal of the primary growth, it will be unnecessary to make special incisions for the removal of the enlarged glands, as those requisite for the plastic operation will generally be carried below the jaw and will permit free access to the glands.

When the glands are not noticeably enlarged, opinions differ as to the advisability of removing the glandular area at once, or of waiting to see if enlargement occurs. If the primary growth is quite small and begins in the skin, and if the patient is old, it is quite allowable to wait and see whether the glands enlarge, but if the growth is of fair size and spreading

on to the mucous membrane, and the patient is comparatively young, it is best to remove the whole of the fat and glands in the submaxillary and submental areas at the same time that the operation on the lip is performed.

Should the growth be adherent to the jaw, a portion of the bone must be removed; it is never advisable to be content with merely peeling off the periosteum. As soon as the growth becomes adherent to bone, the cancer cells penetrate along the Haversian canals and recurrence is certain, unless the affected portion of the bone is removed. At the same time it must be remembered that removal of portions of the jaw always leaves a troublesome deformity, and as much of the bone should be left as possible. When the jaw is affected, it is usually from a growth which has commenced on the mucous surface of the lip and spread downwards on to the gum, and a large portion of the lip will have to be removed as well as the affected portion of the jaw. An extensive plastic operation will usually be necessary.

In some cases the disease affects only the alveolar portion of the bone, the lower margin of the jaw being healthy; in this case the lower margin of the jaw should be left intact so as to maintain the continuity of the bone and prevent deformity. This is done as follows: The teeth on either side of the growth are extracted and a vertical saw-cut is made through the upper two-thirds of the bone on each side about three-quarters of an inch beyond the disease. These cuts are then connected by an horizontal one, which is most easily made by a Gigli's saw. The periosteum must be removed with the bone.

When the bone has been removed, the flaps are brought together so as to restore the lip, and in doing so it is most important to stitch the edges of the mucous membrane accurately together, otherwise the mobility of the lip may be greatly interfered with, owing to adhesion of the lip to the jaw. In bringing up the flaps to form a fresh lip, a raw surface may be left below. If this is so, it is a good plan to cover it with a Thiersch's skin-graft, otherwise the contraction of the scar may pull down the new lip. Later on, a dentist will probably be able to supply the patient with a bar carrying artificial teeth, which will give support to the lip.

In many cases the growth involves the whole depth of the jaw, and it is impossible to save any portion of it. The various operations for removal of parts of the jaw will be found in Vol. IV.

CHAPTER XL.

TRIGEMINAL NEURALGIA.

NEURALGIA of one or more of the branches of the fifth nerve is not uncommon. The disease may be confined to a single branch, or all the main trunks may be affected; it often commences in one branch and extends thence to the whole nerve. The pain is generally intermittent and is frequently accompanied by spasmodic contractions of the facial muscles—the condition known as 'spasmodic tic.' In other cases the pain is practically constant and so severe that the patient's life is almost unbearable; indeed, many ultimately become insane or commit suicide.

In the *primary* or *idiopathic* cases the affection is a true neuritis, spreading from the terminal branches to the main trunks, and leading in severe cases to changes in the Gasserian ganglion or even in the nuclei of the trigeminal nerve. In the *secondary* cases, dental caries is a common cause, although the pain may not be referred to the particular tooth that is diseased. The nerve may also be pressed upon by a cicatrix, a foreign body, callus or a tumour, while sometimes the affection may result from a simple osteitis of the wall of the canal in which one of the branches runs. Intra-nasal conditions may also give rise to the affection; more rarely, it may depend upon caries of the petrous portion of the temporal bone or upon the presence of an intra-cranial tumour.

TREATMENT.—The treatment differs according as the case is primary or secondary.

In the secondary cases it is generally sufficient—in the earlier stages, at any rate—to remove the cause; the affection then subsides and the patient gets well. Should the cause be inaccessible, as it is in disease of the petrous bone, the treatment of the case will be more difficult.

In the primary cases, when no exciting cause can be discovered and the case is one of simple neuritis, the treatment for that

condition must be adopted first (see Vol. II. p. 127). The face should be wrapped up and kept from exposure to cold or draughts, while *quinine* (in five-grain doses four times a day) or *liquor arsenicalis* (in doses of three to five minims cautiously increased up to twelve or more) should be administered. *Antipyrin* (in ten- to twenty-grain doses) is useful during the severe paroxysms; in some instances *methylene blue* (in three-grain pills) seems to exercise a specific action. Among the various other drugs employed are *gelsemium* and *butyl chloral hydrate*. As local applications, *menthol* or *linimentum terebinth. aceticum* sometimes gives relief. The diet should be light but nourishing. This part of the treatment, however, is within the province of the physician, and for further details a treatise on medicine should be consulted.

Should no improvement take place after a prolonged trial of these or similar remedies, and should the patient's condition become unbearable, the propriety of undertaking some surgical measure for the relief of the pain must be considered.

Operative Methods.—The surgical measures employed for this affection fall into three categories:—

(1) Injection of substances into the nerves; that most commonly used is alcohol. (2) Neurectomy of the individual nerves. (3) Removal of the Gasserian ganglion.

Of these, extirpation of the Gasserian ganglion is the most certain method, and, if the patient's condition permits, it should certainly be undertaken, whenever more than one branch of the nerve is involved; in these cases the ganglion is diseased, and it is only waste of time to adopt any minor operation. Even when the disease is limited to one branch, the Gasserian ganglion should be removed if other methods fail. The operation is, however, a severe one, though much less dangerous now than when it was first introduced and, apart from its severity, it has considerable disadvantages. In the first place, the motor root of the trigeminal nerve is usually divided in the course of the operation, and, as a consequence, paralysis of the muscles of mastication on the affected side occurs. In the second place, there is considerable risk of trophic changes in the cornea which may lead to complete destruction of the eye.

On account of these disadvantages of the radical operation, it is well to resort to one of the other two methods in the first instance, especially when the pain is limited to one branch, and to reserve the operation on the Gasserian ganglion until their failure is certain. Division and removal of portions of the various branches was frequently performed at one time, but, of late, these operations have been replaced to a considerable extent by injections of alcohol, either into the large nerve trunks as they emerge from the base of the skull, or into their peripheral portions as they pass out of the foramina on the face. Recently, the Gasserian ganglion itself has been successfully injected with alcohol through the foramen

ovale. Osmic acid has also been used as an injection, but its highly poisonous character has led to its abandonment.

If injections of alcohol fail and the disease still remains limited to one of the branches, neurectomy may be performed.

1. Injection of Alcohol.—This method was introduced by Schlösser of Munich. The injection is made with a strong needle 10 cm. long and 1·5 mm. diameter, marked in centimetres for part of its length. The needle is fitted with a blunt stylet, which can be protruded from the sharp end. The material injected is alcohol (75 per cent.) or alcohol containing 2 per cent. of β-eucaine; about two cubic centimetres are introduced. The operation of injecting the nerves is not particularly dangerous and can sometimes be performed without an anæsthetic, a small quantity of eucaine being injected and allowed to act before the alcohol is introduced. When the operation has been successfully performed, especially when pure alcohol has been used, there is severe burning pain in the area of distribution of the nerve, which is followed

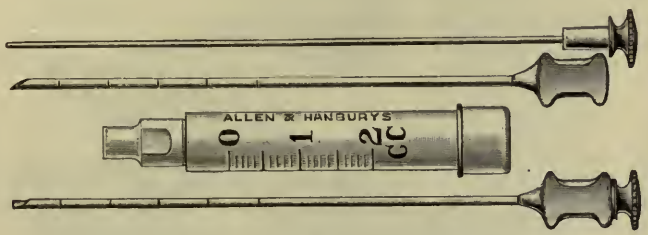


Fig. 209.—Syringe for Injection of Alcohol into Nerves. Above are shown the stylet and the hollow needle. Below, the stylet is in place within the needle. The needle is graduated in centimetres.

by a sense of fullness and tension which, in its turn, is succeeded by complete anæsthesia. In some cases there may be diffuse headache. The anæsthesia is not permanent, passing off in the course of five or six days, but the pain does not return at the same time as the ordinary tactile sensation. There is, however, usually a recrudescence of the pain in from six months to two years, when a fresh injection must be given.

Injection of the third division of the nerve at the foramen ovale.—The guide for this operation is a point immediately below the zygoma and 2½ cm. in front of its descending root, which can be felt just in front of the external auditory meatus; the needle is inserted at this point and, when the skin has been perforated, the stylet is introduced, and the instrument pushed on with the blunt stylet protruding, so as to avoid injury to the vessels, especially the middle meningeal artery, which enters the skull through the foramen spinosum close behind the foramen ovale. The needle is passed inwards, and slightly upwards and backwards, until it is felt to touch the external pterygoid plate; the periosteum is then

perforated, and the needle passed on beneath it until it is felt to enter the foramen ovale, which it does at a depth of about 4 cm. The inner boundary of the foramen is composed of a thin plate of bone which, in some cases, projects a short distance downwards beyond the outer boundary of the foramen, so that, if the needle be passed on further, it will impinge on this plate of bone. The foramen has also some considerable vertical depth. When the foramen is shallow it may be possible in some cases to pass the needle through it into the *Cavum Meckelii*, and so reach the ganglion itself.

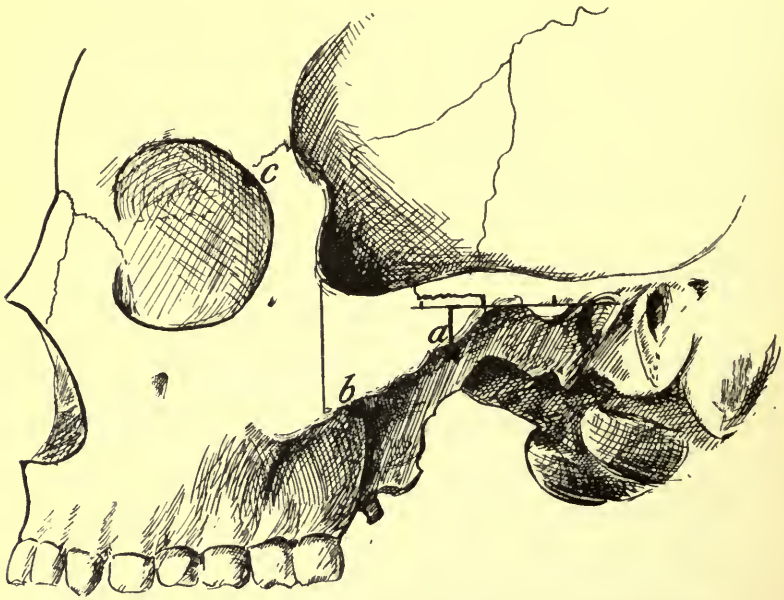


FIG. 210.—LATERAL VIEW OF THE SKULL SHOWING THE LANDMARKS FOR THE INJECTION OF ALCOHOL IN TRIGEMINAL NEURALGIA. *a*, is the point at which the needle is inserted for injection of the third division or the ganglion itself; *b*, that for the second; and *c*, that for the first division. The various measurements and guides are given in the text.

Injection of the second division at the foramen rotundum.—The guide for this procedure is obtained by feeling for the posterior border of the orbital process of the malar bone, and drawing a line vertically downwards to the lower border of the zygoma. At ½ cm. behind the point where this line crosses the lower border of the zygoma, the finger will be directly over the foramen. The needle is inserted almost horizontally, with a slight inclination upwards, and should reach the foramen at a depth of about 5 cm.

Injection of the first division of the nerve at the sphenoidal fissure.—This nerve is comparatively difficult to inject and is often missed, although the alcohol injected into the tissues surrounding it ultimately reaches the

nerve fibres, and produces anæsthesia. The needle is inserted at the outer border of the orbit and then passed backwards along the outer wall of the orbit, until it is felt to be in the sphenoidal fissures.

The peripheral branches of the nerves are easily injected by inserting the needle through the foramina in the facial bones.

2. Neurectomy of the various branches.—Any of the three primary branches may be resected.

Of the First Division.—*Supra-orbital neurectomy.*—This operation is usually performed as follows: The eyebrow should be shaved and the

FIG. 211.—THE SKULL VIEWED FROM BELOW TO SHOW THE COURSE OF THE NEEDLE USED TO INJECT THE THIRD DIVISION OF THE FIFTH NERVE WITH ALCOHOL. The direction in which the needle (graduated in centimetres to allow the depth to be ascertained) is passed is evident from the figure.

parts purified, either with the ordinary lotions or with tincture of iodine. During the preliminary purification and the subsequent stages of the operation it is of great importance to prevent the access of strong antiseptic lotions to the conjunctiva. The position of the supra-orbital notch, which can usually be felt, is defined; it is situated near the junction of the middle and inner thirds of the superior orbital margin. The supra-orbital artery lies close to the outer side of the nerve. An incision three-quarters of an inch in length is made along the upper margin of the orbit, with its centre over the notch, the eyelid being drawn down and the parts steadied as the incision is made. The fibres of the orbicularis palpebrarum are exposed and separated, and the nerve is then seen

emerging from the notch and lying upon the periosteum. It is carefully separated from the artery, picked up and cut off flush with the foramen, pulled into the wound as forcibly as possible, and as much of it removed as can be reached.

The small scar left will be hidden by the eyebrow, and for this reason the incision recommended above is better than the vertical one sometimes employed, which has the disadvantage of dividing the fibres of the orbicularis palpebrarum and sometimes its nerve-supply, besides leaving a noticeable scar. The vertical incision no doubt renders the nerve more accessible, but, if the latter be pulled upon in the manner recommended, enough is brought into view to render subsequent union very improbable.

FIG. 212.—THE INCISIONS FOR NEURECTOMY OF THE FIRST AND SECOND DIVISIONS OF THE FIFTH NERVE. *a*, Incision for supra-orbital neurectomy; *b*, incision for infra-orbital neurectomy; *c*, incision for ablation of Meckel's ganglion.

Of the Second Division. — When the second division of the fifth nerve is the seat of the disease, the pain may be referred to the teeth of the upper jaw, *i.e.* along the course of the superior maxillary nerve, or to the side of the nose, the upper lip and the infra-orbital region along the infra-orbital nerve. In the latter case, the appropriate treatment is to divide the infra-orbital nerve, whilst in the former the trunk of the second division of the fifth, along with Meckel's ganglion, will require ablation.

Infra-orbital neurectomy. — The infra-orbital nerve is easily reached. After the parts have been rendered aseptic, it may be exposed through an incision, an inch long, carried along the natural fold of the cheek and slightly oblique from above downwards and outwards. Its centre should be over the infra-orbital foramen, which is a quarter of an inch below the orbital margin of the maxilla in a line from the supra-orbital notch to the interval between the bicuspid teeth. The skin and fat and a portion of the origin of the zygomaticus major muscle are divided, the fibres of the orbicularis palpebrarum which come into view above are pulled aside, and the levator labii superioris is detached from the upper jaw. The nerve will then be seen emerging from the infra-orbital foramen and should be pulled as far out of the infra-orbital canal as possible; as much as can be reached should be resected. There is generally free oozing from the wound.

This operation can only be successful in a very few cases, because the orbital and posterior superior dental branches are given off before the nerve enters the infra-orbital canal. When therefore these branches are affected or when the pain recurs after the foregoing operation, the trunk of the second division together with Meckel's ganglion must be excised.

Neurectomy of the superior maxillary nerve and ablation of Meckel's ganglion.—This may be done through a V-shaped incision with the apex downwards, the middle of the flap being a little below the infra-orbital foramen. The flap thus formed is turned upwards, and held or stitched out of the way. The infra-orbital nerve is then exposed as it emerges from the foramen, the soft parts are cleared from the bone, and a square hole measuring about three-quarters of an inch in each direction is cut out of the front wall of the antrum with a chisel. This should be so planned that the infra-orbital foramen lies slightly above the centre of the hole. A silk ligature is now fastened to the end of the nerve after it has passed out of the foramen to serve as a guide in the further procedures. After the bleeding has been arrested, a powerful light is projected into the wound from a forehead lamp or reflector, and a slightly smaller hole of similar shape is cut in the posterior wall of the antrum. The oozing here is free, but can be arrested by packing the cavity temporarily with gauze soaked in adrenalin chloride (1 in 1000).

The next step is to remove the floor of the infra-orbital canal as it traverses the roof of the antrum, and this is done, using the infra-orbital nerve as a guide, by very cautious strokes of a fine chisel or with a pair of stout scissors. It is very important to avoid dividing the nerve, otherwise an essential guide to the later stages of the operation will be lost. The floor of the canal is usually very thin, and can often be broken away by introducing a fine steel probe or director alongside the nerve and bending it downwards. The whole floor of the canal is cut away as far as the posterior wall of the antrum, when the nerve will hang free in the cavity and can be traced up to its point of emergence from the foramen rotundum ; at the same time Meckel's ganglion is defined by means of a probe, the aperture in the posterior wall of the antrum being enlarged if necessary. The nerve is now grasped with long-handled forceps and pulled as far out from the base of the skull as possible, and removed together with the ganglion attached to it. This portion should measure, at least, an inch and three-quarters in length. If preferred, the nerve may be seized by powerful forceps close to the foramen rotundum and pulled on forcibly until it is torn away from the skull. In any case, it should be pulled upon before being divided so that the cut end will retract inside the foramen, because a common cause of the neuralgia is a thickening of the periosteum in the foramina at the base of the skull, which gives rise to pressure upon the nerve as it passes through them. The oozing at this stage of the

operation is usually profuse and some time may be required for its arrest; it can generally be stopped by sponge pressure. Should it continue, a fine horse-hair drain may be inserted through the wound into the antrum for a few days; otherwise no drain need be employed.

Of the Third Division.—When the third division is affected, the pain may be referred to one branch alone, and of these the one most commonly attacked is the inferior dental, less frequently the gustatory, and still more rarely the auriculo-temporal. When only one of these branches is attacked, it is well to divide this alone in the first instance, rather than to undertake the serious operation of dividing the third division at its exit from the skull.

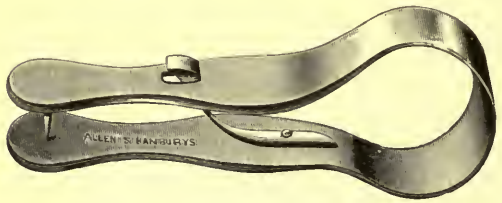


FIG. 213.—TONGUE-CLIP. The clip is kept in position by means of the catch. The tongue is easily pulled in any direction by passing the finger through the bow of the forceps.

Neurectomy of the inferior dental nerve.—The patient is anæsthetised and placed in a good light, with the head propped up and the mouth fully opened with a gag. The cheek on the affected side is firmly retracted by a broad spatula, and the tongue is held over to the opposite side either by a tongue-clip (see Fig. 213) or by a silk thread passed through its substance. The surgeon first feels for the inferior dental spine with his left forefinger; this is situated immediately above the commencement of the inferior dental canal, and the internal lateral ligament of the jaw is inserted into it. The mucous membrane is now incised vertically for about an inch just internal to the anterior border of the ascending ramus, and is detached for a short distance. The surgeon then feels for the inferior dental spine, which must be accurately defined; the internal ligament is then divided at its attachment. The inferior dental nerve

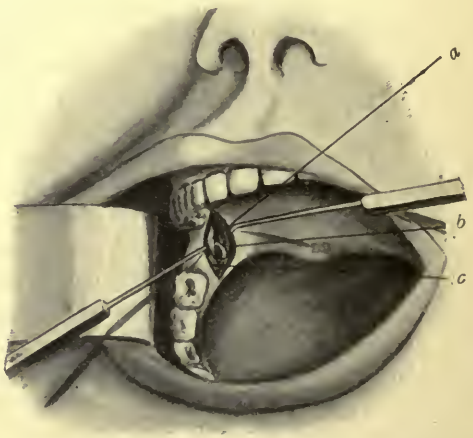


FIG. 214.—EXPOSURE OF THE INFERIOR DENTAL NERVE FROM INSIDE THE MOUTH. The figure shows (*a*), the inferior dental nerve in close proximity to the internal pterygoid muscle (*b*), and just behind, the inferior dental spine (*c*).

lies immediately behind this ligament, and can generally be brought up into the wound with a small blunt hook. As it enters the foramen the nerve lies in close proximity to the inferior dental vessels, but is separated from them by a larger interval higher up. The nerve should not be mistaken for other structures in its vicinity, if proper care has been taken to define and divide the internal lateral ligament. The lingual nerve lies in front of, and internal to, the inferior dental, being separated from it by the internal lateral ligament, whilst the mylo-hyoid branch lies posteriorly in its own groove. When the nerve has been brought into the wound, it is grasped with a pair of Spencer Wells's forceps and divided first high up in the wound and then again lower down, as much of the trunk being removed as possible.

The operation is tedious and difficult, and the surgeon is much hampered by the continual oozing from the wound. Unless care is taken in isolating the nerve, there may be considerable hæmorrhage from a wound of the inferior dental or the internal maxillary artery. It is most important to have a good light during the operation, and a forehead lamp should be employed if strong daylight is not available. No stitches need be inserted after the operation, and the mouth should be frequently washed out with a weak solution of sanitas (two drachms to the pint). There is often considerable swelling and stiffness about the jaws for some days after the operation, but this usually subsides entirely, although in some cases it persists for several weeks. If it does not subside, an ordinary Mason's gag should be introduced, an anæsthetic being administered, if necessary, and the jaw gently and slowly forced open ; this operation is repeated at intervals of a few days until free movement is obtained.

Another and simpler method of reaching the nerve from the cheek by deepening the sigmoid notch finds a place in most of the text-books on operative surgery. On account of the scarring and possible risk of injury to important structures involved in this operation it is, however, very rarely employed.

Neurectomy of the gustatory nerve.—The patient is placed in the same position as for the former operation, the mouth is widely opened with a gag, and the tongue pulled forcibly over to the opposite side, and at the same time drawn somewhat forwards with a tongue-clip. The nerve will then start up into relief immediately behind and below the last molar tooth. It lies behind the pterygo-maxillary ligament, and is easily felt by the finger in the mouth. An incision should be made along the line of the nerve through the mucous membrane ; the nerve is then drawn out and half an inch or more excised.

Neurectomy of the auriculo-temporal nerve.—This branch of the fifth nerve very rarely requires division. Should it do so, it can be excised through a vertical incision immediately in front of the ear, the centre of the incision being opposite the base of the zygoma. The nerve lies immediately posterior to the temporal artery.

It frequently happens that the pain recurs a short time after the division of the branch or branches affected. Under these circumstances, some surgeons expose the third division of the trigeminal nerve as it emerges from the skull and divide it at the distal side of the foramen ovale. This operation is, however, almost as severe as that for removal of the Gasserian ganglion, it is just as disfiguring, and it is no more certain

FIG. 215.—THE SKIN-FLAP FOR REMOVAL OF THE GASSERIAN GANGLION. The merits of the two incisions are discussed in the text.

in its results than the injection of alcohol. We need not therefore describe it here, but may refer the reader to Mr. Rose's description.[1]

3. Removal of the Gasserian Ganglion.—The operation that we prefer is a modification of that practised by Cushing, which, in its turn, is an adaptation of the Hartley-Krause operation. The Hartley-Krause operation has the objection that the opening in the skull is made so much

[1] *The Surgical Treatment of Neuralgia of the Fifth Nerve*, by W. Rose, F.R.C.S. (1892), p. 52.

above the level of the floor of the middle fossa that it involves considerable detachment of the dura mater and compression of the brain, as the latter is lifted up to expose the ganglion. In the operation described below, the opening in the skull is made as low down as possible and is, therefore, much more nearly on a level with the ganglion itself.

The affected side of the head is shaved and purified thoroughly, and

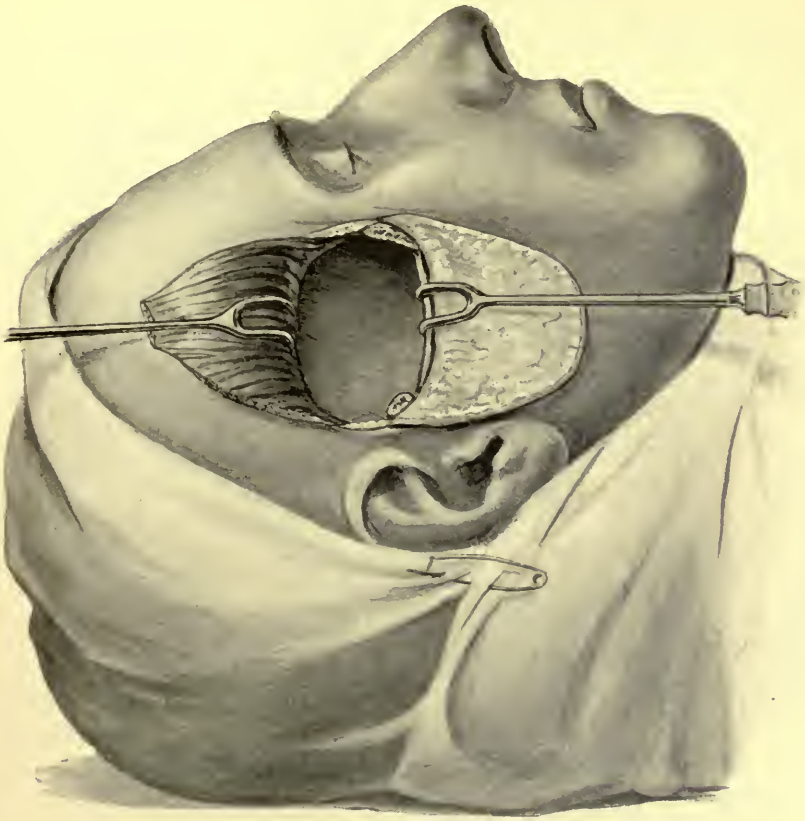


FIG. 216.—EXPOSURE OF THE SKULL IN THE OPERATION FOR REMOVAL OF THE GASSERIAN GANGLION. The zygoma has been divided and pulled down and the temporal muscle stripped upwards out of the temporal fossa.

then the conjunctiva on the same side is carefully irrigated with boric lotion, and the eyelids sewn together by three fine silkworm-gut sutures. The best way to do this is to pinch up small folds of the loose skin about a quarter of an inch above and below the free margins of the lids and to pass the sutures through these. These stitches should be kept in for the first four or five days after the operation, in order to protect the anæsthetic cornea from irritation

The skin-flap is next marked out and dissected up. The incisions

commonly employed are shown in Fig. 215. The usual omega-shaped flap (*ab*) gives very good exposure, but has the disadvantage that the scar is rather noticeable afterwards, and also that the nerve-supply to the orbicularis may be damaged. The sickle-shaped incision (*cd*) is less likely to endanger the branches of the facial nerve and leaves a less conspicuous scar, but the flap has to be pulled forcibly forward in order to obtain

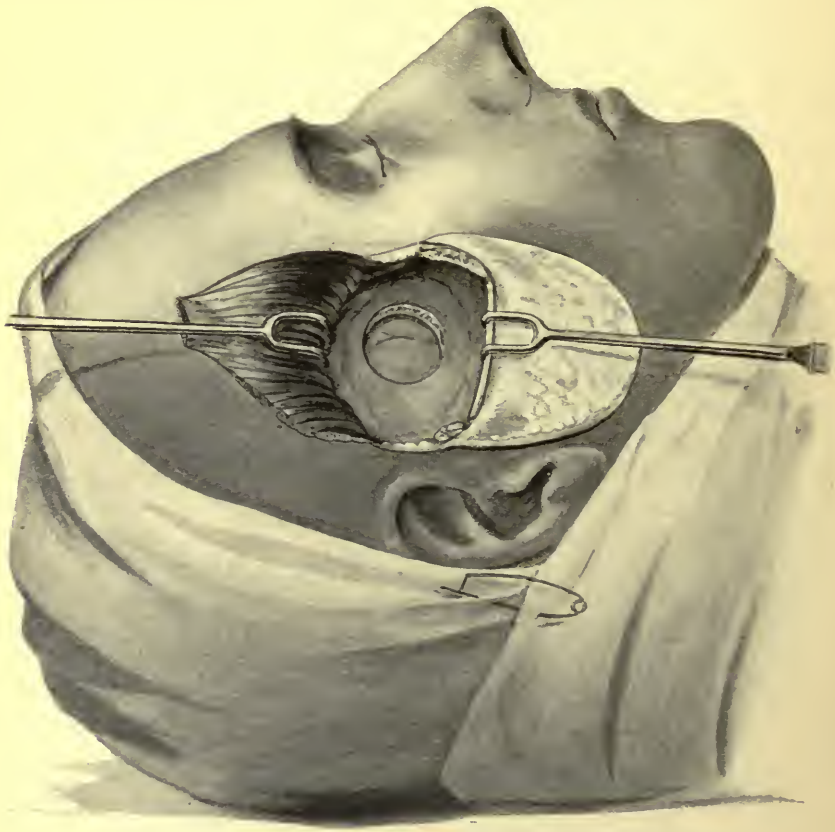


FIG. 217.—OPENING THE SKULL AND RAISING THE DURA MATER IN REMOVAL OF THE GASSERIAN GANGLION. The opening in the skull is enlarged freely in all directions by means of powerful punch forceps, such as those shown in the following figure.

efficient exposure of the area of operation. In either case the incision only goes through the skin and deep fascia. After the flap has been reflected the deeper tissues are infiltrated with about half an ounce of a 1 in 20,000 solution of adrenalin, so as to check oozing, and then the temporal fascia is detached from the upper border of the zygoma, and this process sawn through at each end and pulled forcibly downwards with the masseter muscle attached to it. A little dissection now exposes the coronoid

process of the lower jaw with the temporal tendon attached to it. The latter structure is cut through close to its attachment to the bone, or the coronoid process is sawn through, and the whole of the temporal muscle is turned upwards and kept out of the way with a retractor. This exposes the lateral wall of the skull just above the pterygoid ridge, and the pin of a one-inch trephine is applied at this level opposite to the centre of the zygoma and a circle of bone removed (see Fig. 217).

The removal of the crown of bone must be effected with great care, as a wound of the dura mater, which it is important to avoid, may occur

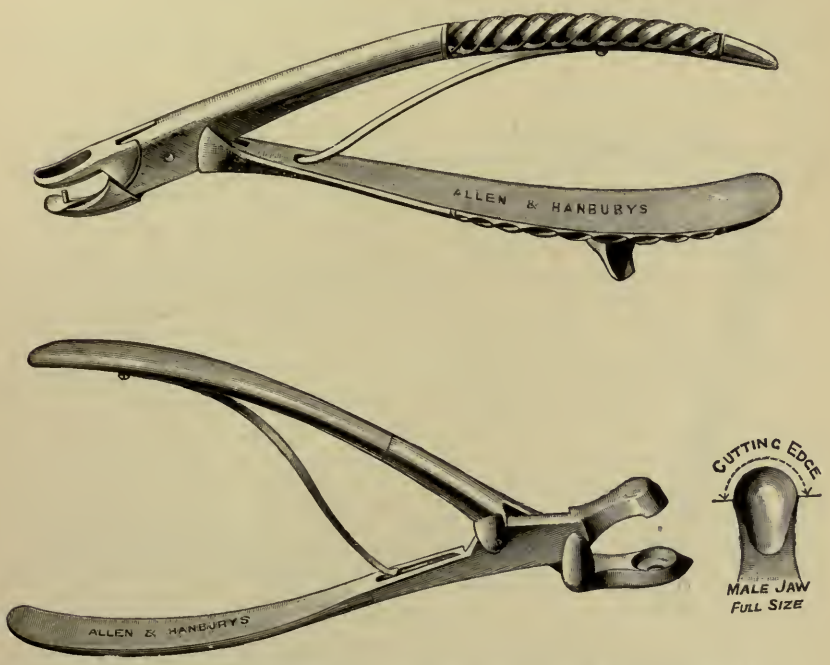


Fig. 218.—Punch Forceps for Cranial Operations. These forceps can be used in very restricted areas and are useful in enlarging the trephine hole downwards towards the base of the skull.

very easily owing to the variability in the thickness of the skull. When the crown of bone has been removed, the opening is enlarged in all directions, but especially downwards with cutting pliers or gouges (see Fig. 218). The foramen ovale is identified by detaching some of the fibres of the external pterygoid muscle and finding the third division emerging from it, and the bone between it and the opening in the skull is cut away as freely as possible. At this stage there is generally free bleeding from the pterygoid plexus of veins, but this soon yields to firm sponge pressure.

The dura mater is next separated from the floor of the middle fossa

of the skull and raised along with the brain above it, and the ganglion looked for. During this stage of the operation a powerful electric forehead lamp is a necessity; the ganglion lies so deep, and the wound is so often obscured with blood that the structures cannot be identified clearly without a good light. The dura mater is separated by sweeping a blunt instrument around the edge of the opening in the skull between it and the bone, and raised with broad retractors until the floor of the middle fossa is well exposed (see Fig. 220). The dura mater is pushed gradually upwards and inwards, the brain being gently moulded into its new position and not violently compressed. The only complication likely to be met with at this stage is injury to the middle meningeal trunk as it emerges from the foramen spinosum, but with care this can

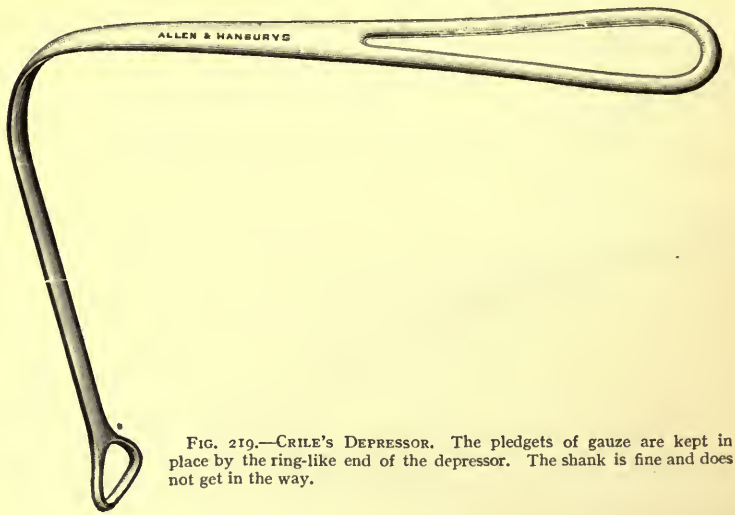


FIG. 219.—CRILE'S DEPRESSOR. The pledgets of gauze are kept in place by the ring-like end of the depressor. The shank is fine and does not get in the way.

usually be avoided; should it be necessary to divide the artery, the best plan is to cut it across between ligatures about half an inch from the foramen. Should the vessel be torn just as it passes out of the foramen, the bleeding is apt to cause trouble; if the lower end of the artery can be seized in forceps, it should be twisted and pushed into the foramen spinosum. Failing this, Horsley's wax may be applied to the foramen.

When the dura mater has been lifted well up, the surgeon will recognise the third division of the trigeminal nerve passing almost vertically downwards from the Gasserian ganglion to the foramen ovale which lies internal to, and a little in front of, the foramen spinosum, and it is here that the serious difficulties of the operation begin. The best procedure is to define the nerve clearly with a fine dissector, and then to cut it across with a pair of fine scissors or a tenotome; the divided end is seized in a pair of

fine Spencer Wells's forceps and serves as a safe guide to the ganglion. The surgeon now proceeds to identify the remaining divisions of the nerve, a proceeding requiring great care owing to the proximity of the cavernous sinus. By detaching the dura mater inwards towards the middle line, the foramen rotundum is identified with the second division passing through it ; the smaller ophthalmic division lies above it. The sixth nerve is also brought into view, lying above and parallel to the second division and must be carefully protected from injury. During the whole of this stage the operator is likely to be much hampered by the free and continuous oozing that takes place from the small veins joining the cavernous sinus ; this must be arrested by pressure, small pieces of sponge upon long-handled forceps being thrust down into the bottom of the wound and held there for a short time. An excellent instrument devised by Crile for this purpose is seen in Fig. 219. Small pledgets of gauze are packed down on to the bleeding points and held firmly in place by the depressor, which does not get in the operator's way and only applies the pressure where it is needed.

When the branches of the nerve have been identified, the surgeon proceeds to find and remove the ganglion itself. To do this, the divided end of the third division is traced back to the ganglion where it lies in a compartment in the dura mater at the apex of the petrous portion. In freeing the ganglion the dura mater may be opened, but this is not a serious accident ; indeed, it facilitates the operation somewhat, as it allows the dura mater to collapse and so gives better access to the ganglion. The edge of the ganglion is separated behind with a fine dissector and it is then raised from its bed—if necessary with a few touches of a tenotome—and seized firmly in strong forceps. With these it is partly pulled and partly dissected away from behind forwards. It is generally recommended that the motor root of the ganglion, as well as the first division, should be left untouched ; no doubt this is advisable if it can be done, but there is generally so much oozing that accurate differentiation is not easy, and in that case it is best to cut across the third division—and with it the motor part—early in the operation. As the ganglion is detached and pulled forwards, the second division is lifted away from the outer wall of the cavernous sinus to which it is closely adherent, and thus damage to this important structure is avoided. Finally this nerve is cut off flush with the foramen rotundum and the ganglion comes away, the ophthalmic division being often torn across in the process. The venous oozing will generally cease directly the dura mater is allowed to fall back into place, and it will rarely be necessary to put a drainage tube into the cranium and, still more rarely, to plug the wound with gauze to arrest bleeding. This latter step may be necessary, however, should the cavernous sinus be wounded in the later stages of the operation ; the bleeding then is most profuse. There is no need to fasten either the divided zygoma or the temporal tendon into place, if the motor root of the nerve has been

divided, since both the temporal and masseter muscles will be paralysed. The flap is sutured accurately in place, a fine drainage tube being inserted at one of the lower angles.

The chief *danger* in the operation is a wound of the cavernous sinus which is indicated by furious bleeding at the time and, perhaps, by thrombosis of the sinus afterwards. Injury of the third, fourth, and

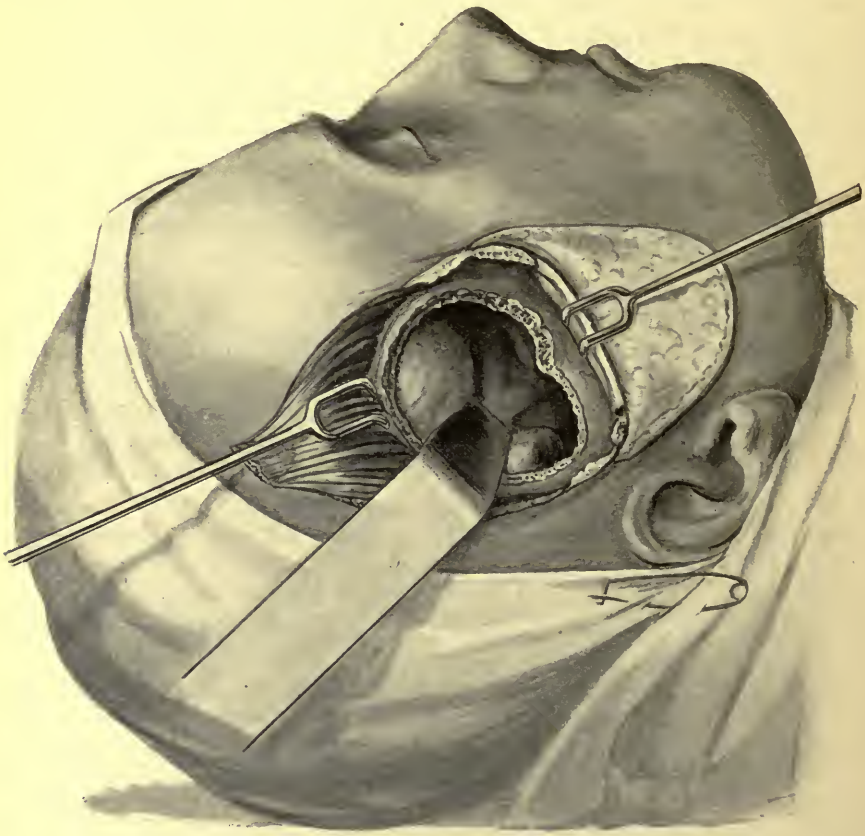


FIG. 220.—EXPOSURE OF THE GASSERIAN GANGLION. The dura mater is held up by a broad flexible spatula. It usually requires the use of a forehead lamp to distinguish the ganglion and the three branches of the nerve.

sixth nerves, with resulting widespread ocular paralysis, may also occur, as a result of rough handling in the later stages of the operation or of cavernous sinus thrombosis.

After-treatment.—The patient is put back to bed with the head somewhat raised, in order to restrain hæmorrhage and to diminish intra-cranial tension. The eyelids should be looked at daily and irrigated with warm boric lotion, after which they are dried and a sterilised dry cotton-wool

pad is bandaged on. The stitches uniting the lids are removed on the fifth day, but for several weeks afterwards the greatest care must be taken to prevent irritation of the anæsthetic conjunctiva ; to this end the patient should use a boric eye-wash frequently and the eye should be covered with a shade. In spite of all precautions, however, trophic ulceration of the cornea (neuro-paralytic keratitis) may supervene and the globe may have to be excised. The drainage tube should be removed at the end of forty-eight hours. The wound heals well and there is hardly any risk of injury to the brain subsequently, as the defect in the skull is quite low down.

CHAPTER XLI.

THE PLASTIC SURGERY OF THE FACE.

When performing operations about the face, the surgeon often has to remove extensive portions of the skin or even of the whole thickness of the cheek, and very serious deformity will result if the gap thus made is not filled up. He may also be called upon to repair defects caused by the loss of tissue from disease or to remedy deformities of congenital origin—*e.g.*, hare-lip. These defects may be recent or of long standing; the latter may be either congenital or may follow an injury or a disease in which serious contraction has occurred during healing.

The general principles of plastic surgery have been already discussed (see Vol. I. p. 157), but two points may be emphasised here. The first is that, when the loss of tissue has been produced by a surgical operation, it is better to perform the plastic operation then and there, rather than at a later period, provided that a sufficient blood-supply can be obtained for the flaps. The second is that when the loss of tissue has been the result of ulceration (especially when this has been syphilitic), care must be taken to see that the disease has become quiescent and cicatrisation is complete before undertaking any plastic operation; failure to observe this precaution may lead to a recrudescence of the disease and sloughing of the flaps.

PLASTIC OPERATIONS ON THE FACE IN GENERAL.

The two chief methods of repairing defects on the face are by skin-grafting or by turning in flaps.

Thiersch's Skin-grafting.—Immediate skin-grafting (see Vol. I. p. 53) is of great value where skin alone has been lost—as after the excision of lupus—and it should be employed in all cases in which flaps are not available and the loss of substance is not deep. Some degree of contraction may follow, but probably this will not be enough to cause any serious deformity; even should deformity occur, it will,

as a rule, be comparatively slight and may be remedied subsequently, either by division of the cicatrix and a second skin-grafting, or by turning in a flap from the neighbourhood. In large old-standing scars with much contraction, skin-grafting is also of great value; for example, in ectropion following extensive lupus or burns of the face, the skin may be so widely scarred that it is impossible to obtain sound skin-flaps in the neighbourhood, and under such circumstances considerable improvement may be obtained by dividing the cicatrix along the lower border of the eyelid, dissecting up the lid, stitching it to the eyebrow so as to leave a broad raw surface, and covering this with a skin-graft. When all shrinkage has ceased, the operation can be repeated if necessary, so that ultimately the ectropion may be completely cured. Skin-grafting has, however, a limited scope in connection with defects on the face, as it is practically confined to cases in which the loss of tissue is comparatively superficial and not extensive.

Turning in Flaps.—In the majority of cases in which plastic surgery is required, there is loss of tissue in depth as well as in superficial area, and often there are cavities to be bridged over; in these cases the defect can only be remedied by turning in flaps. When the defects are made by the surgeon, it is generally advisable to cover them in at the time of the operation. Some have advocated that the wound should be allowed to heal in certain cases and the plastic operation performed later, but much contraction and deformity may be avoided by repairing the defect immediately.

In some cases, however, it may be desirable to allow the wound to cicatrise. For example, after removal of a tumour of the upper jaw in which it has been necessary to remove a considerable amount of skin that was adherent to the tumour, it may not be possible to find flaps to cover in the gap. As healing occurs, the contraction will diminish the gap considerably, and it may then be closed by a plastic operation, or a flesh-coloured metal plate may be used which is held in position by a spectacle frame. These artificial substitutes may give a more sightly result than a plastic operation, and they have the advantage that the area of the operation can be readily watched for signs of recurrence.

In cutting flaps the most important principle is to employ curved incisions when possible. Straight incisions are often used, but they have several disadvantages. In the first place, there is more tension than when curved incisions are employed, as the latter allow the flap to slide into position without undue traction; consequently a rectilinear flap either gives way, or, if it keeps its place, deformity may be caused from the tension, while the angles of the incision at the base of the flap pucker up and cause unsightly projections. Moreover, with rectilinear flaps, it is often impossible to get enough covering for most openings. This is well seen in cases in which the lower lip has to be repaired after a growth has been excised from it (see Fig. 221). In this case, a quadrilateral portion

is excised, and to repair this gap it is sometimes recommended that incisions should be carried vertically downwards into the neck from the two lower angles of the wound; the flap thus raised is pulled up to the original level of the lower lip and stitched in position. This flap constantly tends to retract, and, as a consequence, the lower lip becomes pulled down and proper closure of the mouth is impossible. If, however, curved incisions are made, they allow the flaps to slide into position without tension, and, as there is not the same liability to subsequent contraction, there is not the same tendency to subsequent drooping of the lip. There is also no puckering at the base of the flap; for, though it will generally be found that the skin on one side of the incision is more abundant than on the other, puckering can be avoided if a little

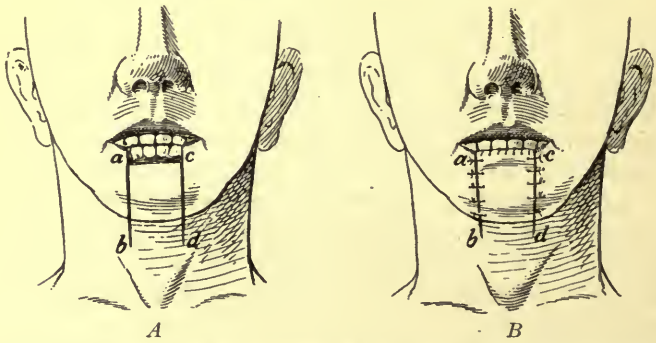


FIG. 221.—RESTORATION OF THE LOWER LIP BY MEANS OF RECTILINEAR INCISIONS. The rectangular gap left by the removal of the lower lip is filled by raising a rectangular flap, *abdc*. This is done by carrying the incisions *ab* and *cd* vertically downwards to the level of the hyoid bone. The mucous membrane is stitched to the skin along the line *ac*, and the flap pulled up and sutured, as shown in *B*. It is obvious that there must be a very considerable drag on the new lower lip as the scar contracts.

more skin is included between each stitch on the redundant side than on the other, and the cicatrix ultimately becomes a smooth line.

Sutures.—Silkworm-gut is the best material where there is tension on the stitches, and fine horse-hair, put in close to the edge of the skin, will suffice for the intermediate ones. Silk is not so good, as it becomes soaked with discharge and may act as a carrier of sepsis. As a rule there is so much scarring that stitch-marks do not matter much, and buried sutures are unnecessary. When, however, the defect is small and the scarring comparatively slight, a great deal of scarring is avoided by using buried sutures (see Vol. I. p. 137). These are especially useful where small tumours or patches of lupus have been excised, and where the edges of the skin can either be brought together or only a small flap is necessary to fill the gap. These wounds heal extremely rapidly, and union by first intention will be obtained in the great majority of cases. When there is no tension on the flap, the stitches can be removed in four five or days. When, however, the flaps have been brought together

with difficulty, the stitches should be left in for from eight to ten days; the earlier they are removed, the less noticeable are the stitch-marks afterwards.

Dressing.—No dressing is required in these cases; at the most, a piece of boric lint dipped in boric lotion may be applied for a few hours until all bleeding has stopped, and then a narrow strip of gauze may be fixed along the line of incision with collodion. In plastic operations about the mouth, the gauze quickly becomes soiled with saliva and becomes septic, and therefore, it is better to dust the line of incision over with boric acid powder and allow it to dry.

PLASTIC OPERATIONS ON THE LIPS.

RESTORATION OF THE LOWER LIP.

This is called for, when the whole lower lip must be taken away for an extensive labial cancer. Here, instead of making a quadrilateral incision (see Fig. 221), it is always best to make a V-shaped one, with the apex of the V at the chin (see Fig. 222), even though considerably more of the healthy lip is sacrificed in so doing. The result is a large triangular defect, which may be closed in one of the following ways:—

In the first plan, the soft parts from the angles of the mouth down to the reflection of the mucous membrane from the lower lip on to the gums are brought up to form a new lower lip, the mucous membrane being stitched to the skin on each side as far as its point of reflection. Curved incisions are carried downwards into the neck on each side from the apex of the V (see Fig. 222, *A*); for example, the incision on the left side of the lip is continued downwards in a bold curve on to the right side of the neck nearly as low as the hyoid bone, and then upwards towards the angle of the jaw. The whole of this flap is freed, the mucous membrane being divided along its reflection to the gum, and a similar procedure is carried out on the other side; the facial artery should be left undivided. The original lines of the incision on the lip made for the removal of the cancer are now brought up to the horizontal, so as to form the margin of the new lower lip (see Fig. 222, *B*). The adjacent edges of the two flaps, which have been made to slide upwards, are stitched together in the middle line for a sufficient distance to leave a somewhat redundant lower lip (in order to allow for subsequent contraction), and the edges of the incision in the neck are then brought together. In order to unite the latter satisfactorily, it is well to undermine the skin below the incision for some distance, so that it can be pulled up and united to the lower edge of the flap above without undue tension; if the sutures are inserted so as to include more of the lower edge than of the upper between each stitch, the incision will come together without much puckering. In some cases, it may be necessary to leave a small

triangular raw surface at the outer end of the incision in the neck; this can be covered at once by a skin-graft.

The second plan is the following: Instead of continuing the V-shaped cut down on to the neck, an incision is carried straight outwards, or with

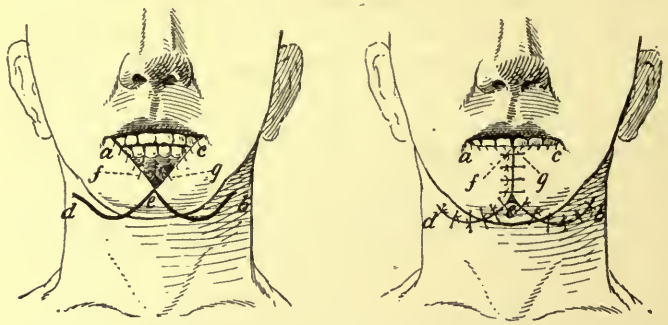


FIG. 222.—RESTORATION OF THE LOWER LIP BY MEANS OF CURVED INCISIONS. Here the lip is removed by a large V-shaped incision *aec*. The incision *ae* is prolonged to *b*, and *ce* to *d*; these flaps are then dissected up and sutured as shown in *B*. The mucous membrane is sutured to the skin along the lines *af* and *cg*, and these form the margin of the new lip. If any raw surface is left at *e*, it can be closed by undermining the triangular flap of skin *deb*, or by a skin-graft. It is clear that there cannot here be the same direct drag upon the new lip by contraction of the cicatrices as there is in the preceding figure.

a slight convexity upwards, from the angle of the mouth on each side as far as the masseter muscles, dividing the whole thickness of the cheek up to that point. When the incision reaches the masseter, it is curved

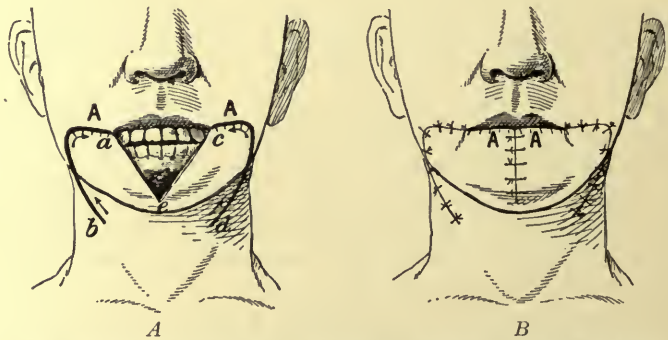


FIG. 223.—RESTORATION OF THE LOWER LIP BY INCISIONS OVER THE MASSETERS. The free margin of the new lip is formed by stitching the mucous membrane to the skin along the horizontal part of the incisions, *A*; *ae* and *ce* are approximated in the middle line and form a vertical scar, as shown in *B*.

outwards and downwards over the margin of the jaw, and then under the latter nearly to the hyoid bone, ending with a slight upward curve in front (see Fig. 223, *A*). The flaps thus marked out are raised from the margin of the masseter and the lower jaw, the mucous membrane being divided vertically downwards along the anterior border of the masseter,

and then horizontally along the reflection of the mucous membrane on to the gum. When fully liberated, these flaps can be made to slide in, so that the sides of the original V-shaped incision meet and are sutured in the middle line. The mucous membrane is then united to the skin along the upper edge of the flap so as to form the free border of the newly-made lower lip, and the rest of the wound is closed by sutures (see Fig. 223, *B*), the skin on the outer side of the incisions being undermined, so as to allow it to be brought into position easily. In some ways this operation is better than the preceding one. The lip has less tendency to drop, and there is a better supply of mucous membrane. The chief disadvantages are the division of the branches of the facial nerve going to the flap, the large scar on the cheek, and the less perfect blood-supply ; the blood-supply is, however, usually satisfactory if the base of the flap is sufficiently broad. The choice between the two methods will depend very much on the circumstances of the case and on the shape of the patient's face ; perhaps the second method will be most often chosen. In all of these cases, however, there always remains a liability to imperfect closure of the lips and dribbling of saliva.

EVERSION OR ECTROPION OF THE LIPS.

Sometimes there is eversion of one of the lips as a result of injury or disease, the red line of the lip being drawn down and the mucous membrane freely exposed.

When the lower lip is affected, the condition may be remedied in the following manner (see Fig. 224) : An incision is carried a little below the lower edge of the everted red line, and the parts separated sufficiently to allow the mucous surface to be brought into its proper position ; this will leave an oval gap below the lip. By carrying a vertical incision downwards from the middle of the transverse incision and curving it away to each side when it reaches the chin, flaps of skin and fat can be detached and brought up so as to fill up this gap and keep the lip in position. When only one side of the lip is affected, the elliptical gap left after freeing the margin of the lip may be filled by a flap turned in from the cheek, in the same manner as ectropion of the lower eyelid is remedied (see p. 504).

RESTORATION OF THE UPPER LIP

When only the central portion of the lip has to be removed, this is carried out on lines similar to those recommended for cancer of the lower lip (see p. 491). When the middle of the upper lip has to be taken away up to the nostril, the part remaining on each side should be freely separated from the jaws and incisions continued upwards around each ala of the nose. A crescentic portion of skin is then removed opposite each ala (see Fig 225), and the two sides of the lip can be brought together and the

wound sutured without compressing the nostrils and with little deformity.

The same principle may be employed when the whole of the upper lip has been removed. In these cases it is well to make the operation wound as angular as possible, with its apex at the columella ; incisions are then

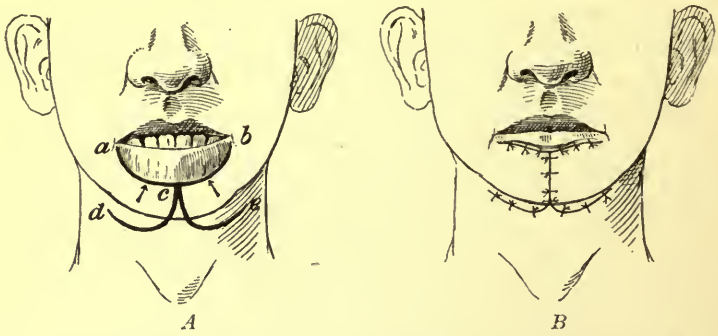


FIG. 224.—OPERATION FOR ECTROPION OF THE LOWER LIP. The lip is liberated by the incision *ab*, and is then kept in place by raising flaps by means of the incisions *cd* and *ce*. These flaps are shown in position in *B*.

carried from the columella round the alæ, and up along the side of the nose on each side (see Fig. 226, *A*). The flaps thus marked out are raised, and a crescentic portion of the cheek is taken away on each side as in the former operation, large enough to allow the flaps to come together and form the upper lip. From the points (*c*) at which the incisions begin to curve

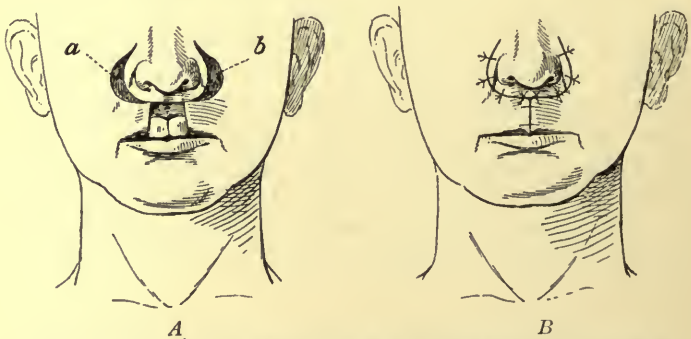
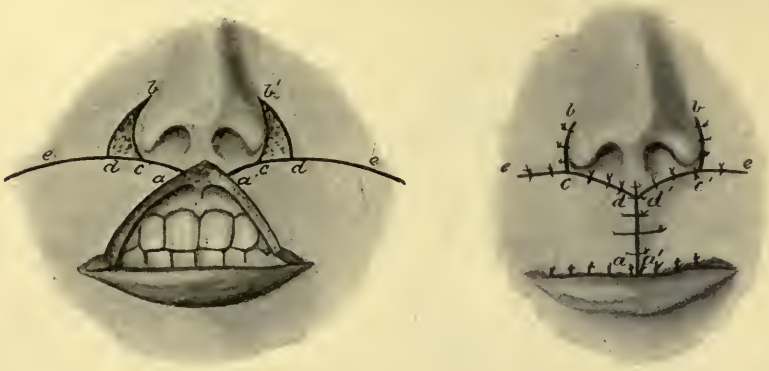


FIG. 225.—OPERATION FOR RESTORATION OF PART OF THE UPPER LIP. In *A* are shown the portions of skin (*a* and *b*) removed from each side of the cheek in order to allow the remains of the upper lip to slide inwards and meet in the middle line as in *B*.

upwards around the alæ, additional incisions are carried outwards into the cheek parallel to the line of the lip. The mucous membrane is now stitched to the skin on each side up to the apex of the V and these two surfaces are brought down to form the margin of the upper lip. At a point (*d*) on each side of the incision parallel to the lip, and at a distance

from the middle line corresponding with the breadth of the new upper lip, a stitch is inserted and tied. The adjacent margins of the flaps below this stitch are united with sutures and a vertical line is thus formed which unites the two halves of the new upper lip. The cheek on each side



A B

FIG. 226.—RESTORATION OF THE UPPER LIP. In *A* are seen the various incisions, while in *B* is shown the method of suturing necessary to restore the lip. The removal of the portions of skin *dbc* and *d'b'c'* give rise to the lines of union *bc* and *b'c'*; while the point *a* being sutured to *a'* allows the cut surfaces in *A* to make the free edge of the new lip in *B*.

is then brought in to the ala of the nose and stitched there (see Fig. 226, *B*). This method is most useful, however, when only the middle portion of the lip has been lost and the lateral portions are intact.

MICROSTOMA.

The mouth may be very considerably contracted at one side as the result of disease or injury, and various methods may be employed to restore it to its proper size. The older plan was to introduce metallic rings through the cheek at the desired new angle of the mouth, and keep them in position until the sinus became covered with epithelium ; the cheek was then split between this point and the angle of the mouth, and the mucous membrane stitched to the skin. This plan does not, however, answer well, as this deformity usually results from some disease which destroys the mucous membrane, the skin, or the whole thickness of the cheek, leaving only scar tissue behind. The method of Dieffenbach is the best under these circumstances and is carried out as follows :—

The whole thickness of the cheek is split out to the point where the new angle of the mouth is to be ; if the mucous membrane has been destroyed to a greater extent than the skin, a small strip is then trimmed off the scar tissue on each side, and the sound skin is undermined and turned in, and stitched to the healthy mucous membrane, so that the two are continuous. When the skin alone has been destroyed, the mucous

membrane is brought out and stitched to the skin, so as to form a lip covered with mucous membrane.

When the skin is lax, a narrow triangular portion of skin, with its base near the proposed new angle of the mouth, is first raised (see Fig. 227), and the cheek is then split to the necessary extent. The flap of skin is

FIG. 227.—DIEFFENBACH'S OPERATION FOR MICROSTOMA. A small triangular flap is first dissected up, and then the angle of the mouth is split along the dotted line shown in *A*. The flap is now turned in around the new angle and sutured as shown in *B*.

then turned in, and sutured to the mucous membrane, and thus covers the new angle and prevents any contraction spreading from that point. The rest of the raw surface is covered by suturing the mucous membrane to the skin in the manner described above. This plan is very valuable when it can be employed; without it, contraction is apt to occur at the angle and to reproduce the deformity.

PLASTIC OPERATIONS ON THE CHEEK.

The method adopted for repairing defects in the cheek will depend upon the extent of the defect—in particular upon the extent to which the cutaneous or the mucous surfaces are destroyed—and also upon the presence of complications, such as closure of the jaws, or eversion of the lips or eyelids.

A recent defect of the skin and subcutaneous tissues, such as occurs after removal of superficial tumours from the cheek, may be closed in various ways according to its size and shape. If the defect is small and oval, its edges can be undermined and stitched together. If, however, the defect is larger and circular or irregular, it may be closed by skin-grafting or by flaps turned in from the adjoining skin, preferably from that between the defect and the ear, or over the lower jaw or the neck.

The flap must be larger than seems requisite at first, so as to allow for contraction, otherwise there may be displacement of the lips or eyelids.

When there is destruction of the whole thickness of the cheek, the case is much more serious. The destruction may be caused by injuries, such as severe gunshot wounds; by operations for the removal of tumours; or by disease, such as cancrum oris, in which there is extensive destruction of the cheek and the neighbouring parts.

In addition to the defect in the cheek, there is often some closure of the jaws. Cancrum oris, for example, often leads to difficulty in opening the mouth, or even to its complete closure; this may be due to cicatricial contraction of the mucous membrane of the cheek, to fibrous union between the jaws, or to infiltration of the masseter with inflammatory material. The last condition is very serious and may complicate either of the others.

A somewhat similar closure of the jaws may result from operations in which extensive portions of the cheeks—particularly of the mucous surface—have been removed. The remedial procedures here are essentially the same, but they should be carried out at the time of the operation; it is easier to keep the mouth open and prevent contraction while the flaps are uniting than to force the jaws open afterwards. In cases due to disease, on the other hand, it is well not to be in too great a hurry to operate. For example, patients recovering from cancrum oris remain very anæmic for a long time, and the vitality of their tissues is greatly diminished; if an operation is performed too soon, the flaps may unite badly or slough altogether.

Hence the treatment of these cases depends rather upon the closure of the jaws than upon the loss of the soft tissues. The latter is fairly easily repaired, but that is of little advantage unless the fixation of the jaws is also overcome.

All sorts of conditions may be met with, but we may classify them broadly into four chief types: (1) A gap in the cheek without closure of the jaws; (2) a similar condition with plenty of skin, but closure of the jaws; (3) a large defect with no sound skin, and with complete closure of the jaws; (4) extensive and irremediable closure of the jaws.

1. *A small gap in the cheek without closure of the jaws.*—Here two flaps are required for the closure of the opening, a deep one with its cutaneous surface looking inwards towards the mouth and taking the place of the mucous membrane, and a superficial one with its raw surface applied to that of the deeper flap and its skin surface looking outwards (see Fig. 228). The edges of the opening are pared so as to leave a broad raw surface for the attachment of the flaps, the side of the opening towards the ear being however left unpared for a time. A flap, with its base near the defect and somewhat larger than is necessary to cover it, is dissected up, as much subcutaneous fat being taken as can be done without damaging the facial nerve. A good plan is to take a pattern

of the opening, lay it on the skin and make the incision a quarter of an inch outside it, so as to allow for shrinking. This flap is turned over so that the skin surface looks into the mouth, and its edges are stitched to the mucous membrane with interrupted sutures (see Fig. 228, *B*). It is usually obtained from the skin over the masseter muscle.

A second flap is made and so fashioned that its pedicle can be twisted sufficiently to allow its raw surface to be applied to the raw surface of the deeper flaps without the circulation being obstructed. This is usually done by carrying a curved incision from the front and lower edge of the opening downwards and backwards under the jaw (see

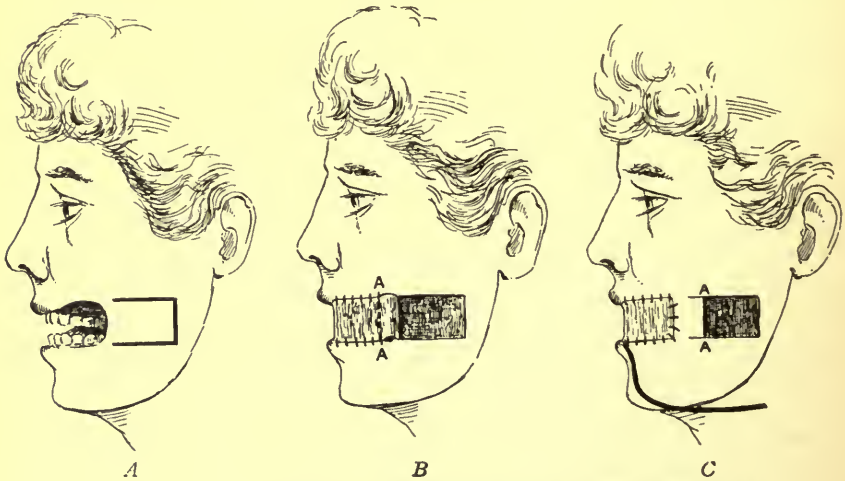


FIG. 228.—PLASTIC OPERATION ON THE MOUTH WHEN THERE IS NO ANCHYLOSIS OF THE JAWS. In *A* the edges of the defect have been pared, and the flap over the masseter is marked out. In *B* this flap has been reflected and sutured into the gap with its cutaneous surface looking towards the buccal cavity. In *C* the flap, after it has united to the margins of the gap, is divided along the line AA, and a small part of its base turned back into place. The remaining raw surface can be covered by skin-grafts, or by undermining the edges. The thick black line passing below the chin is the outline of the skin-flap that is raised and brought over the raw surface of the flap that has been sutured into the gap.

Fig. 228, *C*). The flap thus formed is then slid upwards over the first flap, and sutured to the margins of the defect. The raw surface left after turning forward the deep flap may be closed partly by stitches, after undermining the edges, and partly by skin-grafts. A small portion of its anterior end will be covered subsequently when the base of the flap is divided, and need not therefore be closed at the time. The raw surface left by the displacement of the superficial flap can be closed by sutures. After union of the flaps to each other and to the margin of the opening, the pedicle of the deep flap should be divided opposite the margin of the opening, the part of the base left turned back so as to help to close the raw surface, and the edge stitched to the posterior part of the defect in the cheek which is pared to receive it. When the superficial

flap is applied immediately after the deep one and good union occurs, the base of the flaps may usually be divided after a fortnight. When the operation is done in two stages, three to four weeks should elapse.

This is also a useful operation for gaps left after removal of growths. The chief disadvantage is that hairs grow from the skin which is turned in to replace the mucous membrane, and, although this ceases after a time, it causes the patient great discomfort. Hence a fortnight before operation the surface from which the flap is to be cut should be exposed to X-rays or radium for a sufficient length of time to ensure the fall of the hairs; or if time allows, depilation may be practised (see p. 451).

2. *A small defect with plenty of skin, but closure of the jaws.*—Here the chief trouble is the closure of the jaws. It is best to divide the repara-

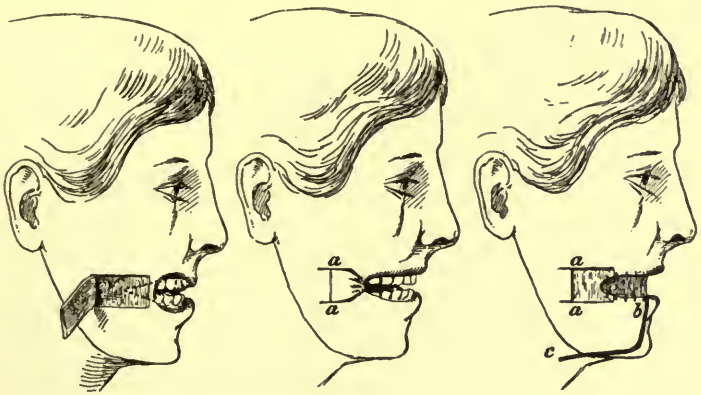


FIG. 229.—GÜSSENBAUER'S PLASTIC OPERATION ON THE MOUTH. In *A* the quadrilateral flap has been raised, and the dotted lines indicate the incisions for splitting the cheek back to the masseter. When this has been done, the flap is turned into the mouth and sutured to the mucous membrane as in *B*. In *C* the flap has been divided along the line *aa*, and turned forwards and sutured to the margins of the gap. The incision *bc* is for the flap that is to be superimposed on the outer raw surface of the one sutured into the defect. The raw surface left by raising the latter is skin-grafted.

tive procedures into two stages, opening the jaws at the first operation and closing the defect three or four weeks later. In the first stage a skin-flap about an inch broad in front and somewhat wider behind (see Fig. 229) is marked out by two incisions extending from the margin of the mouth to the masseteric region. This flap of skin and fat is dissected up and turned back, its base being over the masseter; the cicatricial tissue is then divided from the margin of the mouth to the internal pterygoid muscle, and the mouth forced open. Any cicatricial tissue over the internal pterygoid muscle should be divided and any bands which prevent the opening of the mouth cut across. The skin-flap is turned into the gap thus made and stitched with catgut to the mucous membrane over the inner surface of the pterygoid muscle A good way of keeping the flap applied to the raw surface is to pass a suture

from the cheek just in front of the jaw through the flap and back again at a different spot, so that when tied it brings the deep surface of the flap in contact with the structures underneath. Two or three of these stitches, in addition to marginal sutures, will ensure the satisfactory application of the flap, but care must be taken in inserting them that they do not strangulate the flap. After the expiration of about four weeks, the base of the flap over the masseter is cut across and the free portion turned forward like the lid of a box and stitched into the front part of the defect, so that the epithelial surface is made to look into the mouth and replace the lost mucous membrane. The outer raw surface of this flap is then covered by another flap from the skin over the jaw and neck. Even when there is a hole in the cheek, this plan can be carried out unless the defect is very far back. The deep flap will require depilation (see p. 451).

3. *A large defect with no sound skin and complete closure of the jaws.*— These are most difficult cases, as sufficient material for the deep flap cannot be obtained from the cheek. The flap must therefore be provided either from the neck or from the forehead. The first thing is to divide the cicatricial tissue fixing the jaw, so as to allow the mouth to be opened freely. A box-wood wedge is then inserted between the jaws on the sound side and an attempt made to close the opening by two superimposed flaps. The margins of the defect are first pared (except at the upper part) and a flap is turned down from the forehead (see Fig. 230). If there is cicatricial tissue over the internal pterygoid this must be removed, and the flap should be shaped so as to cover the raw surface left. The flap is taken from the corresponding side of the forehead, the incision being carried along the line of junction of the hair and forehead, and curved backwards around the outer edge of the orbit. It is well to make a pattern of the defect and to cut the flap on the forehead about a quarter of an inch larger than this. The flap of skin and subcutaneous fat is turned down and the eyebrow and upper eyelid are also displaced downwards, the incisions being continued low enough to allow the free edge of the flap to be attached to the lower and posterior margins of the gap, and stitched to the mucous membrane with its cutaneous surface inwards. The prolongation, destined to cover the raw surface over the internal pterygoid, is fixed in position, either by catgut stitches or by sutures running through the whole thickness of the cheek, as described in connection with the preceding operation. It is not necessary to pare the upper edge of the gap at this stage, because no union can occur there and paring it would only entail additional contraction.

A superficial flap is then formed by carrying an incision downwards from the anterior part of the gap into the neck, curving it backwards, and dissecting up a skin-flap. In this way the cut edge of the mucous membrane and the buccinator muscle over it are attached to the deep flap, while the superficial flap is made to slide upwards and forwards,

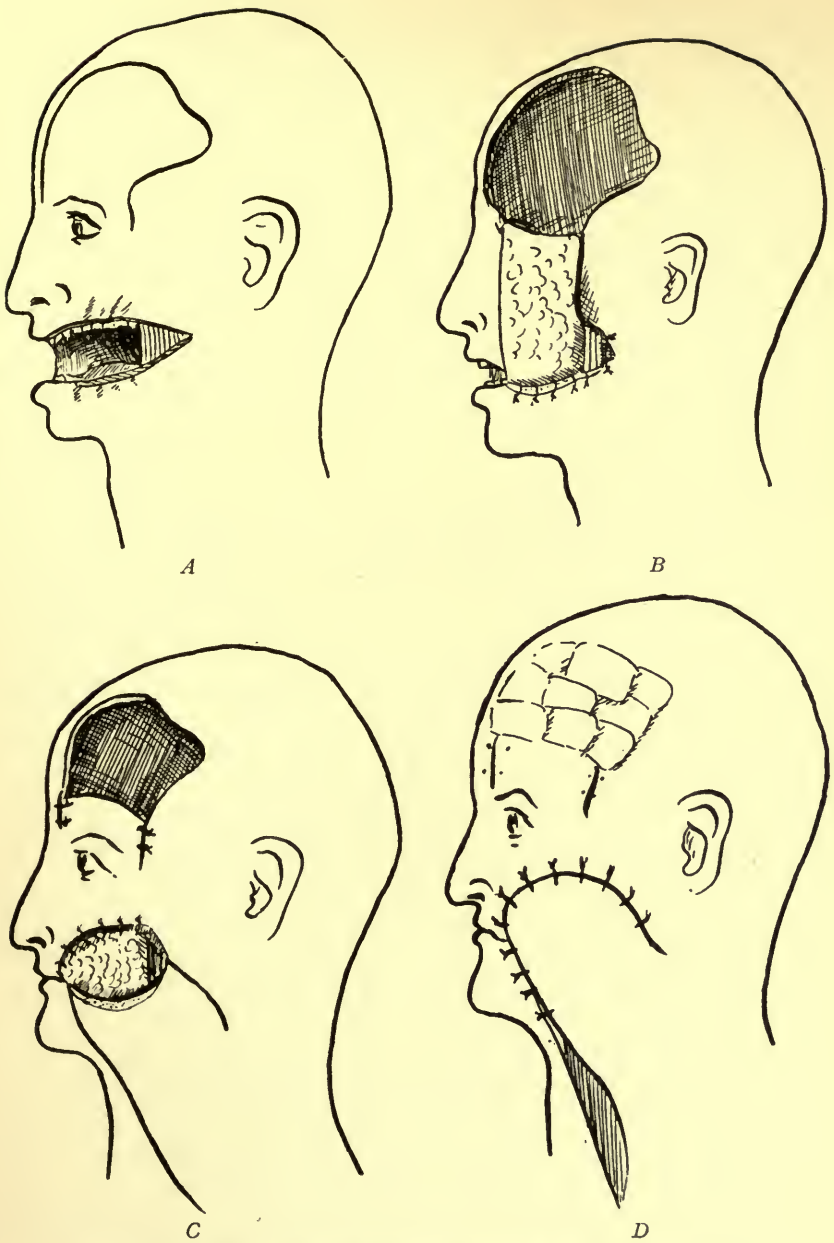


FIG. 230.—PLASTIC OPERATION FOR CONSIDERABLE LOSS OF TISSUE WITH ANCHYLOSIS OF THE JAWS. *A* shows the gap pared, the cicatricial tissue divided, and the forehead flap marked out. *B* shows the forehead flap turned down and its free end sutured into the gap. *C* shows the flap cut free from its base, trimmed up, and its suture completed; it also shows the incisions for the covering flap from the neck. *D* shows the covering flap in place and the skin-grafts applied to the raw surface on the forehead.

and is sutured in front to the edge of the deep flap forming the new cheek and angle of the mouth; it is also stitched to the deep flap along a line corresponding to the upper margin of the defect, and finally to the posterior margin of the opening in the cheek. A small drainage tube should be put between the flaps at the lower part, otherwise suppuration may occur and prevent their adhesion.

If these flaps unite well, the pedicle of the deeper one may be cut through in about a fortnight, opposite the upper margin of the gap, which is now pared; the edge of the flaps are then stitched to this pared edge. The remainder of the forehead flap is turned up and stitched to the sides of the defect on the forehead, the eyebrow being readily replaced after tearing through the new granulation tissue. The raw surface remaining on the forehead is then skin-grafted (see Fig. 230, *D*).

If sufficient skin has been obtained, and there is not too much tension,

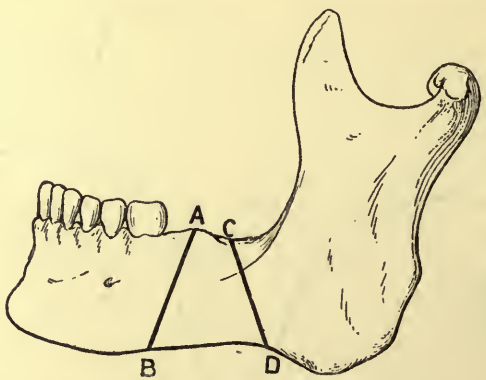


Fig. 231.—Esmarch's Operation for Complete Anchylosis of the Jaw. The lines AB and CD show the incisions; the portion of bone between them is removed.

the result should be good, especially if the prolongation of the deep flap over the inner surface of the horizontal ramus of the jaw has united well. A certain amount of contraction takes place later, but this usually only limits movement to a slight extent.

4. *Extensive and irremedial closure of the jaws.*—This condition is due to destruction of mucous membrane, and consequently cicatricial union between the alveoli; it is usually also associated with infiltration of the masseter and internal pterygoid muscles with inflammatory material which practically converts them into dense fibrous bands.

Under these circumstances, it is useless to attempt to get movement at the temporo-maxillary articulation, and the only plan is to divide the jaw in front of the contraction and make a false joint there, the aperture in the cheek being closed by turning in flaps. The typical mode of procedure is Esmarch's (see Fig. 231), and consists in the removal of a wedge of bone from the horizontal ramus of the jaw, with its base

downwards, the size of the wedge varying with the age of the patient ; in an adult the base should measure about an inch and a quarter in length, in a child, correspondingly less. The wedge should be taken well in front of the cicatrix. An incision is made along the lower border of the jaw, somewhat longer than the intended base of the wedge, the soft parts are separated from the bone in front and behind, and then the jaw is divided with a key-hole or a Gigli's wire saw. If teeth are present, it is usually impossible to open the mouth so as to extract them, and if they get in the way of the saw, they must be cut across, and the fangs picked out afterwards. A thin copper spatula should be passed between the inner side of the jaw and the soft tissues to protect them from injury, and the bone should be cut as cleanly as possible. Any sharp edges left must be removed with bone-pliers or a chisel. The soft tissues on the deep surface of the jaw are then brought over the raw surface of the bone and sutured to the deep fascia in front so as to prevent bony union between the ends ; where this soft tissue is not sufficient or satisfactory a flap may be taken from the deeper part of the masseter or from the subcutaneous tissues. The wound is closed by horse-hair sutures, a small aperture being left for a drainage tube, which may be removed after the first few days.

After-treatment.—The mouth should be washed out several times a day with a non-irritating antiseptic solution such as sanitas, and passive and active movements of the jaw may be commenced about the third day, and must be persisted in for a long time. We must confess that our experience of this procedure after cancrum oris is not altogether satisfactory. In children the loose portion of the jaw is apt to become drawn in, with the result that the line of the teeth is displaced inwards so that the patient cannot bite ; strong fibrous union also often occurs between the two halves and limits their movement. Nevertheless the operation affords the only chance of improving this very distressing deformity.

PLASTIC OPERATIONS UPON THE EYELIDS.

ECTROPION.—The chief deformity of the eyelids which comes under the notice of the general surgeon is ectropion—especially of the lower lid—due to cicatricial contraction. This may result from burns, lupus, syphilis, or necrosis of the orbital margin of the malar bone, with adhesion of the skin to it. The forms of ectropion due to thickening of the conjunctiva and paralysis of the lower lid are generally dealt with by the ophthalmic surgeon.

In these cases no plastic operation should be undertaken until the contraction of the scar has ceased entirely, otherwise the deformity will be reproduced ; and further, the patient should be in a good state of health before operation is attempted. In syphilitic cicatrices, for example,

a considerable time must be allowed to elapse after the ulceration has ceased; unless the patient has completely recovered from the disease, ulceration is very apt to recur in the scar tissue after operation.

The particular operation performed in these cases depends upon the situation and extent of the cicatrix. When this is comparatively small and close to the lower eyelid, the operation introduced by Wharton Jones is quite satisfactory (see Fig. 232). A V-shaped incision is made below the eyelid with its apex downwards, the skin and fat are dissected up, the lower eyelid loosened so that it comes into place, and the two sides of the V stitched together, the result being a Y-shaped scar. This method may also be employed when the ectropion is due to adhesion of a scar to the orbital margin or even to the malar bone. In the latter case, one side of the V will be longer than the other, but when the eyelid is

A *B* *C*

FIG. 232.—OPERATION FOR ECTROPION OF THE LOWER EYELID. The operation shown in *A* is suitable for use when the ectropion is due to an injury. The cicatrix is dissected out so as to leave a wedge-shaped gap which, when sutured, restores the lid to its proper position.

Wharton Jones's operation is shown in the two remaining figures. In *B* the V-shaped incision has been made, and the cicatrix partly dissected up. When the lid is brought into position the incision becomes Y-shaped, as shown in *C*.

pulled up, and the wound sutured so as to make it into a Y-shaped incision, the defect is satisfactorily overcome.

A better method, however, is to turn in a flap of skin, after dividing the cicatrix and raising the eyelid, and, when the cicatrix is limited, this flap can generally be formed from the skin over the malar bone. In the first place, the eyelid is loosened, and with this object an incision is made parallel to and a little below its free margin, and deepened until the orbital fat is exposed. If the cicatrix does not come close up to the margin of the eyelid, the incision should be made below the edge of the orbicularis muscle, which is pushed up along with the eyelid. The lower eyelid is then turned up with the handle of the knife, the incisions being extended on each side in order to remove all tension; this leaves an elliptical gap to be covered in (see Fig. 233, *A*). The next step is to insert interrupted silkworm-gut stitches between the lower ciliary margin and the eyebrow, so as to retain the lid in position. An incision, somewhat longer than the raw surface, is then carried downwards from its outer end,

and at the lower end curved backwards and upwards to a point level with, but posterior to, the commencement of the incision ; in this way a flap is cut with its base just outside the outer canthus and somewhat broader and longer than the gap it is required to fill. This flap is then rotated on its base and stitched into position with horse-hair sutures (see Fig. 233, *B*). As much fat as possible must be raised along with the skin, so as to ensure the vitality of the flap, but the incisions should not be carried so deep as to injure the branches of the facial nerve. The sides of the gap left in the cheek may be brought together after undermining the skin, and a vertical scar will result (see Fig. 233, *C*). The ingenuity of the surgeon must be exercised in these cases, and he must take his flaps from parts where there is no cicatricial tissue.

When the whole cheek is cicatricial, it may not be possible to obtain sound flaps, and in that case the raw surface left after raising the eyelid

FIG. 233.—FLAP OPERATION FOR ECTROPION OF THE LOWER EYELID. The operation is described in the text. The lower lid should be fastened in position by silkworm-gut stitches passing upwards to the eyebrow, but these are not shown in the figure.

should be covered by skin-grafts. Subsequent contraction may occur and partly reproduce the deformity, and in this case the operation should be repeated.

After-treatment.—Wet boric lint is applied until the bleeding has stopped, and then the line of incision is covered with boric acid powder and allowed to scab, or a little salicylic wool is fixed on with collodion. The stitches holding up the lower eyelid should be retained for a few days, and to prevent the accumulation of discharge beneath the eyelids, it is well to syringe gently with warm boric lotion several times a day.

In some cases the after-treatment is complicated by conjunctivitis and ulceration of the cornea as the result of the exposure of the eye, and the purulent discharge escaping on to the line of the incision may interfere with the union of the flap. It is therefore important to improve this condition as much as possible before performing the plastic operation, but as it depends on the exposure of the cornea, it does not usually get well until an operation has been performed successfully.

PLASTIC OPERATIONS UPON THE NOSE.

Apart from the lateral deviations of the nose which have been already described in connection with fractures of the nasal bones, deformities may occur from injury or disease. We may classify these under the following headings.

SINKING-IN OF THE BRIDGE.—This common and very important deformity may result from badly treated fractures or from necrosis after fracture; but it is most commonly due to syphilis, either from necrosis of the nasal bones in adults or from imperfect development of these bones in congenital syphilis. When the nasal bones have been lost or depressed at an early period of life a typical deformity is produced. In place of the prominent bridge there is a depression, and from the lower end of this depression the cartilaginous portion of the nose projects forwards. As a consequence of the contraction during healing, a sort of pivot movement occurs, so that the tip of the nose comes to be much higher than normal and the nostrils look forwards instead of downwards; the result is very unsightly.

LOSS OF THE CARTILAGINOUS PORTION.—The cartilaginous portion of the nose may be lost, while the bony structures and the skin over them are healthy. Such deformities are caused by wounds, such as sword-cuts, or disease, such as lupus or syphilis. More rarely the deformity may be produced by the surgeon in removing malignant disease of the tip of the nose.

SMALL PARTIAL LOSSES.—Smaller partial deformities from injury or local disease, such as the loss of the tip of the nose, or of a portion of one ala, are frequently seen. The loss of the tip of the nose, is not uncommon as the result of gangrene after debilitating diseases, such as typhoid fever or cholera.

TOTAL DESTRUCTION OF THE NOSE.—This is usually the result of syphilis, most frequently of the congenital variety. In place of the nose there is merely a patch of cicatricial tissue, with one or two oval openings in it; when the destruction extends to the septum there is only one rounded opening, when this remains intact there are two. The extent of the defect varies in different cases; it is frequently not quite so complete as that above mentioned.

Treatment.—Of loss of the Bridge of the Nose.—Here there are two deformities to deal with—namely, the sinking-in of the bridge of the nose, and the tilting forward of the aperture of the nostrils. The amount of tilting varies in different cases and may be comparatively slight when it follows an injury in adults; in other cases it is very marked.

Injection of Paraffin.—When there is not much tilting of the tip, an attempt may be made to raise the bridge of the nose by the injection

of paraffin. Formerly, liquefied paraffin with a low melting-point was employed, but this method has so many disadvantages that it has been practically abandoned. Recently, however, the plan of injecting solid paraffin has been introduced, and this has yielded results which are much superior to those formerly obtained. The instrument used is shown in Fig. 234; it possesses a barrel into which a candle of solid paraffin is inserted. To one end of this barrel a hollow needle is connected, through which the paraffin can be forced in the form of a thin thread; the mechanism for this consists of a piston worked by a lever which acts at a great mechanical advantage. The needle is inserted at the lowest point of the depression, and by repeatedly working the lever a thread of solid paraffin is forced out, the needle being withdrawn when sufficient has been introduced. The nose is then moulded into shape by pressure on the skin outside and the puncture sealed. This method bids fair to

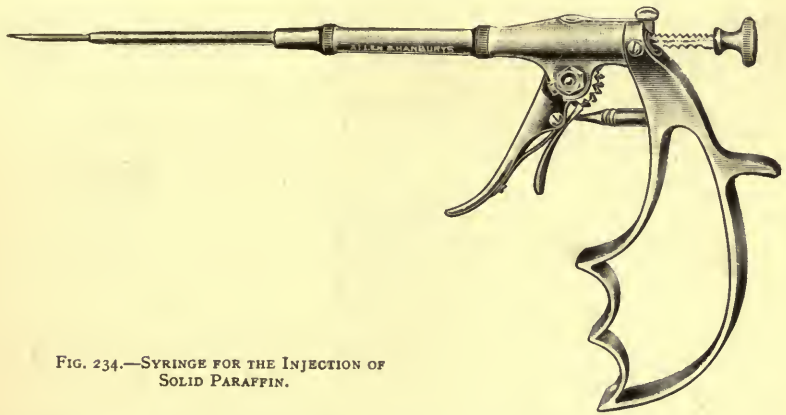


FIG. 234.—SYRINGE FOR THE INJECTION OF SOLID PARAFFIN.

displace all others in cases in which there is no marked tilting forwards of the nares, but operation is necessary when there is marked displacement of the tip.

Operative methods.—A vertical incision is made from the root of the nose downwards and is continued on to the cartilage for about a quarter of an inch. The soft tissues are divided down to the remains of the nasal bones and cartilage. Transverse incisions are also carried across both ends of this vertical incision, and two lateral flaps are thus formed exposing the remains of the nasal spine and the upper part of the cartilage; these are raised along with any periosteum or fragments of the nasal bones that may be present. The cartilaginous portion of the nose is next separated from its junction with the remains of the bony portion by a transverse incision, which passes into the nasal cavity and which must also be carried through the cartilaginous septum sufficiently far to enable the tip of the nose to be pulled down into its normal position.

A bony bridge to the nose is then manufactured in the following manner: An incision, starting about half an inch above the root of the nose and about an eighth of an inch to one side of the middle line, is carried vertically upwards to the margin of the hair, and made to divide the tissues down to the bone. A similar incision is carried up parallel to the first, an eighth of an inch on the other side of the median line, and the upper ends of these incisions are connected by a transverse cut (see Fig. 235, A). In this way a flap is marked out a quarter of an inch broad with its base at the root of the nose. A chisel, about as wide as the flap, is introduced along each lateral incision and a portion of the external

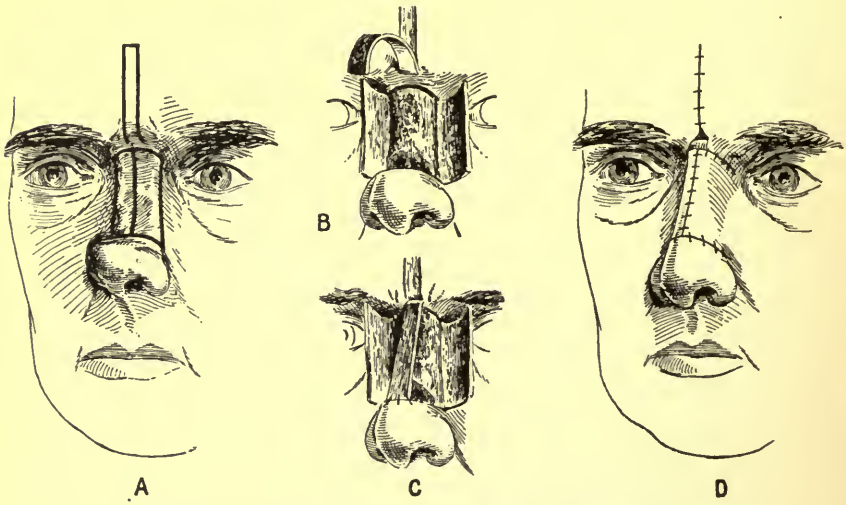


FIG. 235.—RESTORATION OF THE BRIDGE OF THE NOSE. The details of the operation are fully described in the text. A shows the lines of incision for the various flaps. In B the flaps have been reflected and the tip of the nose freed and brought into position. In C the reflected flap from the forehead is sutured in position, while in D the lateral flaps have been brought together over the reflected forehead flap. The small triangular gap left at the root of the nose is afterwards filled by the divided pedicle of the forehead flap, which is trimmed into shape and turned up again.

table is chiselled through; the chisel is then introduced into the upper transverse incision, and is held at a very acute angle with the skull so that the superficial portion of the external table of the frontal bone can be chipped off along with the flap (see Fig. 235, B). At the lower end of the flap, the bone is broken across and the flap turned down as a long, narrow strip which has on its upper surface a thin layer of the frontal bone and, on its under surface, skin from the frontal region. This strip should be long enough to enable its free end when turned down to reach the cartilaginous portion of the nose when the latter is pushed into its proper position. It may be necessary to prolong the lateral incisions a little downwards to enable this to be done without tension, but a sufficiently broad pedicle must be left for the proper nutrition of

the flap. The end of the flap is then stitched with catgut to the freshened end of the cartilaginous portion of the gap (see Fig. 235, C), so that its cutaneous or deep surface covers the aperture into the nasal cavity between the bony and the cartilaginous portions. Above this gap the skin should be carefully stripped off the under surface of the flap, which is thus made raw and can become adherent to the tissues of the bridge. At the root of the nose there is a redundance of skin from the folding of the pedicle, which will be divided subsequently and turned upwards. The lateral flaps are finally undermined and united over the raw surface of the reflected flap (see Fig. 235, D). The upper transverse incisions should be curved downwards and outwards ; this allows a certain amount of sliding of the flaps downwards so that they can cover the opening between the tip of the nose and the bridge. The incision in the forehead is readily stitched up and leaves a hardly perceptible linear scar. At the end of three weeks the base of the reflected flap is divided and the little portion left above is trimmed into a triangular shape and fitted into the lower part of the vertical incision on the forehead.

The result is that the position of the nostrils is corrected and a bony bridge is formed ; but the latter tends to sink downwards during healing, and as a rule will not be high enough. After healing has occurred, we have, however, been able to heighten the bridge to the required extent by turning aside the skin-flaps again and introducing a piece of bone removed from the patient's tibia large enough to raise the bridge to its proper level. This cannot be done at the first operation if there is a free communication with the nasal cavity, on account of the risk of sepsis ; if care be taken not to reopen the nasal cavity at the second operation, however, the pieces of bone will unite and give a satisfactory result. In one case in which the bridge was still not high enough to please the patient we turned aside the flaps and put in some fresh splinters of bone about eighteen months later, with the result that the patient was ultimately completely satisfied. At the present time these subsequant operations would be replaced by the introduction of solid paraffin.

Another method is Langenbeck's. In it a convex incision is made across the nose over the line of junction of the cartilaginous and bony portions, and the tip is liberated, and pulled down in the manner described above. The crescentic defect left is filled by a flap of similar shape turned down from the forehead, taking up the periosteum and having its skin-surface inwards. After union has occurred, the base of this flap is divided and the skin over the nose and the adjacent part of the cheek on each side is brought over it. A similar flap is made by König, but this includes a thin layer of bone. These operations, however, are more concerned with the repair of the opening left after the liberation of the tip of the nose than with the restoration of the bridge ; in bad cases it may be well to commence with this operation and, when the tip has been

fixed in its new position, to form a bridge in the manner described above or by the injection of solid paraffin.

When the tip of the nose alone has been destroyed, the operation introduced by Syme (see Fig. 235) may be useful. The edges of the gap are pared, and a flap of appropriate shape is cut from each cheek and brought inwards so that the adjacent edges meet in the middle line and are sutured together; the outer and lower edges of the flaps are united to the pared edges of the defect. This leaves a raw surface on either side of the nose, which can be covered with skin-grafts.

When the cartilaginous portion is completely lost, the Indian method (see p. 511) may be employed; it was introduced mainly for these cases.

Partial losses of the ala or tip of the nose must be repaired by flaps from the cheek; it is seldom necessary to take them from the

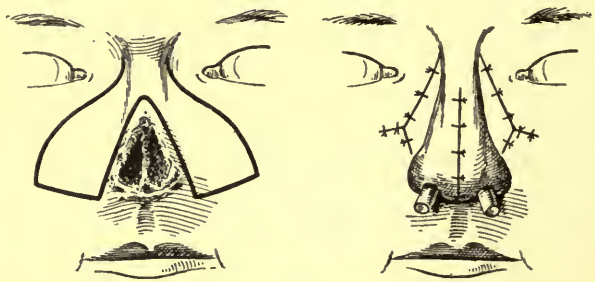


FIG. 236.—SYME'S OPERATION FOR RESTORATION OF THE SOFT PARTS OF THE NOSE. *A*. The gap is pared so as to be of a triangular form, and the flap is marked out on the cheek. *B*. The V-shaped edges of the flap are sutured together in the middle line, and the remainder of the flap is fastened to the raw surface. The surface from which the flap is raised is filled up partly by undermining, and partly by skin-grafts.

forehead. It is impossible to give details of these operations because the defects vary so much in character. In most cases curved incisions should be used.

Loss of the whole or greater part of the nose.—The methods of forming a new nose are very unsatisfactory, as the organ shrinks and ultimately forms an unsightly mass on the face. Indeed, in most cases the patient will be much better off with an artificial nose suitably tinted and held in position by spectacles.

In India, however, the loss of the nose is generally regarded as a social stigma, its removal being a common punishment for infidelity, and hence the surgeon is often called on to restore it—the operation, even if comparatively unsatisfactory from a cosmetic point of view, reinstating the woman in her social position. We shall therefore describe these operations, although they are not to be recommended under ordinary circumstances.

Two operations may be employed: in the one, the skin to form the new nose is obtained from the forehead—the Indian method; in the other, it is obtained from the arm—the Italian or Tagliacotian method; neither gives a really satisfactory result. It is possible that a better result might be obtained in the Indian method if the flaps were provided with a thin layer of bone chipped off from the frontal bone, instead of only containing periosteum.

The defect in the nose is prepared for the reception of the forehead flap. Instead of paring the actual edges of the gap, a double flap may be made by carrying the incision about a quarter of an inch outside its margin and turning in small flaps with

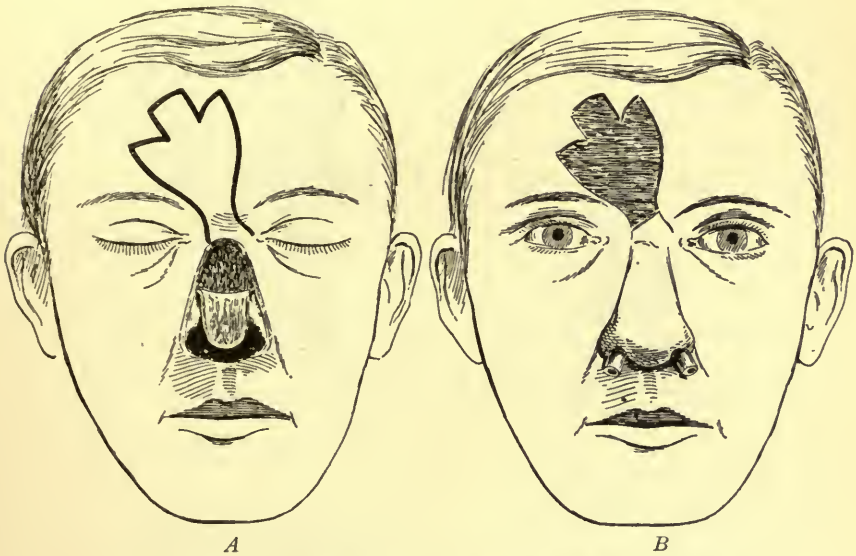


FIG. 237.—THE INDIAN METHOD OF RHINOPLASTY. In the figure the flap on the forehead is shaped so as to form two nasal apertures when in position (*B*). In practice it is better to cut it with a depression in place of the projection destined to be the columella; this gives a single large nasal aperture, and is much better.

their skin surface directed towards the nasal cavity and the raw surface outwards on which the forehead flap is super-imposed. When skin is present over the remains of the nasal bones, an extra long flap may with advantage be taken above, and turned down so as to fill up a considerable part of the gap. The outer surface of these flaps adheres to the under surface of the superficial flap and diminishes the amount of subsequent contraction.

The Indian method.—Before the operation, a model of suitable size and shape is cut from a piece of thin gutta-percha tissue which is flattened out, laid on the forehead and used as a guide for the formation of the flap; the incision should run about a quarter of an inch outside the pattern, so as to allow for shrinking. The flap should be made somewhat to one side of the centre of the forehead, its base being to the left of the root of the nose. By placing the flap somewhat obliquely, there is less twisting of the base in adjusting it in position and consequently less risk of

sloughing. If it be cut too obliquely, however, the eyebrow and upper eyelid may be drawn up by the contraction of the scar. The incision on the side on which the base of the flap lies should be prolonged farther down towards the root of the nose than that on the other. The flap is supplied by one, or if possible both, of the frontal arteries (see Fig. 237). The incision is carried down to the bone and the periosteum is then stripped up; it may be well, however, to turn up a thin layer of bone along with the periosteum by means of a fine chisel, so as to have a certain amount of bone to support the flap.

The forehead flap may sometimes be planned so as to provide a new columella, but, as a rule, it is better not to do so because this is apt to be too broad and, as the new nose shrinks, there will be insufficient breathing space. A new columella can be formed subsequently, if desired, by turning up the central portion of the upper lip (see Fig. 238).

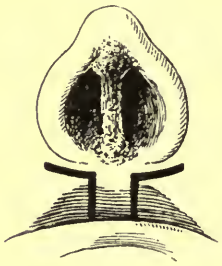


FIG. 238.—FORMATION OF A NEW COLUMELLA IN RHINOPLASTY. The central portion of the lip, isolated by means of the incisions shown above, is turned up to make the columella and sutured in place. The lip is then brought together and sutured below it in the middle line.

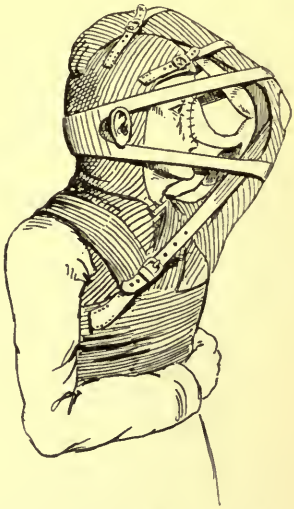


FIG. 239.—THE ITALIAN OR TAGLIACOTIAN METHOD OF RHINOPLASTY. The drawing shows semi-diagrammatically the kind of apparatus required to keep the arm in position during the union of the flap.

After the forehead flap has been raised it is rotated into position and secured to the raw edges of the defect with fine horsehair sutures. The tip of the nose may be supported by thrusting hare-lip pins across the nasal cavity from side to side, so as to push up the sides of the nose and make it stand forward; the pins are pushed in up to the head on one side, and then, by winding silk around the pin on the other side, or by fixing pieces of cork on it, and pushing them up against the flap, the alæ will be retained in position. Usually two pins suffice; the method is similar to that described for fracture of the nasal bones (see Fig. 205). It is well to plug the opening of the nostrils with strips of iodoform gauze, a drainage tube or a portion of a large catheter being introduced through the centre of the plug to maintain the airway.

As soon as the oozing has stopped, the raw surface on the forehead, from which the flap has been raised, may be grafted by Thiersch's method; any angles of the

wound which can be brought together by stitches should be undermined and sutured, so as to diminish the area requiring grafting.

The wound is not touched for four or five days, when the stitches may be taken out. The plug of gauze should be changed once or twice a day. The pins may be left *in situ* for three or four weeks. At the end of about four weeks, the pedicle of the flap should be divided at the root of the nose and the parts there pared and sutured: the rest of the pedicle is then turned upwards and replaced in the wound on the forehead. Subsequently some small plastic operations may be required to improve the shape of the nose thus formed or to cut away redundant tissue.

If the columella has not been fashioned with the forehead flap, it can be formed afterwards from the upper lip. A narrow strip of the middle line of the upper lip is isolated by vertical incisions beginning just below the aperture of the nares on each side and carried downwards through the entire thickness of the lip to the free margins. This small portion is turned upwards, the frenum being divided, and its free end is refreshed and stitched to the tip of the nose. The new columella will have its cutaneous surface looking backwards while the mucous surface is external. Nasal plugs are introduced on each side in order to keep the parts in position, and the divided upper lip is sutured in the middle line after short lateral cuts have been made on each side beneath the nose, so as to allow the upper part of the lip to slide in below the new columella (see Fig. 238).

The Tagliacotian method.—This plan, although successful in some cases, is unsatisfactory on the whole, and entails great inconvenience and the use of special apparatus. In it the arm is fixed to the forehead so that the elbow comes opposite the nose, and a large flap is then fashioned from the skin over the biceps and made to cover the defect in the nose. The arm must be kept in this position for about four weeks before the pedicle of the flap can be divided. The position, however, is so irksome that few patients will submit to it, while the new nose is even more apt to shrink than the one formed by a flap from the forehead; the only advantage of the method is the avoidance of extra scarring about the face or forehead. Fig. 239 will illustrate sufficiently the position of the arm and the mode of attachment of the flap.

CHAPTER XLII.

HARE-LIP AND CLEFT PALATE.

It is best to consider these two deformities together, as they are commonly associated, and the treatment of the one condition is often preliminary to that of the other.

HARE-LIP.

Hare-lip is a gap or cleft in the upper lip of congenital origin, resulting from failure in the union of its component parts. It is usually unilateral, and generally on the left side, although it may be on the right. It is not uncommonly bilateral (double hare-lip), and it may or may not be accompanied by cleft palate.

The defect in the lip varies in extent from a mere notch in the red line to a wide cleft extending upwards into the nostril. In the latter case there is generally also a cleft of the alveolar margin and of the palate, and in addition the nostril on the affected side is unduly widened. When the cleft only affects the red line, the rest of the lip may be normal, but even then the nostril on that side is often broader than on the other. When the gap is wide and there is an extensive cleft in the palate, the edge of the cleft in the lip on one or both sides is bound down to the alveolus by a broad fold of mucous membrane.

When the cleft is bilateral, the intervening portion of the lip, which is called the prolabium, lies over the pre-maxillary bone ; this is of variable size, and there is a gap between it and the superior maxilla on both sides. The central portion of the lip may be quite small, and the columella rudimentary, so that the tip of the nose is bound down to this central portion and the nose itself is flattened. The pre-maxillary bone is usually tilted forwards and attached to the septum nasi ; in bad cases, in which the prolabium is quite small, it may be only connected with the columna nasi.

TREATMENT.—The first question which arises in the treatment

of hare-lip, whether alone or in conjunction with cleft palate, is the age at which the operation should be performed. It may be said that the sooner the operation for hare-lip is performed the better is the result both from the point of view of appearance and also of the development of the parts and the general nutrition of the child. Two points, however, must be taken into consideration in determining this question, namely, the strength of the child and its ability to stand the necessary loss of blood, and the presence of any septic condition about the mouth and nose, such as coryza, snuffles, or aphthous stomatitis. If the child is feeble, the loss of blood at the operation may be sufficient to cause a fatal result, and, apart from that, there is considerable liability to septic infection. As regards the second point, any septic condition of the mouth or nose is particularly prone to lead to septic inflammation of the wound, and thus endanger union. In the absence of these unfavourable conditions primary union almost invariably occurs, and therefore the age at which uncomplicated hare-lip may be operated upon depends, to a large extent, on the size of the gap. In simple cases the operation may be done a few weeks or even a few days after birth. If, on the other hand, the cleft is wide, extends up into the nostril, and entails a long operation and a free separation of the soft parts from the bone with considerable loss of blood, it may be advisable to delay the operation for some weeks, unless the child is losing ground from inability to take food properly. In severe forms, in which the cleft is wide and the whole depth of the lip and the palate are involved, there is considerable difficulty in feeding the child. In such cases, therefore, the sooner the operation is done the better, provided that the child is not emaciated. If it is, careful spoon-feeding must be persisted in until the general health is so much improved that the operation can be performed with a reasonable chance of success. The milk must be placed in the mouth in small quantities slowly and intermittently, and sufficient time allowed for the child to swallow one spoonful before the next is given. In these cases—and especially when there is a double hare-lip, which is always accompanied by cleft palate—it is of the greatest importance to unite the lip as soon as possible in order to remedy the severe deformity and thereby render the proper feeding of the child possible.

When cleft palate complicates hare-lip, the question has to be considered whether the operations for uniting the hare-lip and the cleft palate should be done at the same time or separately. It is a generally accepted rule, and one with which we agree, that the hare-lip, at any rate, should be closed as soon as possible, whether the operation on the palate be deferred to a later period or not. This is advisable, because the development of the parts improves directly the lip is united, the cleft in the palate—and especially in the alveolus—tends to diminish, and the nutrition of the child becomes better.

It is advised by some that the operation on the palate should precede

that on the lip and that the former should be done at quite an early age, from a few days upwards. The principal reason for the first of these recommendations is that the gap in the lip gives the surgeon freer access, and this is no doubt a point of considerable importance when the small size of the parts is borne in mind. This question is discussed in connection with the subject of cleft palate.

The chief essential in operating on hare-lip is to repair the cleft so that no notch is left after operation, and so that the red line of the lip is united accurately. In performing the operation two of the points already referred to must be especially borne in mind, namely, that the edges of the cleft are bound down to the gum, and that the nostril on the affected side is broader than on the other. We shall consider the following cases separately: Those in which the cleft does not extend into the nostril; those in which the cleft does extend into the nostril; those in which this extension into the nostril is

FIG. 240.—OPERATION FOR SIMPLE HARE-LIP WITHOUT WIDENING OF THE NOSTRIL. When the cleft is pared, as shown in *A*, and the edges are brought together, the slight downward projection seen in *B* occurs at the free margin of the lip.

associated with cleft of the alveolus and, perhaps, of the palate as well; and double hare-lip.

1. **Of an Incomplete Cleft in the lip.**—The closure of the gap in these cases is usually a comparatively simple matter. The attachment of the lip to the alveolus must be freed, if present, and the gap pared so as to leave a concave surface on each side. If the nostril is not wider than normal and the structures above the apex of the cleft are of natural thickness, the knife is entered just above the apex of the cleft and the curved incision shown in Fig. 240, *A*, is made through the whole thickness of the lip on each side. When the two cut surfaces are brought together in the middle line, there will be a projection downwards of the red line (see Fig. 240, *B*), which is afterwards obliterated by the contraction of the vertical scar. The stitches are inserted so as to bring the red line on the two sides into accurate apposition. The sutures in the mucous membrane should be of fine catgut, but at the red line and at the centre of the vertical wound it is better to use silkworm-gut going through nearly the whole thickness of the lip. One or two intermediate stitches of fine horse-hair will be needed to complete the union.

In many cases the nostril may be unduly broad, although the cleft does not extend into it, and it will be necessary to remedy this also. Under these circumstances, the concave incision should be carried vertically upwards from the apex of the cleft into the nostril on each side and the ala freely detached from the bone. The narrow vertical strip of the whole thickness of the lip included between the two vertical incisions

FIG. 241.—OPERATION FOR SIMPLE HARE-LIP WITH WIDENING OF THE NOSTRIL. The removal of the portion between the incisions shown in *A* allows the width of the nostril to be reduced.

is then removed, so that the nostril is restored to its proper shape when the resulting wound is sutured (see Fig. 241). It is very important to insert one stitch within the nostril at the upper end of the incision.

2. Of a Complete Cleft of the lip.—Many operations are employed for complete clefts of the lip; we shall only describe those that we usually employ.

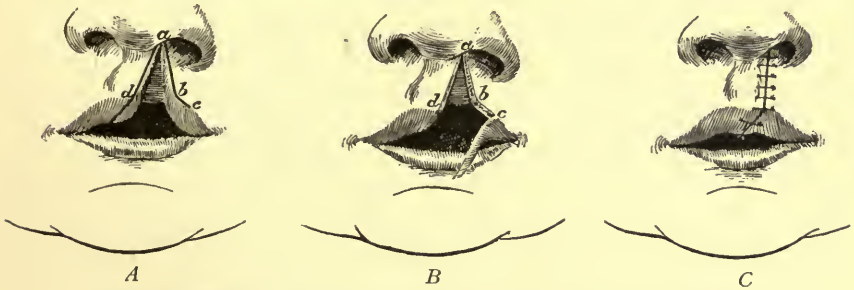


FIG. 242.—MIRAULT'S OPERATION FOR HARE-LIP. The steps of the operation are described in the text. Undue widening of the nostril is corrected by carrying the incision well up into it, as shown in the figure.

When there is a complete cleft of the lip without deformity of the alveolus, the first step in the operation is to detach the margins of the cleft from the gum on both sides; this must be continued upwards until the upper border of the lip on the affected side is separated from the bony nostril. The ala of the nose on the same side is then widely detached and the cheek sufficiently freed to allow the margins of the cleft to be approximated without any tension. The edges of the cleft are then pared in the following manner: A narrow, sharp-bladed knife

is entered just beyond the edge on the median side of the cleft and carried directly downwards through the thickness of the lip parallel to the edge of the cleft; when it approaches the red line of the lip, it turns obliquely outwards through the free edge of the lip (see Fig. 242, *A*). This strip of mucous membrane, which is angular in shape (the angle *d* being a little above the red line), is completely detached. The outer side of the cleft, which is usually the shorter, is pared in a similar manner at the upper part, but just before the red line is reached (opposite *d*), the incision is carried outwards parallel to the mucous membrane into the substance of the lip; this flap is not detached, but is turned down and leaves an angular raw surface *abc* (see Fig. 242, *B*). A silkworm-gut stitch is now put in from the point *d* to the point *c*, and tied. A similar stitch is put in above to unite the margins at the nostril and bring the ala of the nose into position. A third deep suture is inserted between these two, and the rest of the wound is united by horse-hair stitches. The red line of the lip in the flap on the outer side of the cleft must now be fitted accurately to the red line on the mesial side of the cleft, and the rest of the mucous surface of the lip accurately brought together, any excess at the free extremity being removed. Fine catgut stitches are used for the mucous surface. If the incision parallel to the red line on the smaller side of the cleft is carried far enough out, no angular deformity will be left, and the contraction during healing will not produce any marked notch, although it may draw up the lip slightly. If the nostril is unduly small after the stitches are inserted, it is well to put a small drainage tube into it, so as to leave breathing space. If the drainage tube becomes blocked, the nurse should be instructed to clean it, or to evert the lower lip and insert the finger between the jaws so that the child may breathe through the mouth. The nostril will become patent in time.

In ordinary cases no dressing need be applied, but if there is much tension on the sutures the method of supporting the wound introduced by Lord Lister is of value. A double thickness of gauze is cut to the shape of a bat's wing, one broad surface lying over each cheek and the narrow intervening portion passing across the lip. One end of this dressing is fastened to the cheek with collodion, and, when it is dry, the two cheeks are pushed forward and held in position, while the other end is fixed to the other cheek with collodion; in this way tension is taken off the line of incision.

In bad cases with much separation of the cleft, some contraction of the lip may occur opposite the line of union, even after this operation. With the view of avoiding this, flaps may be cut on each side extending as far down as one-eighth of an inch above the red line and turned down, instead of removing the strip of skin on the mesial side of the cleft; this leaves the red line of the lip actually projecting downwards when the sutures are inserted (see Fig. 243). Should the subsequent contraction fail to

obliterate this small protuberance completely, it can be cut away at a later period.

After-treatment.—The horse-hair and catgut sutures may be taken out in two or three days, the deeper silkworm-gut stitches being left in for a week. The child should be fed at first with a spoon, great care being taken to prevent injury to the line of incision; the point of the spoon

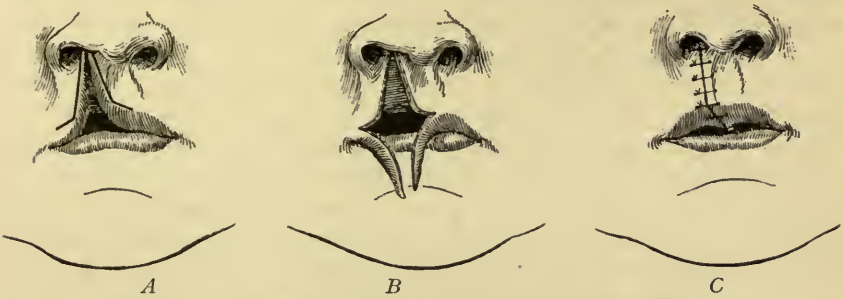


FIG. 243.—MODIFIED MIRAULT'S OPERATION. The ends of the flaps shown in *B* are pared away, after the edges of the cleft have been united, so as merely to leave the slight projection shown in *C*.

should be introduced on the normal side of the lip. After the wound has healed, the child may be fed with the bottle.

When there is a small V-shaped notch left at the free margin of the lip, it may be remedied by making an incision on each side at the junction of the mucous membrane and the skin below; these incisions are carried

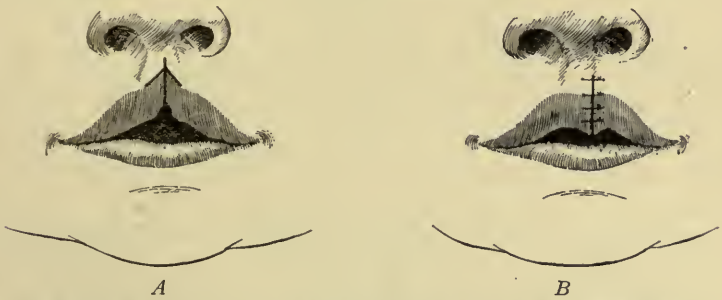


FIG. 244.—NÉLATON'S OPERATION. *A* shows the method of cutting the small flaps which are turned down and pared into shape so as to give rise to the slight projection seen in *B*.

upwards till they meet above the apex of the notch, from which a short vertical incision is made downwards to the point of junction of the flaps. The lower ends of the incisions should not divide the mucous membrane. Two flaps are thus formed and are turned downwards. The refreshed edges of the notch are united by sutures and the flaps adjusted so as to restore the free border of the lip, any excess of mucous membrane being cut away. The operation is very similar to that described above for complete hare-lip.

3. Of Unilateral Hare-lip with a cleft of the alveolus.—Here the deformity is usually greater, and the additional points requiring attention are the projection forwards of the edge of the alveolus on the mesial side of the cleft and the undue breadth of the nostril. The projection forwards of the margin of the alveolus, if only slight, gradually disappears as the result of the pressure of the repaired lip, but when it is marked, the operation cannot be performed satisfactorily until this projection has been diminished to some extent. In these cases the alveolus must be forced into position after the lip has been detached from the bone as in the preceding operations. This is best done by seizing the projecting bone above the roots of the teeth with a pair of strong forceps whose blades are covered with india-rubber tubing and forcibly bending it back into position; it is generally necessary to fracture the alveolus in order to prevent it springing forward again when the forceps are removed. When the projection is very marked, it may also be advisable to pass a silver wire through the alveolus on each side in order to keep the prominent portion back; before this is done, the opposed surfaces of the alveolar cleft should be pared.

The second point which requires attention is the broadening of the nostril. The lip on the shorter side of the cleft is usually deficient, not merely in breadth but in length, and, if the ala of the nose is simply detached as in the preceding operations, the nostril will be completely closed when the two sides of the cleft are brought into apposition. Under these circumstances, it is well to carry an incision upwards around the ala before detaching it, so as to separate it from the upper lip in the manner described for repair of the upper lip (see p. 494), and then to remove a small crescentic portion of the cheek, so that when the edges of the cleft are brought together, the ala is not carried inwards to the same extent (see Fig. 225). In this way the lip can be repaired effectually without narrowing the nostril unduly. This procedure is even more important in cases of double than of single hare-lip. In other respects the operation is carried out on the lines described above.

4. Of Double Hare-lip.—Double hare-lip is usually complete, but if it is not, the incisions for its repair must be carried up into the nostril. The first point for consideration is what shall be done with the pre-maxilla and the prolabium over it. The prolabium must be detached from the bone, but the latter should never be removed if it is possible to save it; if it be taken away, a gap is left, into which the central unsupported portion of the lip falls, and a most unsightly appearance results. In some cases the bone can be readily forced back into position by firm pressure with the thumb after the prolabium has been detached; in other cases it is so intimately connected with the septum that it cannot be forced back until the latter has been divided. This may be done in the following manner: An incision is made in the mouth along the free margin of the septum; the mucous membrane and periosteum are

detached on each side with a fine separator, and the septum is then divided or a V-shaped portion is removed from it (see Fig. 245). If it is merely divided, the anterior part of the septum is pushed a little to one side of the posterior so that it slides alongside the latter, and allows the pre-maxilla to come into position when that bone is forced back. The mucous surface on each side of the pre-maxilla, as well as that on the alveoli, should always be pared, and these raw surfaces should be fastened together by catgut stitches.

FIG. 245.—V-SHAPED INCISION IN THE SEPTUM FOR PROJECTING PRE-MAXILLA. The dotted line on the lip is intended to be upon the septum. The lip should be turned back to show it.

When it is impossible to get the pre-maxilla into position, an incision may be made along its lower edge and the teeth scooped out; a shell of bone and periosteum is left, which will subsequently ossify and support the central part of the lip.

Attention is next directed to the prolabium. In some cases the columella is so short that the prolabium, when pared, is only sufficient to repair this; indeed, it may be necessary to lengthen it by some device such as that shown in Fig. 246, in order to raise the tip of the nose sufficiently. When the columella is long, the prolabium should be pared to a rectangular shape (see Fig. 247, *A*), so as to fit in between the sides of the lip when they are brought towards each other. The lip on each side is then separated from the alveolus in the usual manner, and it may be advisable to carry

FIG. 246.—METHOD OF LENGTHENING THE COLUMELLA IN HARE-LIP OPERATIONS. The columella is divided along the dotted lines shown in *A*, and the tip of the nose is then raised and the columella sutured as shown in *B*.

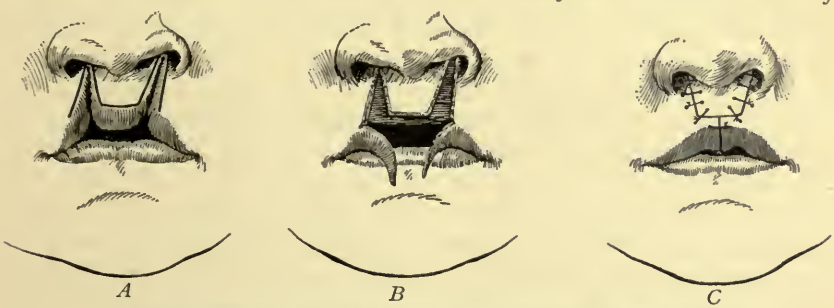


FIG. 247.—OPERATION FOR DOUBLE HARE-LIP. The finished operation gives the usual downward projection of the free margin of the lip in the middle line.

an incision up around each ala and remove a crescentic portion of the skin as already described above (see p. 520), so as to allow the

two sides of the lip to come together without unduly diminishing the orifice of the nares ; the edges of the cleft are then pared (see Fig. 247, *B*). The incisions are carried downwards and outwards into the lip on each side above the red line ; these flaps are then turned down, and no part of them is cut away until the stitches have been put into the vertical portion. The red line, when stitched together, should show a slight downward projection in the middle line ; this disappears as contraction takes place, or, if it does not, it can be pared down later on. In cases in which the lip is very deficient, a notch may remain in the free margin of the lip, and this will require an operation to rectify it at a later period (see p. 519).

COLOBOMA FACIALIS.

In this condition a congenital cleft runs upwards through the lip, and passes external to the ala of the nose as far as the internal angular process of the frontal bone. It is a rare deformity, and may be combined with a cleft of the palate ; it is sometimes bilateral. The operation required for closing the cleft will depend on its extent ; as far as the lip is concerned, it is practically the same as for hare-lip.

CLEFT PALATE.

VARIETIES.—When the palatal processes fail to coalesce, the following conditions may result : Cleft of the soft palate alone. Cleft of both hard and soft palates. Cleft of the alveolar margin without implication of the palate. Besides these, there is sometimes a cleft of the hard palate and the alveolar margin without implication of the soft palate, and very rarely there may be a central aperture either in the soft or the hard palate.

The cleft in the hard palate may be unilateral or bilateral. As a rule the septum is united to one side of the cleft—usually the right—but in bad cases, especially those associated with double hare-lip, the septum lies free between the two sides of the cleft. In most cases of cleft hard palate the roof of the mouth is unduly arched, and in bad cases it runs almost vertically upwards and is narrower than usual, so that the material available for closing the cleft is scanty.

In estimating the ease or difficulty with which the cleft may be closed, the width of the cleft and the amount of muco-periosteum available on each side of it should be taken into consideration, as well as the degree of arching of the palate. A cleft in a low arched palate is often more difficult to close than one of the same width in a patient with a high arch. The most difficult cases of all are wide clefts with a rounded anterior end in a low arched palate ; such clefts are generally incomplete, and do not implicate the alveolar margin.

TREATMENT.—The operation for closing a cleft palate demands more time than that for hare-lip, entails greater loss of blood and more shock, and is altogether a more serious operation, especially for an infant. It is, however, essential that the cleft should be closed before the child learns to talk, otherwise it is almost impossible to correct the peculiar articulation associated with this deformity. While the cleft is present, the air, which normally should be forced altogether through the mouth during the utterance of the consonants, escapes partly through the nose. The peculiar characters of the speech will still continue after operation unless the soft palate can shut off the nasal cavity during speech. Unfortunately it often happens that, in spite of a successful operation the soft palate is too short and rigid to close the naso-pharynx completely. Even when the result of the operation is perfect and when complete closure of the naso-pharynx is obtained, the child must still be carefully taught to use his soft palate and to shut off the nasal cavity during speech, otherwise no real improvement will result. Another, but less probable, explanation of the persistence of a nasal voice after an operation which is apparently successful is that the absence of nasal breathing due to the presence of the cleft palate prevents proper development of the nasal cavities, and thus, when the cleft has been closed, the nasal voice remains because the nasal cavity has not developed properly.

The operation should not be delayed beyond the third year of life, the most favourable period being about two and a half years of age. When the cleft is very wide, and it is necessary to employ some flap method and to close the palate by successive operations, the first of these may be performed before the eruption of the teeth, but no operation should be done during the period of active dentition, otherwise union is apt to fail. Further, the child should be in good health at the time of the operation, and able to stand the necessary loss of blood. It is also a great advantage that it should be old enough to obey its nurse, so that it may not endanger union by crying too much after the operation.

If both the hard and the soft palate are cleft, it is well, if possible, to unite both at the same operation, except when the child is very young and the gap very wide; under those circumstances, the hard palate should be united first. When failure occurs, it is usually at the junction of the hard with the soft palate; failure of union of the hard palate is not very common.

Preliminary Measures.—One of the most important elements of success is the preliminary treatment of the patient. For some time previous to the operation, the feeding should be carefully attended to. As much nourishing food as possible should be given, and, if necessary, iron or other tonics. Young children should be fed with a bottle, the teat of which is fitted with a large palate-shield especially designed for the purpose. Older children should be carefully fed with a spoon. Prior to the operation the teeth, if present, must be seen to and

any carious stumps removed; aphthous or other ulcerations about the mouth should also be appropriately treated. It is not at all uncommon to find in children with cleft palate a chronic pharyngitis accompanied by dryness of the mucous membrane and the secretion of quantities of tenacious mucus. This condition should be treated before the operation is performed, the parts being frequently sponged with boric acid or carbonate of soda lotion (gr. x. ad ℥j.). If coryza is present, the operation should be delayed. Adenoids are common in these patients, and not infrequently they are inflamed. If so, or if they are growing, they should be removed some weeks before the operation on the palate is undertaken. The child should have recovered from the operation, and the wound in the naso-pharynx should be healed before the attempt is made to close the cleft palate. It is not necessary to remove the adenoids in every case of cleft palate; very often the local condition may be improved by the use of chlorate of potash lotion (gr. x. ad ℥j.) applied with a brush, any crusts being removed by forceps.

The Operation.—When performing the operation it is very important to have a good light. The table should be so arranged that the light falls directly into the patient's mouth, and it is well to have the head fully extended, partly because it is thus possible to see and manipulate better, and partly because the blood will then collect in the naso-pharynx, and is not so likely to enter the air passages. The thorax may be raised by suitable pillows, or the patient may be brought to the end of the table so that the head hangs over it. The surgeon may sit at the head of the table and the child's arms and legs should be secured, as he is not always profoundly under the anæsthetic.

The anæsthetic should be chloroform, and is best administered by the open method on the corner of a folded towel. This is better than the usual plan of employing Jünker's nasal tube, for, if the latter be pushed up the nose, it is apt to injure the mucous membrane, and form a focus of future inflammation, while if introduced into the mouth it gets in the way of the operator. Further, chloroform vapour is irritating, and, if blown on the line of incision for some time, it may interfere with union. The best method, therefore, is to get the child fully under the anæsthetic before the operation is commenced, and then to saturate the corner of a towel with chloroform and take advantage of every pause in the operation to maintain the administration. In this way it is comparatively easy to keep the patient under the anæsthetic during the entire operation. The blood in the pharynx must be gently sponged away when necessary.

The assistant's duty is to maintain the gag in position and to sponge for the surgeon; the sponging must be done very carefully so as not to bruise the delicate flaps, but at the same time the throat must be kept clear of blood. The mouth must be held well open with a *gag*, and some self-retaining instrument is the most satisfactory. A very useful one is Whitehead's (see Fig. 248), which is provided with a plate to keep the

tongue out of the way. The objections to this gag are, in the first place, that the tongue-plate is apt to force the tongue back and embarrass the respiration; this can be avoided by careful insertion of the gag, or by dispensing with the tongue-plate altogether. In the second place, the upper half of the gag takes its hold behind the alveolus in the middle line, and may render it difficult to work quite at the anterior part of the cleft. When these difficulties are met with, Mason's gag, or a self-retaining spring gag—such as that shown in Fig. 249, which is prevented from shifting its position by small spikes thrust into the alveolar border—may be used instead. When either of these gags is employed, the assistant must keep the tongue out of the way of the operator.

The *sponges* should be of medium size and are grasped with forceps or special holders. Care must be taken that neither the forceps nor the holder projects beyond the sponge, and that the latter cannot be displaced laterally so as to uncover the end of the instrument which grasps it; otherwise the edges of the palate or the back of the throat may be

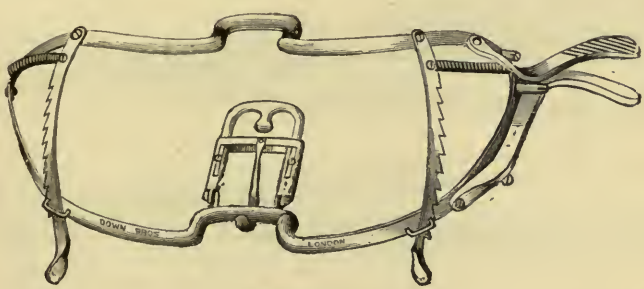


FIG. 248.—WHITEHEAD'S GAG.

lacerated. When sponges are fixed on handles, care must also be taken that the sponge does not become detached—an accident that is rather apt to occur.

The operation most generally applicable to the majority of cases is that introduced by Langenbeck; in a typical moderate-sized cleft of the hard and soft palate, the operation may be conveniently divided into the following four stages: the paring the edges of the cleft; the formation of the muco-periosteal flaps; the passage and tightening of the sutures; and the relief of lateral tension. Advantage is generally taken of the intervals between these stages to arrest hæmorrhage by pressure, to clear the throat of blood, and to administer more anæsthetic.

Paring the edges of the cleft.—This is best done by seizing the extreme tip of the cleft uvula on one side with a pair of special long-handled catch-forceps (see Fig. 250, *A*). The palate is put firmly on the stretch by pressing the forceps backwards and downwards, and a sharp-pointed, long-handled, narrow-bladed palate-knife (see Fig. 251, *A*), held with its back to the forceps, is inserted through the thickness of the soft palate

just external to the edge of the cleft. By cutting steadily towards the apex of the cleft, a strip of mucous membrane, which should be of uniform thickness throughout, is detached from the entire edge. The strip is left attached at the apex, the knife is turned round and carried back, and the paring continued to the tip of the uvula (see Fig. 252). A similar procedure is carried out on the opposite side, and then the strips are completely separated by paring the V-shaped end of the cleft in front. It is important to pare each edge of the cleft in a single piece, so as to ensure that it is thoroughly done; if taken away piece-meal, some part may be overlooked and left unpared, and also the thickness of the pared surface will be very variable. We consider that it is well to commence with the paring of the edges, although some

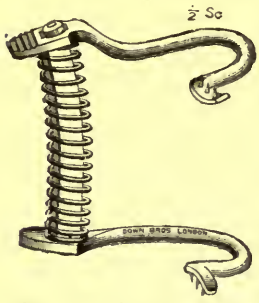


FIG. 249.—LANE'S SELF-RETAINING GAG.

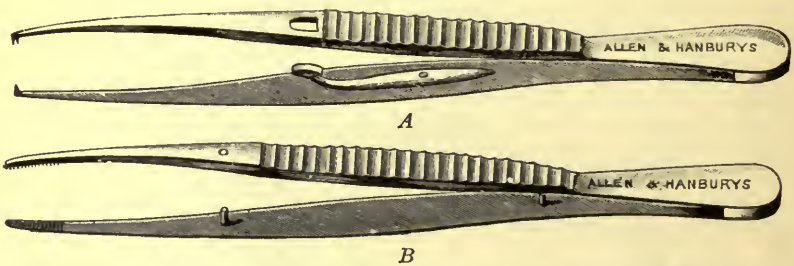


FIG. 250.—FORCEPS FOR STAPHYLORAPHY. *A*, catch-forceps for seizing the uvula when paring the cleft. *B*, forceps for handling the flaps and sutures.

recommend that this should not be done until the flaps have been detached for fear of damaging the pared edges by the sponging necessary to clear the throat. This danger is, however, slight with a skilled

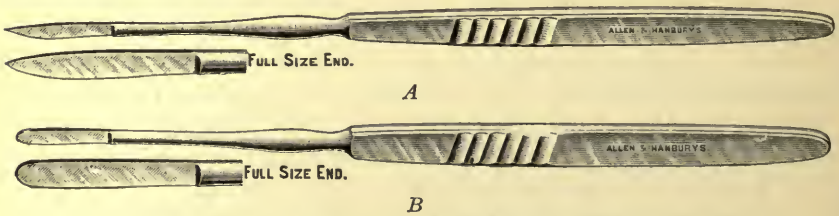


FIG. 251.—STAPHYLORAPHY KNIVES. *A*, the sharp-pointed knife for paring the cleft; *B*, a blunt-pointed one for enlarging the relief incisions, etc.

assistant, and the edges are pared more easily and satisfactorily if done in the manner recommended above. The bleeding at this stage is very slight and stops quickly.

Formation of the muco-periosteal flaps.—If the cleft does not reach the alveolar border, these are formed by making an incision close to the alveolar border of the hard palate on each side of the cleft, commencing just internal to the last molar tooth and running forwards parallel to the alveolar margin, until it reaches the level of the apex of the cleft on each side in front.

Fig. 252.—Paring the Cleft in Staphyloraphy. One side has been pared and the strip is left hanging from the front end of the cleft. The lateral incisions made for the purpose of raising the hard palate flaps are indicated in the figure.

This incision may be followed by fairly smart hæmorrhage from the posterior palatine artery or its branches. The pulsations of that vessel may sometimes be felt beforehand, and the incision can then be planned so as to avoid it; it should begin quite close to the last molar tooth. The knife must be held perpendicularly to the plane of the mucous surface so as to avoid bevelling the edges of the flap. If the hæmorrhage is severe, sponge pressure may be applied for a few moments, and then the detachment of the muco-periosteal flaps from the bone should be proceeded with. This is effected by fine raspatories of varying curves (see Fig. 253) introduced through the lateral incisions. The more curved ones are used first, and the straighter ones are substituted as the detachment

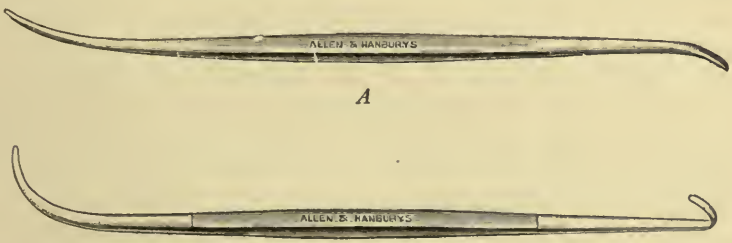


Fig. 253.—Raspatories for Staphyloraphy. *A* is the usual type; *B*, the form best adapted to raise flaps from a flat palate; the sharply curved end is very useful at the front end of the cleft.

proceeds. Special curves may be required for the anterior portion. In detaching these flaps, care must be taken to avoid damaging them as they are often very thin. The point of the raspatory should be inserted

gently between the flap and the bone, and the separation made by gentle lateral movements, so that there is no stretching of the parts and no danger of running the point of the instrument through the flap. When the cleft is reached, the point of the raspatory is brought out between the bone and the soft parts. Special care must be taken at the anterior ends. When both sides have been detached, it is easy to ascertain whether the flaps have been freed sufficiently by introducing a detacher beneath each flap and drawing them together. Their edges ought to come together without any tension.

The next step is to divide the aponeurosis attaching the soft palate to the hard, in order to allow the flaps to come together posteriorly. The mucous membrane extending from the upper surface of the soft palate into the nasal cavities must also be divided so that the soft palate can hang down freely into the mouth. This is done with a probe-pointed knife (see Fig. 251, *B*) or a pair of special curved scissors (see Fig. 254), one blade being inserted between the muco-periosteum and the under

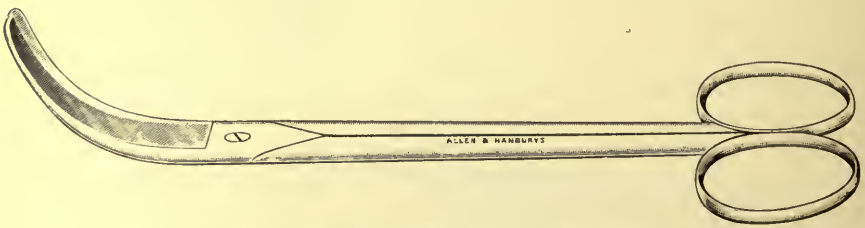


Fig. 254.—Curved Scissors for dividing the attachment of the Soft to the Hard Palate in Staphyloraphy.

surface of the bone, while the other is placed in the naso-pharynx above the upper surface of the soft palate (see Fig. 255).

If, however, the cleft should be complete—*i.e.* if it extends through the alveolus—the incision does not go as far forward as the end of the cleft, otherwise the blood-supply to the front end of the flap from the anterior palatine artery would be cut off. This leaves a small triangular gap in front when the flaps are approximated, and this is closed at a second operation, after the rest of the palate has united, by prolonging the incisions forward through the free margin of the cleft anteriorly and turning in the little flaps thus formed.

Suturing the flaps.—After the hæmorrhage has been arrested, the throat sponged, and the patient brought fully under the anæsthetic again, the third stage—that of passing the sutures—is reached. For uniting the hard and the greater part of the soft palate we prefer silk-worm-gut. Many surgeons employ silver wire, but the gut seems to be less irritating to the dorsum of the tongue, and is also somewhat easier to tie. The sutures uniting the divided halves of the uvula may be of fine horse-hair. The best way of passing the sutures is that known

as the 'loop method.' The stitches are introduced by special long-handled needles (see Fig. 256) bent at varying angles and curves; the eye of the needle is near the point and it is flattened from side to side so that the puncture is at right angles to the edge of the cleft, and when the suture is tightened, the aperture through which it passes is somewhat diminished. A needle is threaded with a long piece of fine silk, the two ends being of equal length, and is inserted about an eighth of an inch from the margin of the cleft; it should pass through the whole thickness of the flap. It is well to insert the first stitch at the junction of the soft with the hard palate so as to insure the exact apposition of the two halves. When the needle has penetrated the flap, the loop of silk in the eye is caught in a pair of forceps or a sharp hook and the needle withdrawn, leaving the loop emerging from the upper surface of the flap (see Fig. 257). A needle curved in the opposite direction and threaded with fine silkworm-gut, is then passed through the other flap at a corresponding point. The end of the gut is seized with forceps, unthreaded from the eye of the needle and the latter withdrawn. The free end of the gut is brought out into the cleft, and then passed into the silk loop already introduced through the opposite side; by traction upon the free ends of the latter the silkworm-gut suture is drawn through the opposite flap[1] (see Fig. 257, *c*). Both ends of the stitch are now picked up by a pair of forceps, and left untied until all the sutures are in position. It is unnecessary to grasp the edge of the flaps in introducing these stitches; indeed, it is desirable not to do so on account of the risk of bruising. If the edge of the flap is put on the stretch by pulling on the uvula, a sharp needle can be stabbed through the palate with ease. The next stitch is inserted about the middle of the hard palate, and then the remaining stitches in the hard

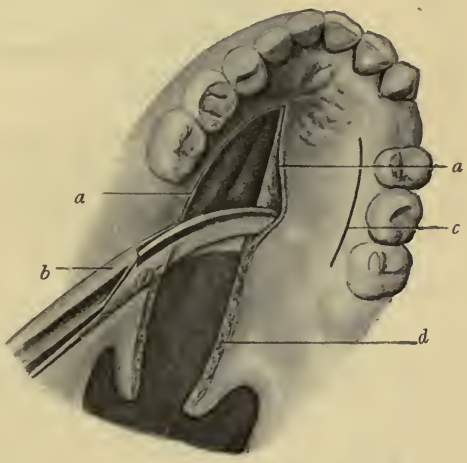


FIG. 255.—DETACHING THE SOFT FROM THE HARD PALATE IN STAPHYLORAPHY. *a*, pared edges of cleft in the hard palate; *b*, curved scissors—one blade above and one below the aponeurosis joining the soft to the hard palate; *c*, lateral incision for raising the muco-periosteal flap from the hard palate; *d*, pared edge of the soft palate.

[1] To permit of this being done, the eye of the palate needle must be large enough to take fairly strong silkworm-gut. Should such a needle not be available, the second method, indicated in Fig. 258—*i.e.* the use of two silk loops—must be adopted.

palate are put in. The two sides of the uvula should now be brought together; here the stitches may be of horse-hair and can usually be passed directly from one half of the uvula to the other without employing the silk loop. The uvula is now grasped with forceps and pulled backwards and downwards so as to put the soft palate on the stretch; this shows the surgeon exactly where the stitches should be introduced. The second soft palate stitch is put in midway between the uvula and the posterior edge of the hard palate, and then intermediate stitches are inserted at intervals of about a quarter of an inch. In the immediate neighbourhood of the uvula two or three stitches of horsehair may be passed direct from one flap to another without the intervention of the

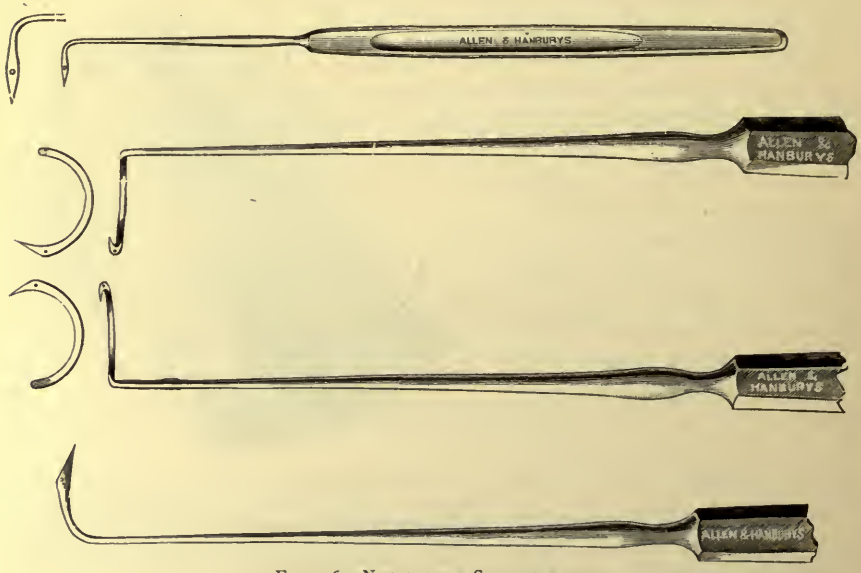


Fig. 256.—Needles for Staphyloraphy.

loop. All the stitches should be inserted before any are tied, each pair being caught in Spencer Wells's forceps. The back of the throat is now sponged out, the line of incision gently cleared from blood-clot and mucus, and the stitches tied. In tying them, it is advisable to employ the surgical knot—that is to say, two turns should be taken in the first hitch so that it does not slip while the second half of the knot is being tied. The ends should be cut moderately long, so that they may lie against the palate and not project directly on to the dorsum of the tongue. At this stage it is necessary that the patient should be deeply anæsthetised so as to prevent retching or vomiting, and care must be taken to sponge away all mucus from the raw surfaces before the stitches are tightened.

The relief of lateral tension.—The last step is to diminish the lateral

tension of the soft palate. It is sometimes recommended that this should not be done unless the tension is marked, as ascertained by the pressure of the finger on the soft palate after it has been closed. It is always well to carry it out, however, as the object is rather to prevent tension from the subsequent pull of the palatal muscles than to relieve any actual tension due to the operation. It is best done by introducing a probe-pointed knife into the posterior extremity of each lateral incision and prolonging it vertically backwards into the soft palate, the incision passing just internal to the hamular process. It should extend through at least half the depth of the palate on each side (see Fig. 259). This incision is sometimes followed by sharp hæmorrhage from the posterior palatine artery or its branches; the bleeding can generally be arrested by sponge pressure or by complete division of the artery with the knife. Should it be serious, a sponge may be dipped in adrenalin chloride solution (1 in 1000) and pressed firmly over the bleeding point. Only in very intractable cases will it be necessary to plug the posterior palatine foramen with Horsley's wax. When the bleeding has ceased, the child is put to bed with the head low and turned to one side, so that blood may escape easily by the mouth.

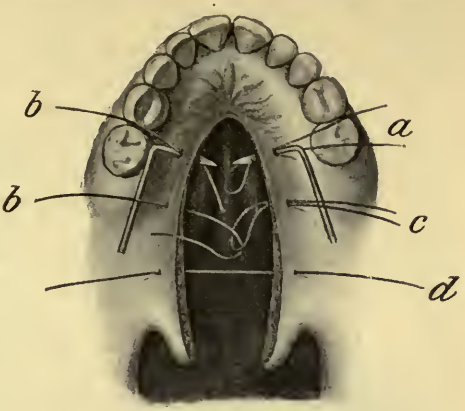


FIG. 257.—PASSING THE SUTURES IN STAPHYLORAPHY. *a*, shows the loop of silk being passed on one side and the single silkworm-gut suture on the opposite side. Both needles are withdrawn leaving the threads *in situ*. Then the silkworm-gut thread is looped into the silk loop (*c*), which is pulled upon and withdrawn, leaving the single silkworm-gut suture in place (*d*).

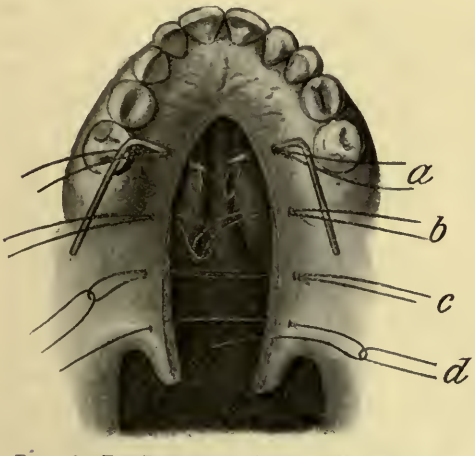


FIG. 258.—THE DOUBLE-LOOP METHOD OF PASSING THE SUTURES IN STAPHYLORAPHY. *a*, shows the two silk loops being introduced; *b*, shows one loop passed through the other, which is then withdrawn, leaving the single loop (*c*) in position through both flaps. Into this is hooked a silkworm-gut suture, which is drawn into place by traction upon the single loop (*d*).

After-treatment.—There may be considerable shock, and plenty of hot-water bottles should be at hand. No food should be given until all danger of vomiting is at an end, and then only

liquids for the first week. The child is fed by a spoon and later on by a feeder furnished with an india-rubber tube, passed far back at the side of the mouth. At first milk, either alone or mixed with soda-water or lime-water, should be given ; at the end of the first week bread and milk, custard and arrowroot may be added, but solid food should be forbidden for at least three weeks.

It is very important to keep the child from crying, laughing, or talking, if possible. It is an excellent plan to mould small splints of cardboard or poroplastic material to the flexor surfaces of the arms and forearms, and thus prevent flexion of the elbow-joints while leaving free play to the shoulders and wrists ; thus the child cannot put his fingers or his toys into his mouth, but can still amuse himself with his playthings. If the child is disobedient and tries to remove the splints, the arms must be tied to the trunk, but this is usually unnecessary.

FIG. 259. — STAPHYLORAPHY COMPLETED. The sutures are tied and the lateral incisions now gape widely. The dotted lines show how these lateral incisions may be prolonged for the relief of tension if necessary.

No one should be allowed to inspect the condition of the wound for at least ten days ; inspection can do no good and might do harm. About the tenth day some of the stitches should be removed ; if the child is fractious, it is well to administer an anæsthetic for the purpose. Should union be good throughout, all the stitches may be removed ; should it be doubtful at any part, the stitches in the neighbourhood of the doubtful area should be left for a few days longer.

Complications.—There are two important complications common to all operations for cleft palate, namely, bleeding at the time of the operation or afterwards, and failure of union.

1. Bleeding.—As a rule the hæmorrhage, though free at first, is easily controlled by sponge pressure. Obstinate bleeding generally results from incomplete division of the posterior palatine artery. Severe oozing is common when the airway is obstructed. Anæmic children are very apt to bleed and the operation should be delayed, if possible, until the anæmia has improved ; hæmophilics should not be operated on at all. Secondary hæmorrhage may occur, but is uncommon ; as a rule, it is not severe.

Treatment.—During the operation the airway should always be kept free, and this will minimise venous oozing. If the bleeding is arterial and sponge pressure will not stop it, the clots should be wiped from the

lateral incisions and the source of hæmorrhage exposed. If this be a partially divided vessel at the end of the incision, extension of the incision will probably suffice, especially if it be combined with direct pressure upon the bleeding point with a small piece of sponge dipped in adrenalin chloride (1 in 1000).

The treatment of secondary hæmorrhage is more difficult. An attempt should be made to check the bleeding by pressure and the application of ice-cold water syringed over the palate, or small pieces of ice enclosed in muslin may be pressed against the area from which the blood is coming. If this fails, an anæsthetic should be given and the bleeding point exposed. If the vessel cannot be picked up in forceps and tied, the bleeding will probably be coming from the posterior palatine canal, and an attempt should be made to stop it by temporarily plugging the canal with a fine probe. If this does not succeed, the canal may be plugged with Horsley's wax (see p. 376).

2. Failure of Union.—The other important complication is failure of union of the edges of the cleft; this failure may be partial or complete. It generally happens that only a portion gives way, and this is most common either at the extreme anterior end or about the junction of the hard with the soft palate. Non-union may be due to one of three principal causes:—

(*a*) *Imperfect operation.*—The cleft may have been insufficiently pared, generally because it has not been pared in one piece; if it has been pared piecemeal, some part may have been overlooked, or only a very narrow raw surface may have been made. The tension upon the flaps may be so great as to interfere with union; the flaps may not have been brought properly into apposition, one edge being curled up so that the raw surfaces do not lie opposite each other; or the stitches may have been tied either too loosely or too tightly. Lastly, the flap may have been so bruised by rough handling that its vitality is seriously diminished.

(*b*) *Intercurrent inflammatory affections* such as severe catarrh, the onset of a specific fever, or ordinary septic infection may entirely prevent union. Rough handling of the flap is very commonly followed by septic infection of the line of incision.

(*c*) *Want of proper care in the after-treatment* may bring about failure of union. Among the most important points which may lead to failure of union after an otherwise satisfactory operation are excessive crying, vomiting, or mechanical violence from the child's fingers or foreign bodies being thrust against the flaps, or from too early administration of solid food.

It is well to remember that the gap left after limited failure of union becomes smaller as healing occurs owing to the contraction and union of the granulating surfaces; this is especially the case in the soft palate.

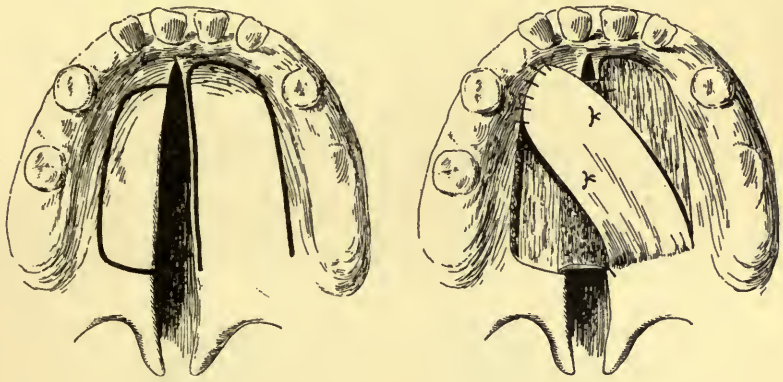
Treatment.—The treatment when union seems doubtful is largely prophylactic, and every precaution must be taken in the way of careful operation and after-treatment to avoid anything that may interfere with union ; any intercurrent affection, such as a catarrh, should receive careful attention before the operation.

If there is any doubt as to the union of the edges when the wound is examined, the stitches should not be removed for a fortnight or three weeks. Should failure of union occur at any part, it is well to leave it alone for some time if the hole is small, because spontaneous closure often takes place. If this does not occur, it is well to administer an anæsthetic before the hole has healed and while the edges are still granulating, and to introduce fresh sutures to draw the sides of the gap together, if necessary freeing them sufficiently to allow them to meet without tension. It is not advisable to pare the granulating edges under these circumstances ; it is sufficient to scrape them slightly. These second stitches should be left in for at least a fortnight. If this secondary union fails, it is well to delay further operative interference for at least six months, so as to allow complete cicatrisation and contraction to take place. The subsequent operation consists either in paring the edges of the defect, making lateral incisions for the relief of tension and then bringing the edges together, or in splitting a flap from the palate as suggested by Mr. Lane (see p. 537). If the soft palate fails to unite, the contraction leads to shortening of the palate, so that secondary operations seldom bring about a perfect result. Hence every care must be taken to secure union at the first operation and in any case a second operation should never be done while sloughing is present.

Various other operations for cleft palate have been introduced, but they have not been generally adopted. Nevertheless, they deserve careful notice and even, though not considered suitable for the ordinary run of cases, they may be of value under certain circumstances. Of these we may mention Davies-Colley's, Arbuthnot Lane's, and Brophy's operations.

Davies-Colley's Operation.—The operation introduced by the late Mr. Davies-Colley is useful in very wide clefts in young children, in whom more than one operation may be required to close the gap in the palate. It may also be of advantage in cases of a cleft in the hard palate when a previous operation has been performed and has failed, leaving much cicatricial tissue. It is done as follows : As large a flap of the muco-periosteum as possible is cut from one side of the hard palate ; if the two sides are unequal in size, it should be taken from the larger. This flap is marked out by an incision starting opposite and close to the last molar tooth, and running forwards parallel, and just internal, to the teeth as far as the apex of the cleft. The incision is then carried backwards along the edge of the cleft about one-sixth of an inch external to its margin and extends well on to the soft palate. The tongue-like flap of

muco-periosteum thus formed is raised with a raspatory. Along the opposite side of the cleft an incision is made about a quarter of an inch external to its margin, commencing in front near its apex and running back to the junction of the hard and soft palates. The extremities of this incision should be carried transversely inwards as far as the free margin of the cleft. The small flap thus formed is separated from the bone with a raspatory, the base of the flap being formed by the tissues covering the edge of the cleft. There is thus no actual paring of the edges in this operation. The smaller flap is now turned inwards upon its base so that its raw surface looks downwards into the mouth ; it is fixed by catgut sutures to the narrow strip of mucous membrane on the opposite side of



A *B*

FIG. 260.—DAVIES-COLLEY'S OPERATION FOR CLEFT PALATE. *A* shows the incisions for the flaps, the large one on the right-hand side of the gap having its base just beyond the junction of the hard with the soft palate. The base of the smaller or reflected flap on the left-hand side is along the margin of the cleft. In *B* the smaller flap is turned back across the cleft and sutured to its opposite edge, while the large flap is raised and applied to the raw under surface of it, its apex being sutured as shown. Two sutures are also shown penetrating the whole thickness of the two flaps so as to keep them together. These stitches are best introduced through the reflected flap before the larger one is placed over it ; the ends are then brought through the latter and tied.

the cleft left after cutting the larger flap ; this strip of mucous membrane can be turned into the cleft by means of a raspatory. The large triangular flap is then carried across the cleft and its apex is attached by a few silkworm-gut sutures to the mucous membrane at the outer edge of the raw surface made by turning in the small flap (see Fig. 260, *B*). These sutures are introduced by means of fine fully-curved needles. The effect of this is to close part of the cleft in the hard palate with a double thickness of soft parts and thus the vitality of the flaps is less likely to suffer, and union is more likely to occur, owing to the two vascular surfaces being brought into apposition. The opposed surfaces of the flaps are fastened together by fine horse-hair sutures passed either through the edges or, better, through the whole thickness of the two flaps ; if the latter plan is adopted, fine straight needles and a fine needle-holder will be

required (see Fig. 261). This operation only succeeds in closing a portion of the cleft, a small triangular gap being invariably left anteriorly; this can be closed later. The soft palate may be united at the same time should the surgeon desire it, but it is, perhaps, preferable to postpone that to a later occasion.

In this operation there is comparatively little hæmorrhage, there is no loss of soft parts, no tension after the operation, and no likelihood

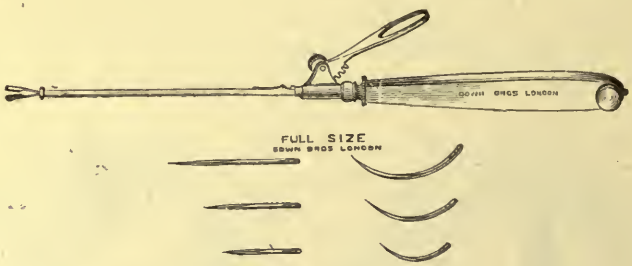


Fig. 261.—Lane's Needles and Needle-holder for Cleft-Palate Operations.

of the flap sloughing, as the pressure of the tongue, which in the ordinary operation is so likely to cause separation of the flaps, is here

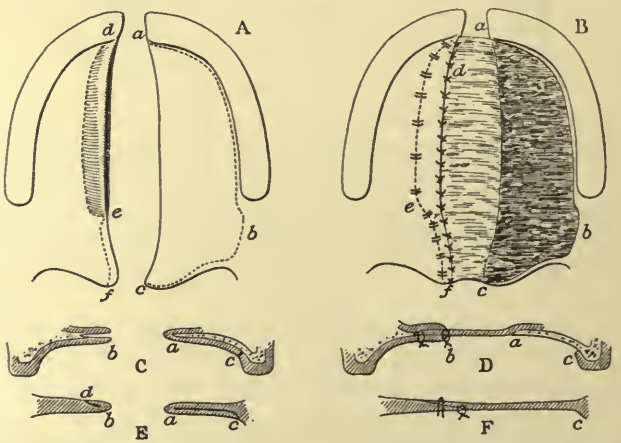


Fig. 262.—Lane's Operation for Cleft Palate. A shows the method of cutting the large flap *abc*. The muco-periosteum is then raised from the hard palate from *d* to *e* for the reception of the edge of the flap *abc*. In B, this flap is turned across the cleft with its edge fastened between *de* and the bone. C and D show the method in horizontal section; *ac* is the flap the edge of which is fastened between the muco-periosteum (*b*) and the hard palate. E and F show the method of cutting a bevel (*db*) from the posterior or upper surface of the soft palate on one side to join to the reflected flap consisting of half the thickness of the soft palate on the opposite side (*ac*).

actually beneficial and presses them together. As the bridge of union thus formed consists of a double flap, it is more likely to unite, and

therefore the operation may be performed at an earlier age than the ordinary one.

Lane's Operation.—Mr. Arbuthnot Lane (*Clin. Journ.*, May 26, 1897) advocates a modification of the above method which he practises during the fourth or fifth week of life, or even earlier. Briefly, it consists in raising practically the whole of the muco-periosteum of the hard, and half the thickness of the soft, palate from the larger side of the cleft and turning it back upon itself so that its base corresponds to the edge of the cleft and its raw surface looks downwards into the mouth. The edge of this flap is fastened beneath the edge of the muco-periosteum on the opposite side; in order to allow of this being done, an incision is made along the margin of the cleft on that side and the muco-periosteum is raised from the bone for a quarter of an inch all along (see Fig. 262, A). The soft palate is joined by splitting a small flap off from the posterior surface on the opposite side of the cleft (see Fig. 262, E).

We are not inclined to regard this operation with much favour. It is certainly difficult to perform, and even slight loss of blood in a child

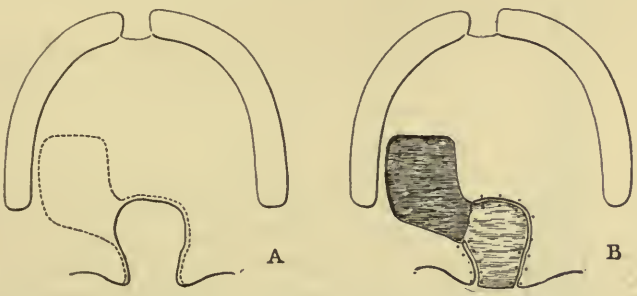


FIG. 263.—LANE'S METHOD OF CLOSING IRREGULAR GAPS IN THE SOFT PALATE. The flap shown by the dotted line in A is formed by half the thickness of the tissues of the soft palate and is turned back upon itself where it is continuous with the gap. It is then sutured to the edges of the gap which have been previously pared (B).

of four or five weeks old is a serious matter. It is very difficult to raise and turn back the palate flap without damaging the upper jaw which is very soft at this age, and we are not satisfied with the prospects of union in so delicate a flap with such a problematical blood-supply.

Further, although the cleft can be closed by this operation the flap is liable to slough subsequently, and besides, the soft palate, instead of being a movable structure, may be represented by a mass of cicatricial tissue. There appears also to be no reliable information as to the value of the operation from the point of view of speech.

For another group of cases—namely, those with circular or horseshoe-shaped gaps left in the soft palate after one or more unsuccessful efforts to unite it—this method of splitting off a flap from the soft palate may, however, be useful, as it allows gaps to be closed that can only be brought together with great difficulty by the old operation.

Brophy's Operation.—The principle underlying this operation is the approximation of the bony margins of the cleft, the edges of which are also pared, so as to ensure their union. In the earlier operations when the cleft was wide, considerable force (even to the extent of fracture) was employed to approximate the bones, and in some cases the attachments of the superior maxillæ to the malar bones were divided. But if the operation is performed soon after birth, these severe proceedings should not be necessary. It is obvious that this method of operating can only be employed when the cleft is a complete one, involving the alveolar arch. It cannot be used for clefts limited to the soft and posterior part of the hard palates. Brophy considers that the most suitable age is from ten days up to three weeks. At this period, and indeed up to four or five months of age, the bones are very soft and can therefore be brought into apposition without much difficulty. After five months, the bones are harder and there is considerable risk of fracture. Hence the operation is not advisable after that age.

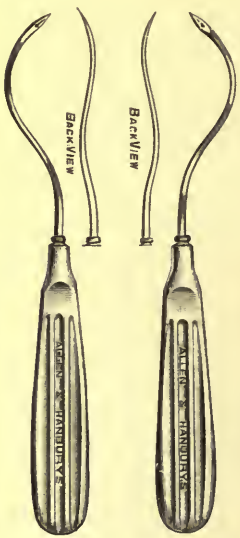


FIG. 264. — BROPHY'S NEEDLES FOR CLEFT-PALATE OPERATIONS. They are right- and left-handed needles.

In favour of this method of operation, it is urged that the position of the pre-maxillary bone is rectified, that the teeth grow in their proper directions, that the jaws develop normally, and that defects of speech do not occur. It seems probable, however, that too roseate a view has been taken of the results of the operation as regards these points, and it is quite certain that in many cases only the anterior part of the cleft in the hard palate and the alveolus have been closed by this procedure.

The associated hare-lip is operated on some two months or more after the operation on the hard palate, and the cleft in the soft palate is not closed until the child is about sixteen months old.

The details of the operation are as follows :—

The infant is anæsthetised, and the mouth held open by a gag. One of Brophy's needles (see Fig. 264) is threaded with a long silk suture, of the same size as the silver wires which are to be used, the gauge of these wires being 18 to 20 (American gauge). The needle is then made to penetrate the alveolus as far back as possible, and is pushed on through the superior maxilla until the eye of the needle is seen in the cleft. During the passage of the needle, great care must be taken to keep its point below the orbit, and it should lie just above the hard palate. The space intervening between the floor of the orbit and the alveolus is very small and damage may easily be done. The developing teeth may also be encountered, and

if this happens, the point of the needle must be moved one way or other, so as to damage them as little as possible. As soon as the eye of the needle is seen in the cleft, the loop of silk is seized and held whilst the needle is withdrawn. There will thus be a loop of silk lying in the track of the needle, the free ends of the loop being allowed to hang out of the corners of the mouth, with a pair of pressure forceps holding them. By using a 'reverse needle,' another loop of silk is passed in precisely the same way, through the other maxilla, and exactly opposite the first silk loop. A short distance in front of these loops, a second silk loop is passed on each side, and on the longer side of the cleft (if it is a unilateral one) or on one side only if the cleft is bilateral, a third loop of silk is placed still further forwards, so that the actual loop is in the anterior part of the cleft. Reference to Fig. 265 will show the exact positions of these loops. There will thus be in the cleft three loops of silk on one side, and two loops on the other, and the free ends of each loop hang out of the mouth. The two posterior loops are interlocked and, by making traction on the free ends of one of them, the other loop is withdrawn, so as to occupy its position. The same manœuvre is carried out with the next pair of loops, and there will then be lying across the cleft, but above the level of the palate, four silk threads, each pair having a loop outside one alveolus, and the free ends outside the other alveolus (see Fig. 265, *C*). The anterior loop of silk up to this stage has been left lying in the cleft, and has not been touched since it was placed in position. A long piece of silver wire bent into a V-shape, the two limbs being equal in length, is then placed in each of the two posterior loops of silk (see Fig. 265, *D*). By traction on the free ends of the silk, the wire comes to lie in the track of the silk. The loop of each wire is divided, and there will therefore be four wires in the place of the two loops of silk. The most anterior wire is withdrawn from the side which is shortest, till its end appears in the cleft. This end is then seized bent into a V-shape, and placed in the loop of silk lying in the cleft (see Fig. 266, *E*). By traction on the silk, the wire is carried across the cleft from one alveolus to the other (see Fig. 266, *F*), and there will thus be four wires penetrating the alveolus on one side, through two apertures in the bone, and, on the other, through three apertures.

The next step is to take two leaden plates of the same thickness as the silver wire, and cut them of such a size that they will take the wires and lie easily on the outer surface of each alveolus. One plate will require to have three holes punched in it, and the other two holes, so that the wires may pass through them. The plates are then placed in position, and the superior maxillæ are gently yet firmly pressed together by the thumb and fingers applied to their outer aspects. As the bones approximate, 'the slack' in the wires is taken up by twisting the ends round one another, first on one side, and then on the other. The wires must never be used to force the bones together—their purpose is to hold them in position after they have been approximated by

the pressure of the thumb and fingers, reinforced if necessary by a flat instrument, such as a broad periosteal elevator. It is most important to twist together the corresponding wires, and a reference to Fig. 266, *G.* will show how this is done.

When the edges of the cleft are nearly in apposition, they should be

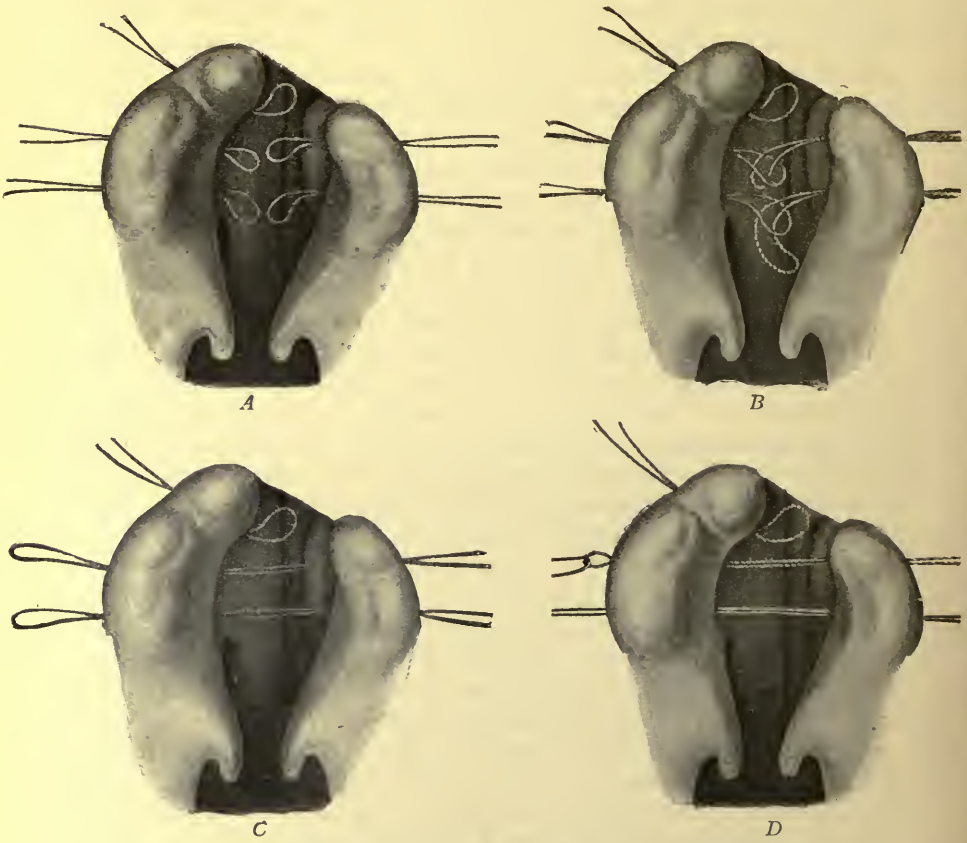


FIG. 265.—BROPHY'S OPERATION. *Passing the silk sutures.* *A*, five stout silk sutures have been inserted; the loops project into the cleft. *B*, by using two of the loops of the right side as tractors, the silk loops of the left side are drawn across both the maxillæ. *C*, two of the loops of silk now extend right across both maxillæ and the cleft. *D*, a long piece of stout silver wire has been threaded through the middle loop of silk by which it is about to be drawn through the jaws. Behind this the double wire is shown already in place. The anterior loop is still of silk. (*Berry and Legg: 'Hare-lip and Cleft Palate.' Churchill, London.*)

scarified or pared, so as to produce a raw surface on each side along which union may take place.

If the pre-maxilla is so prominent that it cannot be placed in its proper position by the pressure of the thumb and fingers, the septum may be divided obliquely a short distance above and behind its attachment, so as to allow of this being done.

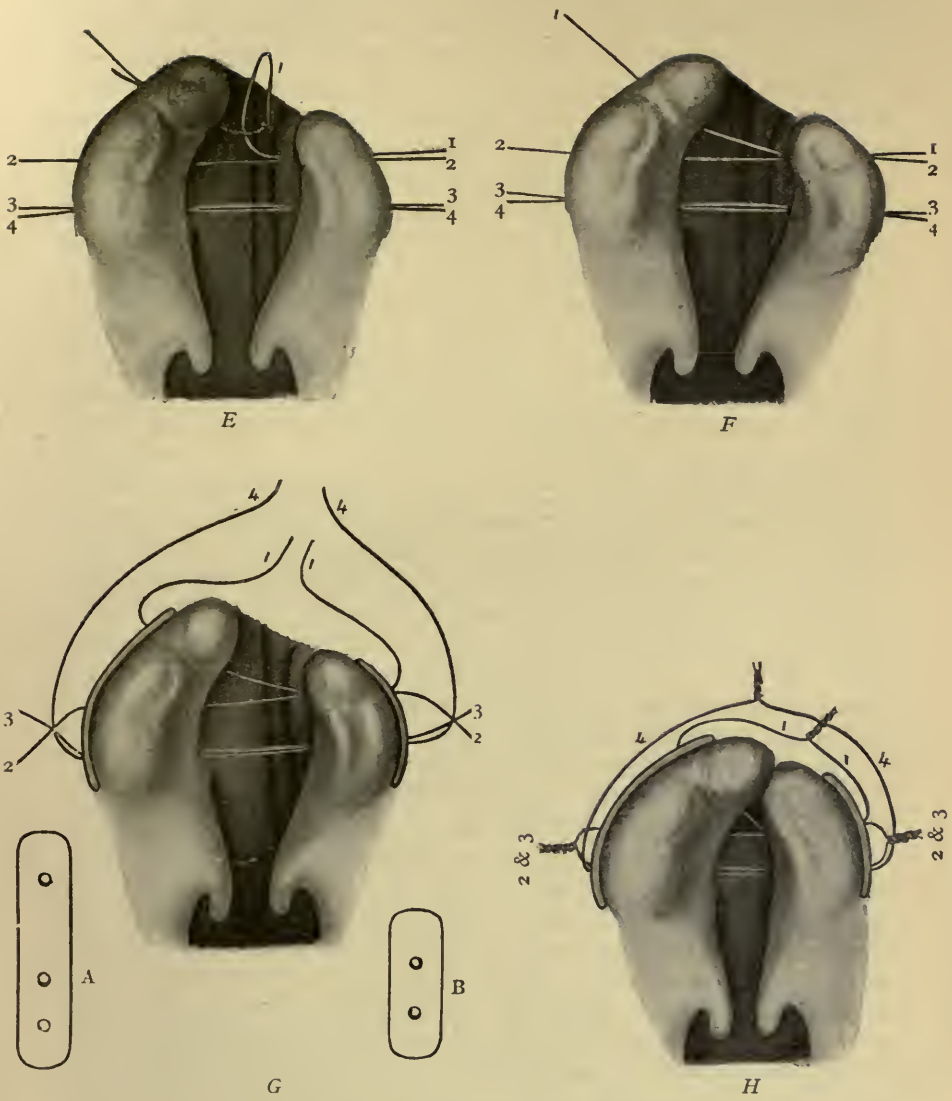


FIG. 266.—BROPHY'S OPERATION. *Inserting and twisting the wire sutures.* *E*, one of the anterior pair of wires has been withdrawn from the right maxilla and has been threaded through the front loop of silk, which is about to draw it through the premaxillary process. *F*, shows the front wire passing through the premaxillary process. *G*, all the wires having been placed in their correct positions, perforated lead plates are threaded upon them. As the jaws are slowly approximated by gentle digital pressure, the ends of wires 2 and 3 are twisted together, the first and last wires (1 and 4) are brought forwards and their respective ends twisted together in front of the premaxillary process; A and B show the perforated lead plates. *H*, the maxillæ are being brought into contact and the front part of the cleft has been closed. For the sake of clearness the wires and their twisted ends are shown at a little distance from the jaws In reality they would of course lie close to the lead plates and the gums. (*Berry and Legg: 'Hare-lip and Cleft Palate.' Churchill, London.*)

After the wires have been tightened up to the full extent, their ends are cut short and hammered down on to the lead plates, the margins of the latter being slightly everted so as not to press unduly on the gums.

There is very little shock following the operation and the amount of blood lost is quite small. After the expiration of six weeks the wires and lead plates may be removed. There is practically no risk of necrosis of the jaws or ulceration of the gums, if the operation is carried out as described, and all that is necessary afterwards is to keep the mouth clean and to remove all food débris. This can be done by means of swabs soaked in a mild antiseptic.

Up till quite recently the operation has not been often performed in this country. If properly carried out, it is not a difficult procedure in suitable cases. It is not certain, however, that the results are in any way superior to those obtained by the older methods of operating, and it should never be attempted without the proper instruments.

Voice Training.—After any operation for cleft palate it is necessary for the patient to undergo a careful and prolonged course of *vocal training* in order to get rid of the nasal twang which has already been acquired, and which will persist, if not treated. The movements of the lips and the soft palate are also greatly benefited by training of this kind; nose breathing is most important and should be taught regularly. In most large towns there are institutions where this can be done. We add here a short note on this subject which has been kindly written for us by Mr. Cortlandt MacMahon, Instructor for Speech Defects at St. Bartholomew's Hospital, Dulwich College, and Eton College.

'The training of the voice after operation for cleft palate is a matter of very great importance as so much can be done to remedy the imperfections in the voice, thereby adding very materially to the comfort of the patient and of those with whom he or she is brought into contact. The extent of the defect in the speech varies naturally with the extent of the abnormality, and where hare-lip is added to a cleft of both hard and soft palates there is, of course, additional vocal trouble to be remedied.

'"Voice" being caused by air vibrating in the various vocal resonating chambers of the body, which comprise the chest, pharynx, larynx, the mouth, the nasal cavities, and the other cavities of the head, it is at once apparent that, if the two very important resonators formed by the mouth and nasal cavities are impaired, there will be very serious interference with its quality. Whether the cleft includes both the hard and the soft palates or is confined only to the soft palate, the speech is certain to suffer to a more or less serious degree as the soft palate, when intact, has the enormously important function to perform of directing the ascending air column during vocalisation in proper proportions into the mouth and nasal cavities. Before the cleft is repaired the air column finds its way into the nasal cavities in undue proportions, thereby

helping to make speech generally very indistinct. The tongue also, owing to the cleft, is unable to accomplish what is required of it in the production of the linguo-palatal consonants. When, however, the cleft has been repaired by operation early in life, the soft palate and the tongue can be trained to perform their functions in a manner very nearly approaching the normal. The orbicular muscle of the mouth, after operation for hare-lip, requires careful training so that the tension necessarily following the operation is relieved and the lips made mobile and elastic by means of exercises, and especially by use of the "oo" sound for which the lips are protruded as far as possible. One cannot over-emphasise the enormous importance of free lip-movement whenever the voice is used.

'The nature of the instruction given to the individual must vary somewhat in accordance with the time of life when the operation was performed. If the patient has been operated upon in early infancy or before speech has been established, one can expect more perfect involuntary natural movement in the levator muscles of the soft palate than would be the case if the operation had not been performed until speech had existed for a considerable period. In the latter case, instead of leaving the muscles to act involuntarily, one will generally have to teach the patient to contract the sterno-thyroid and the sterno-hyoid muscles continually during vocalisation and so cause a descent of the larynx and of the muscles forming the floor of the mouth, which movement will compensate for the inefficient working of the soft palate and will enable the air column to be directed more on to the lips, and so largely made to escape the nasal cavities. In all cases, whether the muscles are deliberately contracted or left to act involuntarily, a deeper pitch of voice will be found very helpful in acquiring the requisite apportionment of the air column.

'The first instruction should consist in teaching the patient to breathe properly and to produce, as perfectly as possible, the main vowel sounds: "oo," "oh," "aw," "ah," "a," and "ee," each of which has its own shape at the lips, its tongue position, and its space between the teeth. When the word 'resonator' is made use of in connection with one of the main vowel sounds, as when, for instance, the "EE" resonator is spoken of, one is referring to the whole conformation brought about by the setting of the lips, tongue, and jaw for that particular sound. The main vowel sounds and positions are made use of either alone, in combination, or subordinately whenever speech occurs. When these sounds have been learnt, the chief consonants—and especially those which one knows from experience are a source of considerable difficulty—should be put in front of the main vowels and practised assiduously until they are produced with clearness and ease.

'The most difficult consonants are G and K, whatever the nature of the cleft. If the cleft has been through both palates, one will find serious

difficulty with the D and T—in fact, in the early stages of training one frequently finds D, G, K, and T entirely missing. If there is also hare-lip one naturally finds trouble with the labials P and B. All words containing subordinate vowels on the " EE " resonator—such as " British," " little," " singing," and words beginning with " s," when joined to another consonant as in " ship," " stoop," and " speak "—will be a cause of considerable trouble before improvement is attained.

' As the training progresses the main vowels, when used in combination in various words as, for instance, " ah " and " oo " in " town," " aw " and " ee " in " boy," " oh " and " oo " in " boat," must be given their definite positions, and words containing subordinate vowels, as previously instanced, must have their main vowel position recognised and correctly shaped for. By so doing overtones and harmonics will occur in the vocal resonators and the voice will, in consequence, have a much improved quality.

' The voice-training of cleft palate cases after operation is extremely interesting and differs considerably from that of every other form of speech defect. The treatment of the air column is a very difficult matter until the patient learns how to manipulate it with skill; sometimes it must be full and powerful, and at other times it will have to be light and rapidly dealt with. It is remarkable how cleverly, in most cases, the patient learns what is necessary for improvement in the voice. When the required knowledge is combined with regularity in carrying out daily physical, breathing and vocal exercises one may, within a reasonable time, expect the voice, in less severe cases, to become very nearly normal and the cleft to be unsuspected, but in all cases one can certainly anticipate a very definite improvement both in the quality of the voice and in clearness of enunciation.'

Mechanical Treatment.—In some cases it is evident that closure is of the gap will not benefit the patient ; for example, the operation not likely to succeed when the cleft is very wide and the flaps can only meet with difficulty, when the soft palate is badly developed, when failure of former operations has left a shrunken soft palate, or when the patient does not come under observation until adult life has been reached. Under these circumstances, there is practically no hope of any real benefit from operation, as the palate is so short that it cannot reach the back of the pharynx and, therefore, the nasal voice and trouble in feeding continue in spite of closure of the cleft. Under such circumstances, the patient will be more comfortable with an obturator than with a partially closed palate ; indeed, the latter interferes very much with the fitting of a suitable obturator. These obturators can be made to supply the place of both the hard and the soft palate. They are difficult to fit, but when properly fitting, they are better than a faulty operative result. As a rule they cannot be fitted before the age of six

years, and when first employed for defects of the soft palate they are liable to cause retching. A patient must be trained to their use, and hence they should not be discarded if unsuccessful at first. Moreover, they require to be constantly changed if the patient is young, and they also become inefficient from the perishable nature of the material of which they are made. The fitting of these obturators falls into the province of the dentist.

ACQUIRED PERFORATIONS OF THE PALATE.

These may be due to injury or disease. Perforation from disease is generally due to acquired or congenital syphilis; it occurs during the tertiary period, and is the result of the formation of gummata and is often accompanied by extensive necrosis of the palate or the vomer; the destruction of the palate is rapid and extensive.

TREATMENT.—The treatment of these cases is at first palliative. *When it is due to injury*, the frequent use of a mouth-wash of sanitas, chlorate of potash, peroxide of hydrogen (10 vols.), or boric acid is indicated until granulation has occurred. If possible, stitches should then be introduced and the aperture closed. In some cases, portions of tissue may be lost and an obturator must be employed, or some plastic operation performed at a later period. *In syphilitic affections*, the important point is whether operative interference should ever be practised; in the early stage while the gumma is forming, vigorous antisyphilitic treatment (see Vol. I. Chap. XI.) should be employed at once, because the disease spreads very rapidly. When necrosis has occurred, any sequestrum present should be removed, and no question of operative interference should be entertained until the patient has definitely got rid of the disease and been free from it for a considerable time. An obturator may be obtained in the meantime, or the aperture in the hard palate may be packed with gauze when the patient is eating or talking. Success is not likely to attend operation except when the patient is comparatively young, the aperture small and the parts not extensively cicatricial. Davies-Colley's flap method (see p. 534) will be more likely to succeed here than simple paring of the edges and bringing them together, although the latter operation may be successful when the opening is small.

CHAPTER XLIII.

THE AFFECTIONS OF THE AURICULAR AND PAROTID REGIONS.

DEFORMITIES OF THE AURICLE.

The chief congenital deformities of the auricle calling for a plastic operation are excessive size or undue prominence.

If the auricle is unduly prominent, an attempt may be made to remedy this by removing a triangular portion of the skin and cartilage from the posterior surface of the pinna (see Fig. 267); the amount taken away will vary according to the degree of the deformity. When the wound thus made is stitched up, the ear should lie back in its normal position. The cut edges of the cartilage are united separately by catgut sutures.

Excessive size of the auricle may be diminished by excising suitable portions of the whole thickness of the pinna, the vertical measurement being reduced by taking a wedge from the upper part with its apex near the external meatus, and the breadth by removing a strip of cartilage and skin from the middle portion (see Fig. 268).

MALIGNANT DISEASE OF THE AURICLE.

As long as the malignant growth is confined to the auricle there is no difficulty in the treatment, which consists in the removal of a sufficient portion of the auricle with some healthy tissue around the disease. In some cases, however, the malignant disease begins in the external auditory meatus or in the auricle in its immediate vicinity and spreads rapidly up the meatus; the operation then becomes more difficult and unsatisfactory. The glands in the parotid region are affected early in these cases, and when they are involved, the chances of eradicating the disease by operation are very slight. Under these circumstances, the whole parotid gland should be removed without any regard to the preservation

of the facial nerve. Any attempt to combine removal of malignant glands in the substance of the parotid with preservation of the branches of the facial nerve will almost inevitably be followed by recurrence.

When the disease is confined to the interior of the meatus, the removal of the external auditory meatus is not a particularly difficult operation, and when the auricle is healthy it may be retained and subsequently stitched back into position. An incision is made in the interior of the auricle around the posterior margin of the meatus, and this is connected at each end with a more or less vertical incision anteriorly, which runs in

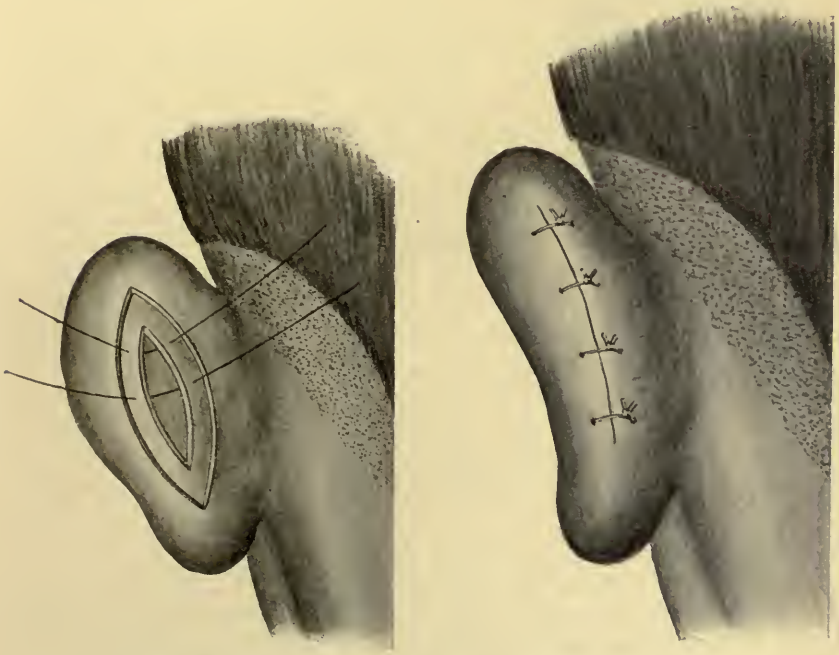


FIG. 267.—OPERATION FOR OUTSTANDING AURICLE. Sutures are used to draw the cut edges of the gap in the cartilage together and a separate layer to suture the skin.

front of the tragus. It is usually advisable to extend this vertical incision upwards above the ear to facilitate the pulling forwards of the parotid gland. The soft parts on the posterior surface of the cartilage are left intact, and are pushed backwards along with the remains of the auricle. The incision is now deepened behind down to the bony meatus, while in front it is carried down close to the cartilaginous meatus until the parotid gland is reached. The capsule of the parotid gland is now divided and the gland pulled forwards along with the vessels and nerves which it contains; the cartilaginous portion of the meatus can now be freely exposed. If the disease extends inwards beyond the region of the

cartilaginous portion, but not actually on to the tympanic membrane, a portion of the bony meatus must also be removed. This is done by means of a gouge and hammer, a tube of bone being taken away, along with the cartilaginous meatus. The bleeding is arrested and the wound brought together above and below, leaving a central cavity, at the bottom of which is the tympanic membrane. The auricle is then stitched back into position and skin-grafts may be placed over the cut surface of bone around the tympanum to promote immediate healing, and to maintain a passage leading to the membrana tympani.

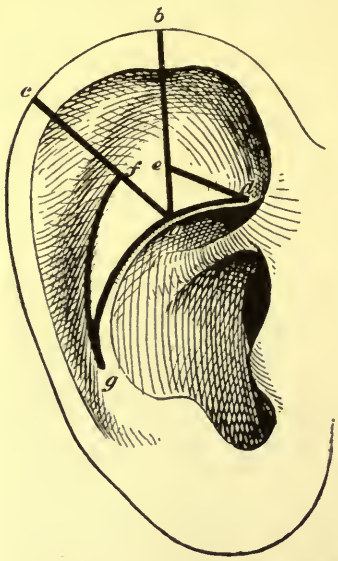


FIG. 268. — PLASTIC OPERATIONS FOR REDUCING THE SIZE OF THE AURICLE. The lines *abc* show the incisions for reducing the vertical dimensions of the ear; while *de*, *fg*, *dg* represent those necessary to reduce its transverse measurement.

When the disease has penetrated through the cartilaginous meatus and extends into the tissues around, especially the parotid, it is best not to operate in the majority of cases. If operation be undertaken it will be necessary to excise the parotid gland completely, and not to make any attempt to remove the diseased portions alone or to pick out the infected glands. Unless the entire parotid gland is removed, the disease is certain to recur almost immediately.

WOUNDS OF THE PAROTID GLAND.

Wounds of the parotid gland are of importance because they may injure the external carotid artery and its branches, the facial nerve or the salivary ducts.

TREATMENT.—So far as the wound is concerned, the treatment is similar to that for accidental wounds elsewhere. The essential points to be considered in connection with these injuries are the three complications just mentioned.

Of Hæmorrhage.—When a large vessel has been injured, the wound should be carefully enlarged, avoiding, if possible, any damage to the facial nerve. The opening should be enlarged in a transverse or oblique direction rather than vertically. When the parotid gland has been exposed, a flat dissector may be used to separate the parotid tissue itself, so as to avoid injury to the facial nerve. In most cases it is not advisable to enlarge the wound sufficiently to apply a ligature to a deep-seated vessel, as the chance of injuring the nerve is very great;

if the bleeding point can be caught in a pair of forceps, the latter should be left on for twenty-four hours, and this will ensure the occlusion of the vessel. If the bleeding is venous, it is only necessary to introduce a gauze plug down to the bleeding point.

When the terminal portion of the external carotid artery itself has been divided, the condition is very serious, because the vessel is deeply-seated, difficult to expose, and almost impossible to ligature without damage to the facial nerve. Hence, in very severe arterial bleeding from a wound of the parotid, it is best to compress the bleeding point with the finger and then expose the external carotid artery at its origin (see Vol. II. p. 204). A ligature is passed around it, but not tied. The artery may then be constricted by pulling upon the ligature, so that the wound can be sponged free from blood, and another effort made to catch the divided end. If the vessel is only partially divided, it must be cut across completely. If the bleeding cannot be controlled in this manner, a vertical incision must be made close in front of the auricle extending upwards and dividing the skin and fascia; the capsule of the parotid gland is then opened and the gland pulled forward, so as to expose its deeper surface and the vessels in that situation. The bleeding point can then be got at, and dealt with. When, however, the surgeon does not wish to perform this operation, the ligature round the external carotid should be tied and the wound in the parotid plugged for a couple of days, so as to prevent bleeding from the upper end. The plug may then be withdrawn and the wound sutured; if, however, there is much contusion, it is best to leave the wound open. This method of arresting the hæmorrhage is not a good one, however, as secondary hæmorrhage is very apt to occur when the sloughs separate.

Of Division of the Facial Nerve.—When the facial nerve has been divided after it has broken up into its terminal branches, there is little hope of getting satisfactory union. If, on the other hand, the injury occurs behind this point, a careful search should be made for the cut ends, and they should be united with fine catgut (see Vol. II. p. 116). The chances of success, however, are not good, because it is not easy to identify the distal end or to bring the two ends together if they are found. To do this, it is better to expose the main trunk of the nerve by the ordinary operation than to try to find it by enlarging the wound.

Exposure of the Facial Nerve.—An incision is carried along the anterior margin of the mastoid process down to its tip and thence forwards to the angle of the jaw. The auricle and the parotid gland are pulled forwards, and the nerve is found as it leaves the stylo-mastoid foramen above the digastric muscle; when it has been exposed it can be traced forwards to the point of injury, and an attempt made to unite the divided portions (see Vol. II. p. 116).

In some cases, the question of anastomosing the distal end of the

nerve to the hypoglossal nerve will have to be considered. It may be easier to carry out this procedure than to unite the divided ends.

Anastomosis of the Facial Nerve.—In cases of permanent facial paralysis due to some lesion situated between the origin of the nerve and the stylo-mastoid foramen—usually middle-ear disease—it may be possible to relieve the unsightly facial paralysis that ensues by grafting the distal end of the facial, after its emergence from the skull, upon some other sound nerve in the hope that the latter may send motor impulses down the terminal branches of the facial and that thus the functions of this nerve may be restored. For this purpose the hypoglossal has been frequently used with fair success ; previously the spinal accessory had been used for a similar purpose, but the operation in this case is rather more difficult and, moreover, associated movements of the face and shoulder are apt to occur and persist for a long time.

In the operation of *facio-hypoglossal anastomosis* the incision is made behind the ear close along the anterior margin of the mastoid process, beginning on a level with the centre of the external auditory meatus and running down the anterior margin of the sterno-mastoid muscle to the level of the hyoid bone. If the patient is fat or very muscular, this incision may be curved a little forward below over the submaxillary area, or a second short incision may be made from the centre of it to the angle of the jaw. The facial is exposed at its emergence from the stylo-mastoid foramen (*vide supra*). It should then be divided at the foramen and its distal end turned forwards, while the hypoglossal is defined as it emerges beneath the digastric and stylo-hyoid muscles and just before it hooks round the occipital artery. From this point it is carefully traced back to the nearest point to the divided distal end of the facial which is pulled down into contact with it. If necessary both the digastric and stylo-hyoid muscles may be divided. A small slit is made into the sheath of the hypoglossal nerve at the spot chosen and a few of the nerve fibres are divided transversely. Into this slit the divided distal end of the facial is implanted by the method of suture described in Vol. II. p. 122.

Anastomosis of the facial with the spinal accessory nerve can be performed through a similar incision. For the reasons given above it has been largely abandoned in favour of the former operation.

WOUNDS OF THE SALIVARY DUCTS.

These may result from wounds of the parotid gland—in which case one of the smaller ducts is usually damaged, and the fistula may be only temporary—or from injuries to the cheek, when Stenson's duct may be injured, and a permanent fistula results.

Wounds of Ducts in the Parotid Gland.—When a wound over the parotid gland is accompanied by an escape of saliva, deep

stitches should be put in to bring the gland substance together over the divided duct, and the wound in the skin should be sewn up. When the injured duct is quite small, the wound may heal without any trouble. In other cases a small opening remains in the line of incision through which saliva escapes. Even here, however, the tendency is for the opening to close as the wound contracts. If the closure is very slow, it is well to touch the wall of the sinus with solid nitrate of silver or the actual cautery from time to time, so as to prevent the spread of epithelium along the wall of the fistula and at the same time to stimulate the growth of granulations.

Sometimes, however, the wound of the parotid gland may be complicated by considerable loss of skin and subcutaneous tissue, and a plastic operation must then be performed, a flap being turned in so as to cover the defect. A small fistulous opening usually forms somewhere in the line of union, but this fistula generally closes as the parts contract ; closure may be hastened by the treatment mentioned above.

Wound of Stenson's Duct.—This is a much more serious matter, but, owing to its small size and deep position, the duct is comparatively rarely injured except in the course of operations, or by stabs or gunshot wounds. The accident is of great importance, because it is usually followed by a salivary fistula which is extremely difficult to cure. Hence the condition of the duct should be ascertained in all cases in which there is a wound in its vicinity.

Treatment.—If the accident is recognised at the time of its occurrence —for example, in the course of an operation—and if no portion of the duct has been removed, an attempt should be made to suture the duct with fine catgut, and then to unite the deeper parts and the wound in the skin. When the duct has been completely divided, a good plan is to take a piece of silver wire with blunt ends and pass one end along the proximal portion of the duct, and the other along the distal part making it emerge at the opening in the mouth. The two ends of the duct are then stitched together over this wire with fine catgut and the external wound is closed. The saliva finds its way into the mouth along the wire ; the end of the wire in the mouth should be bent up against the cheek and guarded by a small piece of gauze. It will remain in position because it is pressed against the gums, and may be removed after two or three days ; but mastication and talking should be rigorously avoided for some days longer.

When the tissues are much bruised and there is danger of sloughing, this plan is not likely to succeed, and a fistula will almost certainly follow. Therefore, when the wound in the duct is in front of the masseter, the incision should be deepened into the mouth ; in doing this it is well to bear in mind that the branch of the facial nerve which runs along with the duct may have escaped division and should be avoided. All cutting must be done parallel to the duct. A medium-sized drainage tube is

then passed through the wound so that one end projects slightly in the mouth, while the other lies about a quarter of an inch beneath the opening in the skin. The buccal end of the tube is stitched to the mucous membrane and the skin wound is closed if it is healthy. When all sloughing has ceased, the tube is gradually shortened by pulling it into the mouth. When the external wound has soundly healed, the tube may be removed, the pressure of the saliva as it is secreted being sufficient to keep the buccal end of the wound open until a permanent orifice has been formed.

SALIVARY FISTULA.

This is a communicaton between one of the salivary ducts and the exterior; in the case of the parotid it occurs directly over the gland when one of the larger ducts of origin has been opened, or in the cheek when Stenson's duct has been injured. The condition may arise from a wound, from injury during operations, as the result of sloughing or abscess formation, or as a sequela of syphilitic or tuberculous mischief. The treatment of a fistula over the gland has already been indicated (*vide supra*); we need therefore only discuss the question of a fistula of Stenson's duct.

The fistulous opening in Stenson's duct may be either over the masseter or further forward on the cheek; the opening is usually small, and when once established never closes without operation.

TREATMENT.—Two points are aimed at in the treatment, namely: to divert the stream of saliva into the mouth, and to close the opening in the skin. When the orifice of the duct is contracted and the opening in its wall is quite small, it may sometimes suffice to dilate the orifice of the duct, and then to pare the edges of the opening in the skin and stitch them together. The dilatation may be done with probes, but it is much more satisfactorily effected by slitting up the orifice so as to make a larger and more oblique opening. If possible a stitch should be inserted on each side between the duct wall and the mucous membrane.

In most cases, however, the duct is more seriously damaged, and this treatment will not suffice. The exact method will then vary according to the situation of the fistulous opening; in any case it must commence by providing free escape for the saliva into the mouth.

If the fistulous opening lies over the masseter, the channel required for the escape of the saliva into the mouth is of considerable length and is best made by thrusting a large-sized trochar from the opening in the cheek forwards into the mouth; if necessary the opening into the mouth may be enlarged. A drainage tube is now introduced through this opening, one end projecting into the mouth and the other through the skin wound. This is kept in position by silk threads at each end, the two ends of the silk being knotted together behind the ear; the tube should be maintained in position for at least four days, when the

communication into the mouth will be fairly well established. The tube should then be shortened, so that its outer end just reaches the duct; the

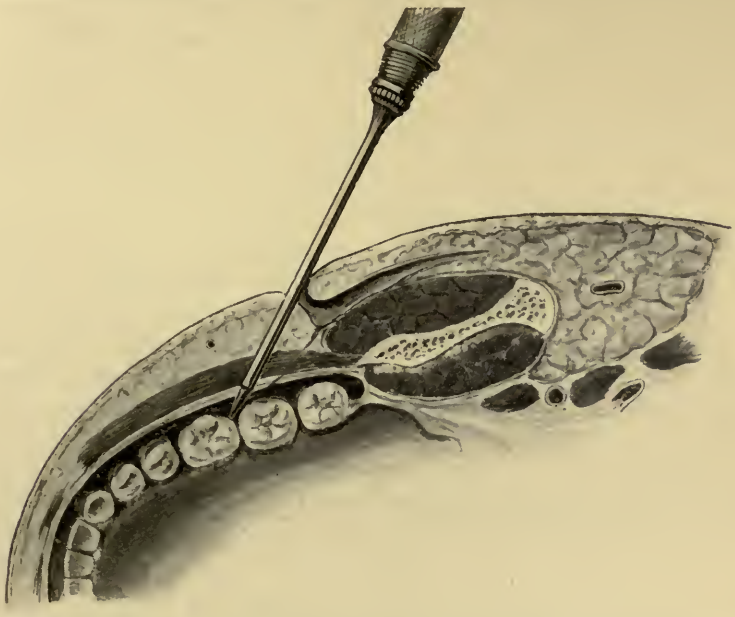


FIG. 269.—REPAIR OF A SALIVARY FISTULA IN FRONT OF THE MASSETER. The trochar is thrust through the cheek from the fistulous opening obliquely forwards and inwards into the mouth.

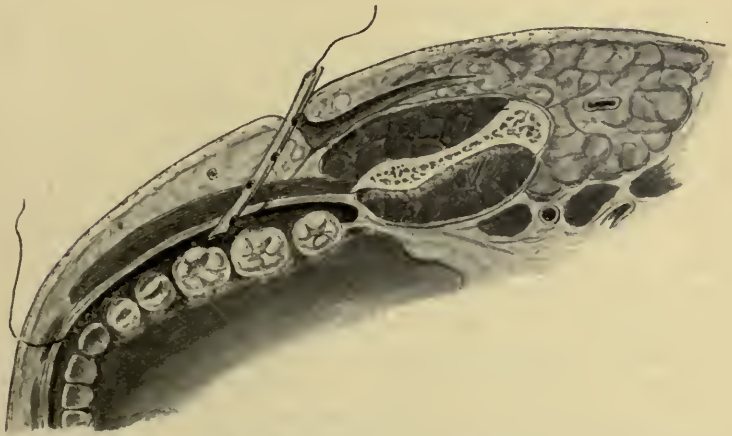


FIG. 270.—THE DRAINAGE TUBE IN POSITION FOR THE REPAIR OF A SALIVARY FISTULA. The silk thread is seen passing through the tube.

inner end in the mouth is cut level with the mucous membrane and stitched in position. The external opening of the sinus is now pared and brought together. Union of the skin wound will usually occur

readily enough as the saliva passes freely into the mouth through the drainage tube; the latter should be kept in place until sound union has taken place. If any point in the skin fails to unite, it may be touched with caustic, or may be pared and stitched up again. When union is complete, the drainage tube may be withdrawn and the flow of saliva will keep the track open.

When the fistulous opening is situated more anteriorly on the cheek, it may be possible to make an incision over the duct, dissect out its posterior uninjured portion, divide it across at the fistulous communication, and then make a puncture through the thickness of the cheek into the mouth just anterior to the masseter muscle, and pull the duct along that track into the mouth. The end of the duct should be slit up for about an eighth of an inch, so as to leave a larger orifice, and then stitched to the mucous membrane of the mouth by catgut sutures. In this way the stream of saliva flows directly into the buccal cavity, and the external wound can be pared and stitched up. This procedure, however, can only be carried out when there is a considerable length of healthy duct between the masseter and the fistulous opening; when this is not the case, the plan recommended for an opening over the masseter must be adopted, but in this case the length of the track is much shorter.

INFLAMMATION OF THE PAROTID GLAND.

Inflammatory conditions of the parotid gland are due to a variety of causes, such as the too free administration of mercury, impaction of a calculus in the duct, the spread of septic inflammations from the mouth or more general infection occurring in the course of general sepsis. Inflammation of the parotid is also the chief feature in mumps.

Acute inflammation of the parotid gland is not very uncommon after abdominal operations, such as the suture of a perforated gastric ulcer or the removal of a gangrenous appendix. The affection is almost certainly secondary to the condition of the mouth and teeth, and most frequently occurs when there is stomatitis or when the teeth are in a bad condition. It is therefore very likely to occur when the patient is very ill. By some, the occurrence of parotitis, under these circumstances, is considered to be a pyæmic manifestation, but the view mentioned above is a more probable explanation. In some cases the parotid glands are also affected after operations done under less urgent conditions.

The inflammatory signs usually appear within a few days of the operation, though they may not come on until later. Both glands are generally involved, and suppuration frequently follows. The pus at first is deeply-seated, and may be seen exuding from the orifice of the duct into the mouth, or may be made to exude by pressure on the gland or along the duct; burrowing is very likely to occur, unless evacuation is promptly undertaken. Sometimes pus formation may be absent.

When a calculus has become impacted in Stenson's duct, the parotid gland swells and becomes hard, and this may cause considerable enlargement of the gland. The blocking of the duct is usually incomplete, but suffices to cause a certain amount of hindrance to the flow of saliva, especially when that is secreted in large quantities as at meal-times. Suppuration seldom occurs.

TREATMENT.—*When the inflammation is due to the administration of mercury*, the use of the drug should be suspended at once. Hot fomentations should be applied over the swollen gland, chlorate of potash given in doses of ten grains four times a day, and the mouth washed out frequently with a gargle of chlorate of potash, or some antiseptic or astringent mouth-wash, such as sanitas or alum. The condition may or may not end in suppuration.

When the inflammation is due to a calculus impacted in Stenson's duct, the obvious treatment is to remove the calculus, when the inflammation will subside at once and the thickening of the gland will gradually disappear. The methods of removing these calculi are described in connection with salivary calculus (*vide infra*).

An abscess in the parotid gland occurring in the course of infective diseases, such as pyæmia or typhoid fever, or after an abdominal operation, should be opened as soon as it is evident that pus is present; otherwise it may burrow deeply in the neck. When opening these abscesses the external incision should be made as small as is consistent with thorough evacuation of the pus, it should be horizontal and situated behind the angle of the jaw, and should not go deeper than the capsule of the gland. As soon as the latter is reached, the knife should be laid aside and a channel burrowed into the abscess cavity with a pair of dressing forceps. When the cavity is reached, the separation of the blades of the forceps in an antero-posterior direction (in order to avoid tearing the branches of the nerve) will enable a satisfactory opening to be made, through which a good-sized drainage tube can be introduced. The subsequent treatment is similar to that for acute abscess elsewhere.

Mumps is a disease which only accidentally comes under the notice of the surgeon. Usually both parotid glands become infected within a short time of each other, and in some cases also the other salivary glands. The affection is generally devoid of danger, and the pain and swelling subside after a few days. In some cases orchitis in the male, or mastitis or ovaritis in the female, may occur as a complication; suppuration very rarely takes place.

Treatment.—Hot fomentations should be applied, the patient put on a fluid or semi-fluid diet, kept in a warm room until the inflammatory symptoms have abated, and isolated until the infectious period has passed (*i.e.* about three weeks). A simple saline mixture containing nitrate of potash and sulphate of magnesia may be administered.

SALIVARY CALCULUS.

Salivary calculus may occur in the parotid, although it is more frequent in the submaxillary gland. In the parotid it may occur in the substance of the gland or in Stenson's duct.

The exact etiology of these calculi is not clear. They are probably due to some alteration in the composition of the saliva whereby small hard masses accumulate in the duct and, if retained for any length of time, become infiltrated with calcareous salts, especially phosphate of lime; in this way the characteristic small ovoid calculi are gradually formed. These calculi usually find their way forward until they are arrested close to the orifice of the duct. Their presence in the duct gives rise to considerable inflammation of the lining membrane, and ulceration may occur. Indeed, if the obstruction persists for a long time, suppuration may take place around the calculus.

TREATMENT.—When the calculus is impacted in Stenson's duct it is usually situated close to the orifice, and then all that is necessary is to evert the cheek, pass a fine probe-pointed canaliculus knife into the orifice and slit up the duct sufficiently to admit of the calculus being squeezed out with the finger or withdrawn with forceps. The orifice of the duct is usually prominent and somewhat fixed by the inflammation, and it is therefore easier to pass a probe into it under these circumstances than in the normal state. In passing a probe it should be remembered that though the duct runs parallel to the cheek, the terminal portion pierces the mucous membrane almost at right angles, and, therefore, the probe should be passed in this direction for about one-eighth of an inch before being turned backwards along the duct.

The most difficult cases, however, are those in which the calculus is impacted at some considerable distance from the opening. Even then it can generally be pressed forward by the fingers until it is within reach, when the duct is slit up and the calculus removed. If not, it may be necessary to cut down on the calculus through the mucous membrane just in front of the masseter and to slit up the wall of the duct. No stitches need be put in, as it does not matter whether the slit in the duct closes or not. It is very important that the calculus should be removed by incision in the mouth; otherwise a salivary fistula is very apt to form.

NEW GROWTHS OF THE PAROTID GLAND.

Several varieties of new growths are found in the parotid, such as fibroma, myxoma, lipoma, or angioma, but these present no special points of importance.

THE 'PAROTID TUMOUR.'

The so-called 'parotid tumour' often consists of a mixture of tissues generally containing a good deal of cartilage, patches of myxomatous tissue interspersed with a certain amount of fibrous tissue, various glandular elements, and sometimes tissue histologically resembling sarcoma. Most of these tumours probably belong to the group of the endotheliomata, but their exact place in pathology is not definitely settled. As a rule, these tumours are firm in consistence, irregular in

FIG. 271.—INCISION FOR THE REMOVAL OF A 'PAROTID TUMOUR.'

outline and encapsuled. They often grow very slowly; the simple forms do not affect the lymphatic glands, and a cure results if the whole growth and its capsule are removed. As the tumours enlarge, they may become displaced downwards by their weight, and indeed in some cases they may pass so far downwards that their connection with the parotid gland is not recognised.

TREATMENT.—*When the tumour is small,* it can be readily removed by an incision over it parallel to the branches of the facial nerve. When the capsule is reached, the tumour is enucleated, and if in doing so any portion of it is broken off, this must be taken away after the main mass has been dealt with. Care must be taken to keep close to the tumour so as to avoid damaging the branches of the facial nerve. The scar is very slight.

When the tumour is large, the skin incision should be as free as possible because branches of the facial nerve are very apt to be adherent to the capsule of the growth, especially at the deeper part, and it is essential therefore to see exactly what is being done during removal of the tumour. When the growth is situated low down, a curved incision over the lower part of the parotid gland running forwards to the jaw will generally give good access. The skin and subcutaneous tissue are dissected up, but care must be taken to avoid injuring the branches of the facial nerve as the incision is deepened. The parotid tissue over the growth is torn through where it is thinnest; indeed, in many cases the tumour is found uncovered by gland tissue. The capsule of the tumour is thus exposed and its separation from the parotid is effected with a blunt dissector until the growth can be pulled or pushed out of its bed and its deeper connections separated. It is at the deeper part that the branches of the facial nerve are most likely to be met with.

The hæmorrhage is usually unimportant unless a vein is torn in separating the deeper parts. In that case an attempt should be made to seize and tie the bleeding point, but if this fails, it may be better to plug the wound for twenty-four hours and stitch it up afterwards rather than to enlarge the opening in the gland tissue.

MALIGNANT TUMOURS.

Malignant disease of the parotid may arise primarily in the gland or develop in a 'parotid tumour' and ultimately involve the gland. It may also occur secondarily from the development of cancerous glands in the substance of the parotid or from the spread of malignant disease by direct continuity from carcinoma of the ear or the skin.

TREATMENT.—If an operation is to be performed at all, it must be complete removal of the parotid gland, and although this is not worth while in the majority of cases, it may be done when the disease is fairly limited and after any primary focus elsewhere has been completely eradicated. The operation must, of course, involve facial paralysis; any attempt to preserve the nerve will almost certainly end in recurrence of the disease.

Excision of the Parotid Gland.—As a preliminary step, a loop of silk should be passed round the external carotid artery at its origin (see Vol. II. p. 204). This can be pulled on gently during the operation if necessary, so as to control the bleeding temporarily; the thread can be removed at the end of the operation. The shoulders should be raised and the head turned to the opposite side and allowed to fall back.

When the skin is not involved, a curved incision is made commencing above at the junction of the zygoma with the malar bone, extending along the zygoma to the front of the ear, curving downwards behind and parallel to the ascending ramus of the jaw, and finally turning forwards

again over the angle as far as the anterior border of the masseter. This flap of skin and fat must be turned forwards over the face. If the gland extends downwards into the neck to any extent, it is well to add an incision along the anterior border of the sterno-mastoid muscle. The lower and posterior part of the gland should then be lifted gradually from its bed. This can usually be done by dividing the deep fascia at the anterior border of the sterno-mastoid, gradually separating the tissues with the handle of the knife and pulling the gland forwards. After a time the external carotid artery is exposed as it passes beneath the gland, and this vessel should be clamped and divided. The facial nerve enters at the posterior margin and divides into two main branches, the temporo-facial and the cervico-facial, and should be saved as long as possible, but it is usually out of the question to retain any part ultimately. The deeper lobules of the gland which pass between the mastoid process and the ramus of the jaw and between the internal and external pterygoid muscles are best enucleated with a dissector, great care being taken to avoid injury to veins which might be a source of very considerable difficulty and danger. The shelling-out of the deeper part of the gland is facilitated by pulling the jaw as far forwards as possible. The anterior part of the gland is superficial and is readily removed. The divided end of Stenson's duct should be ligatured with catgut, the bleeding points secured, and the wound stitched up, a drainage tube being inserted at the lower angle.

When the skin is implicated, a wide area must be taken away, and it will be necessary to turn in flaps from the neck to fill the gap.

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